Technical Arts 101
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Lecture - 35
Lab Session – 07

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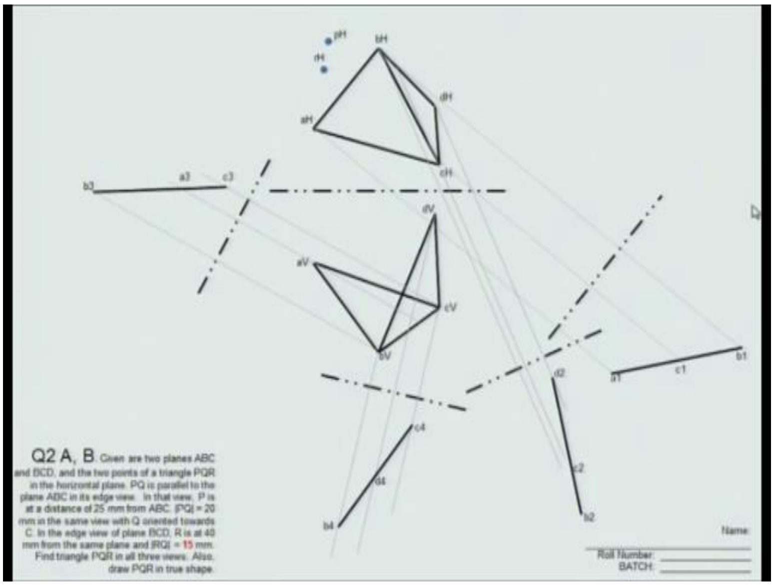

So, this is a problem on lines and planes. When I was working on this problem I did not realize that, this problem would have become very interesting and very challenging. In particular because we have multiple solutions with this problem and I will talk about them as I move long.

So, the question the problem statement is this, given are the two planes a b c and b c d and the two points of the triangle p q r. So, point p is here, point r is here in the horizontal plane, p q is parallel to the plane a b c in its edge view. In that view p is at distance of 25 millimeters from a b c. So, remember that a b c in the edge view the distance p q is 20 millimeters in the same view, with q oriented towards c. Now, this is important, point q is such that it is oriented towards c in the edge view of plane a b c.

Now, in the edge view of plane b c d, point r is at 40 millimeters from the same plane and the distance r q is 15 millimeters. But, the question is to find the triangle p q r in all three views? Also you need to find p q r in true shape? So, we are talking about two edge views edge view of plane a b c and the edge view of plane b c d.

Now, if you look at the view in the vertical plane and the horizontal plane, it is possible for us to extract the edge view from the vertical plane or both these planes. And the edge views of both these planes from the horizontal plane. So, they are going to be two edge views of triangle a b c and two edge views of triangle b c d, and the moment I say that I refer to multiple solutions to this problem. Let us try to explore all possible solutions to this problem.

So, we start with the hinge line that would separate the horizontal plane with the vertical plane, and then we start extracting the edge view of b c d from the vertical plane. So, we take a horizontal line, we take the projection of this point in the top view. So, this is in the third angle setup, we get this true length of this edge, we take the projection of this point.

Draw hinge line perpendicular to this projection and then we start projecting these points to get the edge view of b c d. For that we need to measure distance b or we need to measure vertex b from this hinge line and transfer that distance on to this projection here. Likewise, we need to measure this distance and transfer this distance here. And, similarly, this distance needs to get transferred. So, we transfer all these distances and we get the edge view of the plane b c d, we call them b 1 c 1 and d 1 here.

Likewise, if we extract the edge view of plane a b c starting from the front view, very similar procedure. Project this point upwards get this in true length, extend this projection, draw a hinge line perpendicular to this projection and then project a parallel to this projection line b as well as c. And then transfer these distances over here.

To get the edge view of plane a b c, we call this a 1 b 1 and c 1. We will have two more edge views 1 for b c d and the other 1 from a b c, starting from the top view, let me quickly go through the construction identically similar to what we had seen before.

So, we transfer distances now. And here we get another edge view of plane a b c. And, likewise if we draw horizontal line, take this projection down, get this length in true length extended, draw a hinge which is perpendicular to this projection. Project the rest of the vertices b and c, and transfer distances. We would get the edge view of b c d. Now, come back to the question, we are required to work with the edge view of a b c and also the edge view of plane b c d.

So, we can choose any of these edge views for a b c and likewise any of these edge views for b c d for example, if you choose this as a b c edge view of that, then we can work with either this and this, or if we choose this as an edge view of a b c then again we can work with this and this. So, we have four possible combinations. Let us try to investigate each combination 1 by 1.

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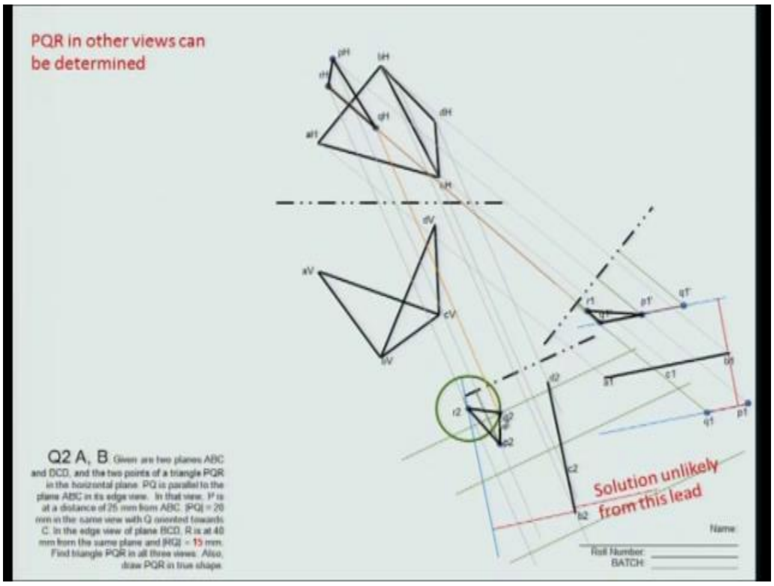

So, let us say we start with this combination. Now, let us go back to this line here. p q is parallel to plane a b c in its edge view, so p q is supposed to be parallel to this line here, and in that view p q is had distance of 25 millimeters from a b c. So, p could lie either on this side of the edge view of a b c or on this side.

But, for that or before that, if we are working with these two views, let me project starting from point p and r. These projection lines, which are parallel to these projection lines, and let me also project a projection line which parallel to this projection line here starting from p h. Now, as i said before, p is at a distance of 25 millimeters from a b c.

So, p could either lie on this side of a b c or on the other side of a b c. Now, p also needs to lie on this, on this projection line. So, we will have two possibilities for p in this edge view, this is the first possibility, this is second possibility. Possibility represented by p 1 and this 1 represented by p 1 prime.

Now, the second statement, the distance p q is twenty millimeters in the same view and q is oriented towards c. So, if I choose p 1 as this point, I will have to move towards c at a distance 20 millimeters and mark point q. So, this is q 1, likewise I can either go this way or this way. Now, if I go this way, it makes more sense because then I am traverse towards c. So, I can choose this as my point q 1 point or if I want to go this way, which slightly contradictory with this statement that p q needs to be oriented towards c. Well I can I can do as well, but before that it may start working with edge view of b c d.

Now, here I have need locate point r r is at the distance of 40 millimeters from the same plane that b c d, so r can either be on this side or on this side of the plane. So, r would be line either on this blue line, and if I consider r to be lying of this blue line. If I take a projection starting from r h over here parallel to this projection line, the intersection, this projection and the projection blue will give me a unique point r 2.

Now, I measure this distance assuming that, I chose q 1 prime here. So, notice that this view is common between this view and this view. So, my q 1 in this view or my q 1 this view has to be a line on this line, which is at a distance measuring this 1 here, from this hinge line. So, q in this view will be lying on this line.

If I choose this, has point q 1 again something very similar. I will have to transfer this distance over here and, so q 1 will be lying on this line. And notice that if I am to draw a circle of radius 15 millimeter, that circle center of this point here will not be intersecting either this line or these line solutions where q 1 plane here and q 1 are not feasible. Then let me explore this point here q 1 double prime. If I take this distance transferred over here, my q 1 double prime is going to be lying here on this line and, if I draw a circle centered over here with radius fifteen millimeter, I will get two possibilities 1 is this, and the other 1 is this for q to be identified in this view.

So, let me identify this as q two. And to locate p in this view again something very similar noting that, this view is common between this view and this view. I measure this distance and transfer it on to this projection ray here, and this would help me identify p two. So, I have identify the triangle p q r here, and if i project q back from this view, so that this projection line in orange is parallel to this gray line here, and if I do something like very similar.

Project q 1 double prime backwards noting that this projection line is parallel to this 1, the intersection of these two projection lines will help me identify q h and the horizontal plane or the top view. So, will I have this triangle p q r here? And to identify r in this view is very simple, I measure this distance, I have already have this projection from r, I transfer this distance over here.

So, this is me r 1 and this is my third triangle. As I said before solution is not likely from this lead because if I look at this projection over here, this projection is not going to be participating with reference this line. And then p q r in other view, it is can be easily determined. So, once I have p q r here, p q r here and p q r here, it is also not going to be difficult for me to compute the true shape or identify the true shape of p q r.

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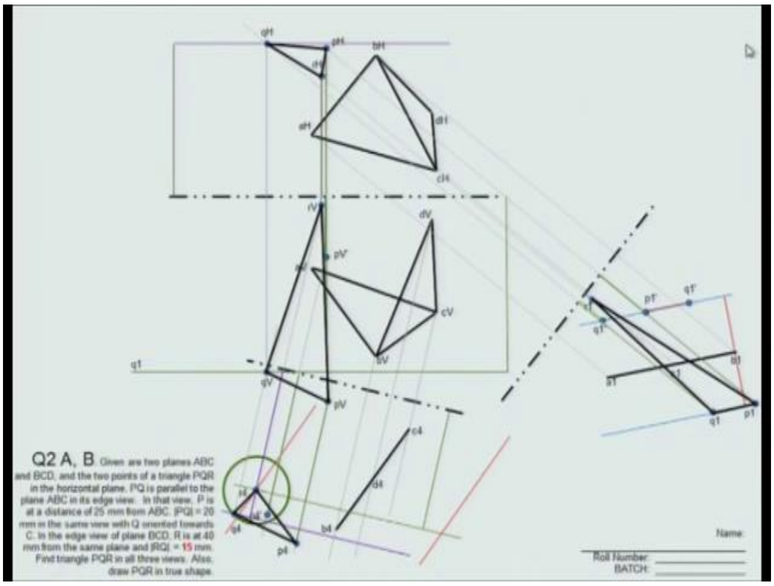

Now, let me explore a different solution. So, edge view of a b c is here, and edge view of b c d is here. It is a different edge view of b c d, that I had considered before. Again projectors from p parallel to this projection line p is either going to be lying on this side or on this side. p is either going to be lying on this blue line or the blue line below. This is something that you know there are two possibilities 1 is p 1 here, the other 1 is p 1 prime here.

This is the first possibility for q, this distance is 20 millimeter second. Possibility for q is here, and the third possibility for q is on this side. Now, note that all these three possibilities, this 1 is the only feasible possibility. And so is this 1, this 1 will not give you solution. Although, I have discussed the solution in the previous slide with q 1 double prime as one of the candidate solutions for q 1 this 1 and it will not give the solution.

Anyway, let me proceed. So, I measure this distance, I drop a vertical projector from p here, and then I will identify my point, my point p in this front view. A horizontal plane, this distance is the same as this distance, if I am to work with p 1 I measure this entire distance. Extend this vertical projector down and I will have corresponding p v point here. Now, r is that forty millimeters from the edge view of b c d.

So, we have the edge view of b c d here 40 40 millimeters from here on this side, 40 millimeters from here on this side. So, will have two possibilities and r is going to be lying on one of these possibilities. Now, I already have r positioned in the top view. So, I can measure this distance. Now, this view is common between this and this view. So, r is going to be lying at this distance away from this hinge line and this distance is the same as this one here.

So, essentially r is going to be lying on this green line here. So, there two possibilities, this point and this point for r. So, let me mark them as r 4 and let me worry about this solution over here. Now, I draw a circle of, yes 15 millimeters centered at this point. I still have not been able to locate point q, which is going to be tricky thing here.

Now, if I need to locate r in the front view, I need to extend this or this projector here, and I need to extend this projector from this point r. Now, this projector is going to be parallel to all these projectors here. Intersection of this projector and this one will give you a point r v and the vertical plane or the front view.

I now draw this projector parallel to this one I already have this distance, no identified. I transferred this distance over here and identify point r in this view, where a b c is in the edge view. I measure this distance over here and I transfer this distance here to identify this point p 4 prime and I can do something very similar with this point. So, again, so notice that, there two possible solutions for point p and the front view or vertical plane.

So, this is the first possibility and this one would be the second possibility. So, this distance here from hinge line is the same as this distance here. Notice that, this is point p 4. So, got p 4 here, r 4 here, I got these p’s here q’s and the r’s. Now to get q, which I have not been able to locate as of now, let me try to explore possibilities from all these q's. That is q 1 double prime q 1 prime and q 1. I measure this distance, now I transfer this distance over here.

So, in the front view my q will be lying on this horizontal green line. So, q 1 double prime is going to be lying on this green line here. I extend this projection over here and to identify q, I do not have a straight forward method. So, what I will do is I will go for the hit and trial approach to determine q and this is what I would do. So, let us say I would take some distance, and I will formalize this method later on. So, let us say I will take this distance and assume q to be lying on this lying here, and q also needs to be lying on this circle. So, there is two possibilities, possibility 1 and possibility two.

Now, this distance would be the same as this distance, and if I draw horizontal line q in the horizontal plane or top view will be lying on this line. And from here, q has to be lying on this projector. So, q will be lying over here, I will take this projection down and I make a projection, which is parallel to one of these projection lines over here. Assuming that, this is one of the solution of q q 4 double prime and I will be able to then identify point q in the front view q v double prime and, of course the corresponding projection in the top view will be this point here q h double prime.

So, this is the first triangle I am looking for second triangle, I am looking for the third one and the forth one over here quite complex. Now, if I take this as alternative solution q 1 prime measure this distance, my q 1 prime is going to be lying on this horizontal line in the front view again the hit and trial approach. Now, assuming that if I have q 1 over here, I measure this distance, go on to my top view q 1 prime is going to be lying here somewhere and if it intersects with this projection line, which it has to. So, I will be able to identify q 1 as this point.

Now, if I take this second alternative solution, this distance would correspond to this distance correspondingly q is going to be lying on this horizontal line. Here, in the top view I take this projection down from here, the first possibility and I will make a projector parallel to this projector over here, and ideally I would assume that this projector is going to be intersecting with this circle, but that is not apparently happening.

So, would this distance or this solution over here give me a unique position for point p? I will say no, likewise, this point here the intersection between this horizontal line and this projector emanating from q 1 prime projected down to lay on this position here. And from here, if I draw a projector parallel to these guys with this projector, also intersect with this circle again, the answer is no. So, these two are not possibilities or they are not possible solution for q.

So, this distance and this distance they would be unlikely to be giving me a solution for q and, therefore, the corresponding triangles p q r will not be possible for us to find. Again, so here I have use the hit and trial approach to determine q. Let me start with q double prime over here, or rather let me start with q 1 here. So, I measure this distance and correspondingly in the front view my q is going to be lying on this horizontal line. Again, let me go for the trial and error approach. So, let me assume this distance.

Let me draw a line which is parallel to this hinge line over here. So, I have two possibilities to identify, q 1 is at this point the other one is this point the intersection point between this line and the circle and since this view is common between this one and this one, I can transfer this distance over here and realize that my q h is going to be lying on this horizontal line.

Now, noting that I am getting this projector already from here q 1, the intersection of this projection line with this horizontal line will be a solution for q here. And if I drop a perpendicular I will have one solution over here that is going to be nicely related to this scheme of things in this view.

So, I have identify q 4 here, correspondingly q v here, q in the front view correspondingly q h here, q in the top view and, therefore I have been able to identify the triangles p q and r and all four views. Once I have been able to do that, determining the true shape of p q r should not be difficult. Once again I have use the hit and trial approach to determine q.

So, the previous two solutions where done with the edge view of a b c somewhere here, now we change things. Now, we consider this as the edge view of a b c and we perform something very similar with the edge view of b c d. So, by now the dynamics of the problem is clear to you, I will try to briefly explain what is happening.

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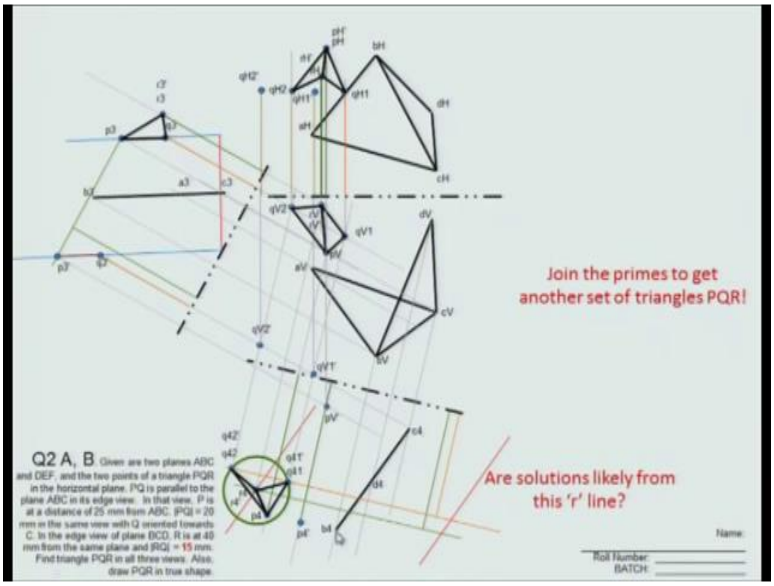

Distance is 25 from a b c, p will be lying either on this horizontal blue line or the blue line on the other side. So, by the way this is not horizontal this is parallel to this line here a b c. Now, we measure this distance, this view is common between, sorry this view is common between this 1 and this 1.

So, this distance gets transferred over here, so p will be lying on this edge or on this line and, of course p is either going to be at this point or at this point. Let me call them p three and p three prime. Now, it is much clearer that if I identify q three, I will have to identify q three in such a way that we travels towards point c.

So, of course this would be 1 possibility for q three, and this would be the second possibility for q three. So, let me call this q three prime, of course q three or point q cannot be located over here or over here that is moving away from c three not towards the c three. Now, in the edge view b c d, r is to be lying at forty millimeters from the plane, we measured this distance, this view is common between, sorry this view is common between this view and this view.

We measured this distance, transfer this distance over here. So, r is going to be lying on this red line as well as this green line, of course r is then going to be lying at the intersection between these two lines. So, we uniquely identify r. So, we call it r 4, project that onto the front view, extend this projection over here, intersection of these two projection will give me r v point r in the front view a vertical plane.

And, if I draw a circle with centered at r four radius fifteen millimeters on this circle is where q is going to be lying. Let us try to identify q now. So, if I take this as one of the possibilities, draw a projector parallel to these projections, measure this distance and transferred over here, of course q is going to be lying on this horizontal line, sorry this orange line and since q also lies on this circle. So, we have two possibilities, one over here, the other one over here.

Let me mark these possibilities as q 4 1 and q 4 2. So, appreciate how complex this solution to this problem becomes, if I project this point backwards, this would be my first candidate q in the front view q v 1, the second candidate for q in the front view q v 2. If I project these guys on to the top view and if I measure this distance transferred over here, this where I will get q h 1. Likewise if I do something very similar I will have q h 2 so plenty of possibilities for q.

Starting from the same point here, identifying p will not be difficult, because p would be the intersection between this projector and this projector. And if I extend this projection line, parallel to this one this distance is the same as this distance. So, I have identified p 4 here. So, looks like I have been able to identify p q’s and r’s in all of these or possibly not, so we have r three here, this distance the same as this distance and then we have a bunch of triangles p q r’s. So, you will have to be a really careful if you are attempting to solve this problem it is not straightforward.

Now, if I look at this as one of my candidate solutions. Once again this distance is the same as this distance. So, q 3 prime will result in two points here q 4 1 prime and q 4 2 prime, which are going to be the same as q 4 1 and q 4 2, but p will be different. A projector parallel to these projectors over here from here p 3 prime and a projector which is vertically downward intersection of these two will give me p v prime and you know how to get p four prime. So, I would not worry about that very much.

So, looks like r 4 prime and r 4 will be the same and three prime and r will be the same. A little more exercise will help you appreciate that, this is another self-solutions, and those solution would come through the primes. You know, q 3 prime, 4 2 prime, 4 1 prime. So, you can join these primes to get another set of triangles p q r. So, this entire setup becomes lot more complex.

The bottom line is we want to appreciate how many possible solutions are available to us? Another question. So, we had considered only this line as the line carrying r 4. Now, the question that you would want to answer yourself is, are there solutions possible with point r lying this line at 40 millimeters on this side of b c d?

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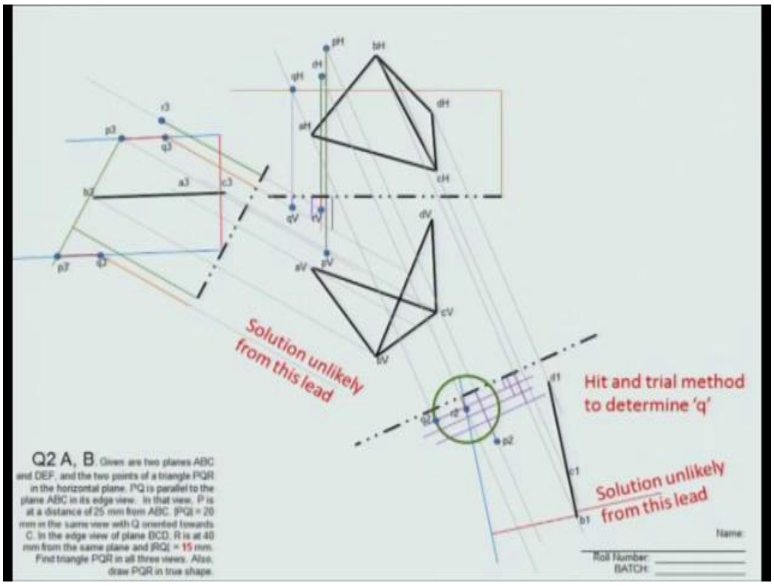

Final, set of solutions edge view of a b c here. A different edge view of b c d p to be lying on this side or on this side a distance 25. Measure the distance, transfer the distance, you know about this. Two possibilities for point p, p 3 and p 3 prime and of course q 3 will be towards z. It will be chosen towards z on both these lines so we have q three and q 3 prime and these distances are 20 millimeters.

Now, from here, I draw projectors parallel to these projectors over here. So, in this view point's p and r will be lying on this projectors to identify the r, r is that 40 millimeters either on this side or on this side. And since r also lays on this projection line r will get determined as the intersection between this blue line and this gray line here, alright.

So, this is the circle of radius fifteen millimeters centered at r two here is in my opinion not likely to find a solution from this lead. So, we will not worry about that. Now, from here I will draw a projector parallel to these projectors, hoping to identify point q. In other views, measure this distance and transfer this distance on to the top view, realizing that point q is going to be lying on this horizontal line in the top view. Now, here let me formalize the trial and error method to determine point q.

So, what I will do is, I will choose a bunch of vertical lines rather distances. Assuming that q would be lying on this ray and then do something about those distances. So, I draw a bunch of those distances. Assuming that this is 1 possibility, this is the second possibility, this is the third possibility. For us to identify q in the front view now notice that this view is, rather this view is common between this view and this view. Therefore, these distances, they get transferred on to this view which is precisely what I am planning to do.

So, I am planning to transfer this distance this one and this one over here. I already transferred one, the second one, the third one and I draw these three lines which are parallel to this hinge line. So, realize what is happening, so I see a bunch of points or intersections between these lines and the circle all of these intersection points giving the impression that these are the possible solutions for point q on this view or rather in this view.

Now, if I need to identify point q in this view, it will have to be lying on a ray which is parallel to this or rather these projection lines. And if I choose this as 1 candidate solution, I have to project this point along this direction and, of course point q will be then lying over here, intersection between this gray line and this orange line. This intersection would correspond to this distance. So, would this system be the same as this distance looks like it would?

And therefore, we have one solution q v here. Once we have the solution q v, it is straight forward for us to find q h and then let us try to identify point p. Now, we have measured this distance point, p is going to be lying or point p would be the result of the intersection of this vertical projector and this projector over here p v. This distance gets transferred over here and this would also lie on this projector line.

So, therefore, this would be point p 2 and, of course this is point q 2. So, we have p q r available over here, p q r available over here. Do we have p q? And r available over here looks like we do not have r in this view. Let us try to identify that, now r in this view will be such that it will be lying on this vertical projector and this distance would be the same as this distance.

So, this is point r v here and r would also be lying on this ray, which is parallel to all of these projectors here. And how do we identify r along this ray? We measure this distance transfer, this distance over here and this is my point r three. We can do something very similar with q three prime, measure the distance and it would be an exercise for you to figure if the solution is possible from this lead or not.

And the clue is at this distance, is not of sufficient length. Now, we can do something very similar with this as the candidate point for q. Now, what we can do is, we can start with the projector and start with measuring this distance and, of course this distance would be the same as this distance over here. So, the corresponding q h will be again lying on this horizontal line.

Now, it is an exercise for you or let this be an exercise for you to find possibilities with this as the candidate q 3 and this view. In my opinion a solution is quite unlikely from this lead. Now, for that, you need to figure what is happening in this view. In particular this distance over here, well, I will let me, let me stop giving clues to you, you might figure it this thing out yourself.