Technical Arts 101
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Lecture – 26

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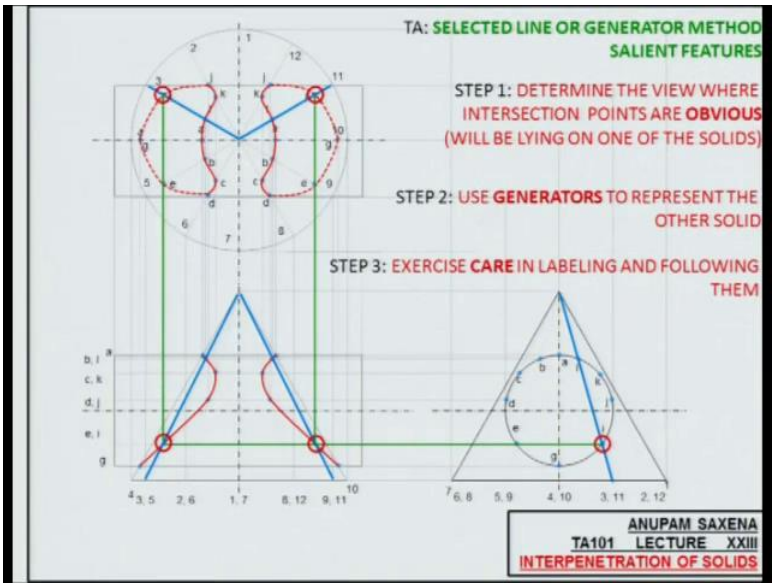

So, last Tuesday I had introduced to you 2 methods to find the intersection between 2 solids. The first one was the select line method or the generator method and the second one was the cutting plane method. So, here is a little revision. So, the first one is the generator method; important points or salient features. Step one that something which is critical you have to figure out the view where the intersection points are obvious. And the way to figure that thing out is to figure; if the intersection points are going to be lying on one of the solids; look at the front view, look at the top view and look at the profile view. And you will figure that your intersection points will be lying on this circle in the profile view. So, once you are figured that thing out; the next thing you would do is you would generate a bunch of lines that would represent the surface of the other solid; you would generate again a bunch of lines that would represent the surface of the other solid. And that is the reason why they name the generator method or the select line method.

Step 2 use generators to represent the other solid. For example, this line, this line would be a line on the slant surface of the cone. So, this line is 3 11, line 3 11; in fact these are 2 lines; the first one is towards you and the second one is away from you that is behind

the cone right. So, first one is towards you, the second one is behind the cone. And the best way to visualize this in the front view is this. So, this is the first line; line 11 and this is the second line, line number 3. So, this line that is on the slant surface of the cone is in fact representing 2 lines in the front view. And in the top view of course if you project this guy over here this would be line 11 and this one here would be line number 3 ok.

Step 3 and this is something which is important; you have to exercise care in labeling and following them. If you do not label these lines properly and these intersection points properly it will be difficult for you to connect the dots later on. Now, Basu was asking me this before how did I connect these intersection points here and here. So, if I look at the intersection points on the circle in the profile view; I go a, b, c, d, e. So, I go in order and I follow the same order in the front view as well as in the top view. So, I go a, b and then c and then d and then e and so on; likewise here a, b, c, d and so on.

Now, if you notice from this height and above; this part will be visible in the top view. So, this part is going to be visible in the top view and from d onwards from this height down below; these guys will be hidden they will be invisible; that is the reason why these lines are shown using hidden lines or dotted lines. So, you have to be very, very careful in following the labels properly. Because if you do not then you will mess up the connections between dots, between the intersection points all right. So, once you have all these lines ready you figure out the intersection. For example, this is one of the intersection points I call it i; I project it on to the front view. Now, these are in fact 2 intersection points again one is towards you and the other one is behind the cone. So, this intersection points get gets mapped at these 2 points in the front view. And these intersection points lie on lines or generators number 3 and 11 respectively 3 and 11.

Now, which of these 3 and 11 generators is towards you; is it 3 or is it 11? If you stand here and if you look at this view which one of these will be towards you?

Student: ((Refer Time: 05:50)).

So, once you have these intersection points map them on to the front view. So, this one will be lying on generator 11 and this one will be lying on generator number 3; importantly do not miss any intersection point, all right. So, this was the select line method or the generator method. And works only when the inter section points are obvious in one of the views; the other method was the cutting plane method. And look at

these views for example and the method works better when the intersection points are not obvious; and I will give you an example later today ok. Step number 2 you should know what the intersection between the cutting plane and solids yield. For example, if I you know cut through this assembly of the cone and the cylinder through these horizontal planes; the intersection between the cone and the horizontal plane will be a circle of course. And the intersection between the cylinder, this cylinder and the horizontal plane will be a rectangle. So, eventually determining intersection would boil down to determining the intersection between the circles and the rectangles in the top view. So, this step is critical; you should know what the intersection between the cutting plane and solid yields ok.

Let us take an example. So, let us take plane d slicing the assembly of cone and cylinder. So, corresponding to this plane, the intersection between this plane and the cone gives me a circle; and the intersection in this plane and the cylinder gives me a rectangle. So, in the top view how many intersection points could you see? You would see 4 intersection points. So, you need to compute the intersection number 1, number 2, number 3 and number 4; these intersection points are going to be lying on which plane in the front view; plane number d, plane number 4; project points of intersection to the respective planes. So, you are going to be drawing a bunch of lines, a bunch of circles, a bunch of arcs. And you know somewhere in between you will be thoroughly confused and you will be like all right. So, be very careful and that is where labeling happens to be very important all right. So, all you need to do is project these points down on to the respective plane and in this case these are the 2 intersection points in the front view.

So, summary of what we had discussed on Tuesday? Notice here that you will have 2 other intersection points on the back side of the cone; which ones are going to be in the front, this one or this one which ones are going to be at the back these 2 guys ok. Once again do not and do not miss out on any intersection point; otherwise your connectivity will not be proper. So, the connection or these contour or rather these contours will not be proper all right.

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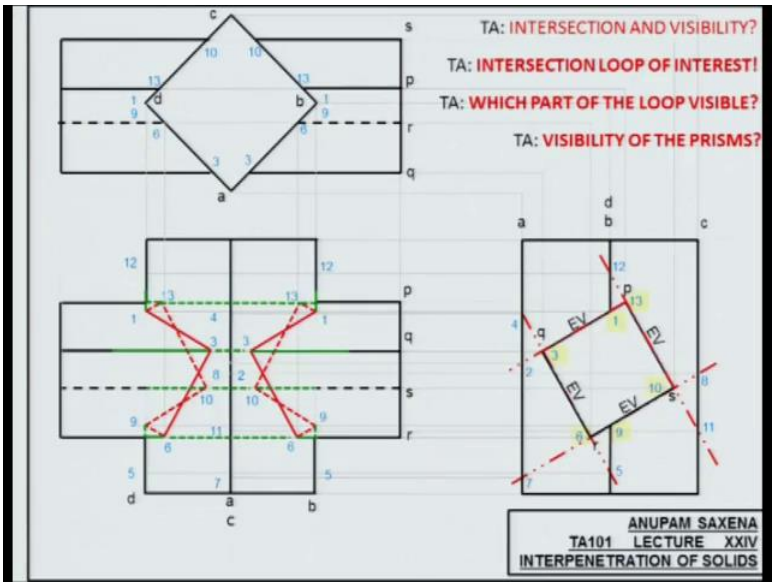

Another example and I give you a slightly different angle to solve this. So, this is the example of determining the intersection between 2 prisms, 2 rectangular prisms; one is vertical, the other one is horizontal. Inspect the 3 views are the intersection points obvious, are the intersection points obvious; yes or no?

Student: Yes sir.

Yes; from where do you think you would be getting intersection points?

Student: ((Refer Time: 10:28)).

Profile view, wonderful. But I will so you can use the generator method to solve this but I will give you another method. And this is something along the lines of the lines and planes the concepts that you had learnt in previous lecturers hopefully. First thing you would want to do is start labeling. So, p, q, r, s is this prism that is penetrating the vertical prism inside. So, p is actually a line and source q and source r and source s ok. So, p is this line, q is a line which is closer to you or away from you it is closer na; r and then s is another horizontal line which is away from you. So, if you go on to your top view line p appears here, q appears here, r again at the center and s on to the top all right; label the vertical prism in the front view; so a, b, c, d. So, this is a, b, back side or the back edge c and d; likewise over here a comes from here, d comes from here the center, c

comes from the top over here and d again at the center. Step one you have to do labeling properly ok.

Now, you can think about these 2 prisms as being composed of 4 different planes a, b, c, d is composed of 4 planes and p, q, r, s is also composed of 4 planes all right. So, the problem boils down to figuring out the intersection between any 2 planes. So, it is like a plane, plane intersection; notice again that in the profile view p q, q r, r s and p s they happen to be in the edge view. So, this plane, this plane and this plane here they happen to be all in the edge view; in the profile view. So, it is easier for us to figure out the intersection between planes and planes; if we have a view where one of the planes in the edge view na all right. So, extend this plane p q; where do we expect the first point of intersection? So, if you are trying to figure the intersection between 2 planes a b and p q. So, this is plane a b and this is plane p q; where do you expect your first point of intersection to be? Here, it is quite obvious na, it is quite obvious.

Now, this point of intersections lying on which of the edges, which of the edges in or on the vertical prism a and do not miss any intersection point a and would be a b and d na. So, one point is here, the second point is here; all right. Now, this point intersection correspond to this point will not be obvious and that is the reason why I had extended this plane. Now, it is easier for me to locate this intersection point. So, this intersection point will be lying on edge a point number 2. But the intersection is actually happening here; but before that plane plane inter section would give me what a line; intersection between 2 planes implies a straight line. So, one line would be this one joining one and 2 the second line will be this one joining one and 2 all right.

Now, my actual intersection is happening here, right. So, if I extend this edge q s these are the 2 points were my were my actual intersection is happening all right; this is like a pseudo intersection point, this not the real intersection point; this is where the actual intersections are happening these 2 points, having set that it is actually the edge q which is going inside which is kind of you know hampering this intersection from happening. So, you need to extend edge q from both sides because edge q is going to be visible in the front view; second guy intersection between which of the 2 planes q r and…

Student: ((Refer Time: 16:22)).

Well, are you, are you solving the intersection between 2 planes or 3 planes; notice this is q r and q r is intersecting with plane a b and plane a d on the back side. So, be very careful and that is the reason why labels help all right. So, extend this one obvious intersection point is point number 3, this point on the vertical prism is going to be lying on edges b and d. So, this point 3 will lie here, this point 3 will lie here and this pseudo inter section point that will lie on a. If I call it point number 4 extended they lie here; again intersection between 2 planes will give me a straight line; in this case that straight line will be joining points 3 and 4 I will get one of these and the second one of these ok.

Once again this is not my actual intersection point, intersection; actual intersections are happening over here all right. So, my intersection lines they get extended only to this point r s, point number 5; project that point number 4 and 5 they will be essentially here at the same point p q extend that get the pseudo intersection point number 6; project that your point number 6 will be here; relatively simpler example. Now, notice that the intersection between plane r s and the back side of the vertical prism is hidden. And so is the intersection line between p s and the back side of the prism. And they are hidden precisely behind these lines and that is the reason why they are not visible. So, that something that you will have to keep in mind all right.

So, the horizontal prism is penetrating inside the vertical prism. So, you will have a hidden line there, a hidden line there and a hidden line there. Notice how these 2 points they correlate with the top view. So, if you take the projections up from these 2 points this is where they occur.

Student: ((Refer Time: 19:15)).

Would not they be a hidden line.

Student: ((Refer Time: 19:20)).

That is what my next questions think and analyze; what you have to think about or what you have to say about these hidden lines; this one, this one and this one are they going to be there or are they not going to be there, are they going to be there or are they not going to be there?

Student: ((Refer Time: 19:41)).

I for the drawing na think about that all right. So, let me do a little what we say in I I T Bombay ((Refer Time: 20:01)); you know what ((Refer Time: 20:03)) is so it is one of the linger words in I I T Bombay. So, this was a relatively simpler example. So, let me rotate this horizontal prism by some angle and see how interesting my problem becomes. I rotate it clockwise by some angle; similar story intersection between 2 planes, 4 planes forming a vertical prism, 4 planes forming a horizontal prism; the labels happen to be the same you know p q, q r, r s and p s they all happen to appear in the edge view in the profile view. So, it is kind of obvious for me to extract the intersection point information from the profile view having said that. Now, of course when I rotate this horizontal prism p, q, r, s the corresponding projections in the front view and the top view will change na ok; first intersection point; we need to figure out the intersection visibility of both the prisms extend this prism. So, you will have one intersection point, pseudo intersection point. Now, do you say that the first intersection point which is kind of obvious is going to be this one; yes where is that intersection point going to lie?

Student: ((Refer Time: 21:47)).

b d all right; this is my second section point pseudo intersection point not real; project this guy on to b and d. So, this is one and this is one. So, notice that I am labeling my intersection points as I identify them and as I project them on to different views. Because if I do not you know what is going to happen; project point number 2, point number 2 is going to be lying on edge a not c but a; intersection of 2 planes they give me a line. So, the real intersection is going to be happening here at point number 3; likewise over there at point number 3 I am not formulizing my drawings as yet; I will go forward I will extend q r. Now, in this case I do not have real intersection points here and here. So, I will need to extend this plane on both sides till I hit the 2 edges of the vertical prism ok.

Pseudo intersection point number 4 and number 5; 4 lies on edge a project that this is where my 4 is, 5 lies on b and d project these. And this is where point number 5 a points number 5 they lie; straight lines joining 4 and 5. So, if you extend this plane 4 and 5 will be the actual straight line between the 2 planes that will be representing the intersection 2. This is point number 6 which is the actual or real intersection, and point number 6 is going to be lying on 4 5, here and here. Point number 6 is there and 6 is there with me. Let us continue, extend this guy once again we will get 2 pseudo intersection Points; number 7 and number 8. 7 lie on a, 8 lies on edge c of the vertical prism. Project 7; 7 lies

on a, 8 lies on c the back side the back side, alright. So, 7 and 8 will be a straight line alright.

Point number 9 this is where the actual intersections happening. Project that number 9 would lie on b and d. So, 9 would lie here on b and it would lie here on d. And the actual intersection line will be the line joining points 8 and 9 there and there. But this one is the actual intersection point. So, if I project that identify this 10, if I project that point number 10 is here and here, messy already messy. And the final planes extend P S; identify that intersection point is 11, this one as 12. Project 11, 11 is going to be lying on the back side of the vertical prism c and 12 will be lying on b and d. Join 11 and 12 or maybe join 10 and 10 and 12, in fact they would essentially happen to be on the same straight line. So, join 11 and 12, the actual intersection is happening here 13; 13 lies somewhere over here and here. Once you have identified these intersection points, now you need to connect them. Which ones of these will be real, which ones of these will not be real? All those points which lie on the horizontal prism, for example, 1 3 6 9 10 and 13 they will be real intersection points ok.

Number 1, number 3, number 6, number 9, 10 and 13. Once you identify the loop, the connectivity, you can connect the dots in the front view. Now, 1 2 3 is that line going to be visible? 1 2 3 line 1 3 is that going to be visible? Well of course, you need to project these intersection points up, that is something which is going to be a little tedious but you should be able do those. This would be an exercise for you alright. So, line 1 3 that is going to be visible. How about the next one 3 6, 3 6; is that going to be visible? Now, 6 to 9 will be a hidden line, because it is going to be on the back side of this prism. If you are looking at the assembly from here this guy is going to be behind. 9 to 10 visible, not visible? 10 to 13 visible not visible? Hidden, 13 to 1 you need to be a little careful because.

Student: ((Refer Time: 28:50)).

13 this guy here, although it might appear to you that this would be visible actually these 2 points are lying on the back side of the vertical project. So, be very careful be very careful, this would be hidden. So, you know the previous example was quite straight forward you know this line and this line they merged, this line and this line they merged.

And you actually got a very nice v shape thing na. This one is quite tedious so very nice example of how labeling helps you connect the dots better, yeah.

Student: ((Refer Time: 29:40)).

You can, if you want to…

Student: ((Refer Time: 29:54)).

Easy less messy yeah you can, alright. You figure out the visibility of the prisms now. Figure out the visibility of the prisms. So, you know the concepts from lines and planes the visibility try to figure that thing out. I would not say a word I just keep flashing different lines which are going to be green in color. This going to be visible, that will be visible, this will be visible, this one here will be hidden. Why is that?

Student: ((Refer Time: 30:54)).

S is on the back side yeah. This guy here, this line here is hidden and so is this line. Mirror image the same thing and you will get the result. This line is going to be hidden P is inside or P is penetrating the vertical prism. And what about 3, 3 10, 10? This guy and this guy yeah.

Student: ((Refer Time: 32:11)).

If they are equal in size, yeah.

Student: ((Refer Time: 32:31)).

No it was no, in that model it was a cone that was cut it is quite obvious, yeah.

Student: ((Refer Time: 32:47)).

What? Come again yeah.

Student: ((Refer Time: 33:08)).

Which one have been cut and which one has not been cut? If they are of the same size no, yeah.

Student: Both of them are solid, ((Refer Time: 33:25)).

So, they should be, so you are saying that there should not be any lines here because, you have you do not have much clue about which one is penetrating which one.

Student: ((Refer Time: 33:56)).

This could be a single piece yeah, this could be a single piece yeah, true true. So, the question is this; so given 2 prisms the horizontal one the vertical one how do you figure which one is penetrating the other one ok. Number one, question number 2 or related question is what if the entire thing is a single piece that none of the prism is penetrating the other one. So, if the latter is the case, then these horizontal lines may not be shown. But if the former is the case then you need to show those horizontal lines. And the q has to be derived from the 3 views that are given to you. The clue has to be taken from the 3 views which are given to you.

Student: ((Refer Time: 35:10))

I have not actually shown the intersection the top view; have I?

Student: ((Refer Time: 35:34))

Yeah; so no so you guys are in a habit of getting everything on the plate na do not, you figure it out. We have to be some thinking and analyzing that you need to do. So, if you are going to be using or if you are going to be drawing these lines of course, you need to figure out the corresponding lines, whether they are going to be there or not in the top view.

Student: ((Refer Time: 36:06))

You figure it out. I have to go, how does the 3 views communicative if one of the solids is penetrating the other solid? What if I give that information that one of the solids is penetrating the other solids? Then it is going to be clear, otherwise not going to be clear. So, assume that I am going to be giving that information to you.

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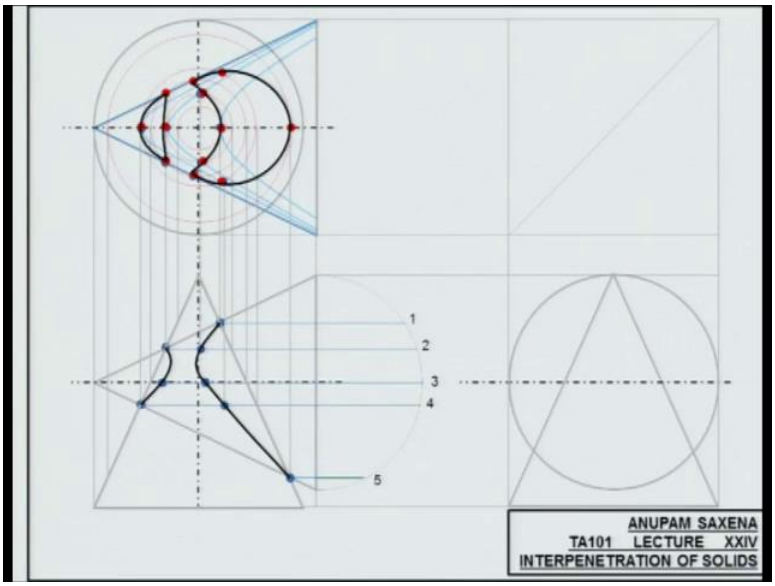

Alright, so this one is quite interesting, intersection between 2 cones a vertical cone and a horizontal cone. The 3 views are shown to you and my first question is; are the intersection points obvious from these 3 views? Is it possible for you to figure out the intersection points just by inspecting each of these views? Yeah, no so it is not going to be easy for you to use the generator method or the select line method. So, instead you would want to use the cutting plane method, so the intersection points to me at least they do not seem to be obvious. Use the cutting plane method.

So, use the bunch of horizontal planes slicing the assembly of these 2 cones. Now, if you slice the assembly using the bunch of these horizontal planes, intersection between one horizontal plane and this vertical cone will give you what? Will give you a circle. Intersection between the same horizontal plane and this horizontal clone, this horizontal cone it is going to be giving you what? A hyperbola. So, your intersection problem your problem of intersection boils down to figuring out the intersection between the circle and a hyperbola, alright.

Now, what I have done, what I have done is; I have you know use the information that the intersection going over here, intersections going to be happening over here and here and correspondingly I have chosen the respective horizontal planes to slice the assembly. It makes my work a little easier, but I do not guarantee that my solutions going to be. For more accurate solution you should be using more number of horizontal planes slicing the

assembly of these cones. So, the first horizontal plane is this one, second one is this one, third one is the center or third one contains the axis of the horizontal cone, fourth one and the fifth one ok.

Now, follow this very carefully, because things are going to be a little messy alright. So, plane number 1; if I look at the intersection between horizontal plane number 1 and the vertical cone I am going to be expecting circle in the top view. And this plane when cutting this cone will give me a hyperbola. The vertex of the hyperbola is going to be lying over here. So, essentially I will be expecting a single point of intersection there and there ok. Stay with me, stay with me. Now, this one this one is just a fluke. I do not need to actually draw this because I know the intersection points this going to be a single intersection point. Wait for the rest of the construction.

Alright, so plane number 2 intersecting with the vertical cone will give me this circle and when intersecting with the horizontal cone will give me a hyperbola. The vertex of that hyperbola is going to be here. We need to construct here, we need to construct that hyperbola. So, for that for that how is the base of the hyperbola going to be? The 2 points which will be lying on this edge of the horizontal cone they are going to be separated by twice this distance from here to here and from here to here. 1 and 2 once would that and once I know the fact that my apex or the vertex of the hyperbola is going to be lying over here. I can draw a box; once I draw a box, I would divide this edge of the box into equal number of parts and this edge of the box into equal number of parts.

Now, from this point I am going to be joining all the points on this edge and from this point the apex of the cone I am going to be joining all these guys, alright. So, let us say equal number of parts, I am just using a bunch of points for demonstration not so very many. Join this point of the box were that point over there on that edge. Likewise, for the second set this one with this one and this one with this one. So, you will get a bunch of intersection points.

So, intersection between this line and this line which is this point here will give you the first point on the hyperbola. And intersection between this line and this one here will give you the second points. Two points, you already know that this point is going to be lying on the hyperbola the vertex draw this hyperbola. Draw the mirror image of that so once you have the hyperbola in order find the intersection between the circle and the

hyperbola. This guy projected down on to the same plane, this guy projected down on to the same plane. So, this would be one intersection point, 2 intersection points over here and this one plane number 3. And the assembly; the vertical cone will give me a circle the horizontal cone will give me kind of a triangle. So, intersection points getting that is not a problem. 2 intersection points over here and 2 intersections over there being projected downward on to plane number 3 you will get these 2 points.

Plane number 4, again the vertical cone is going to be giving me a circle, the horizontal cone is going to be giving me a hyperbola. So, you need to draw that hyperbola I will quickly go through that. So, measure this distance make that distance over there and over there. Draw this box the same construction procedure. Divide this edge into equal number of parts that edge into equal number of parts. Start joining the lines, find the intersection points. You will have four intersection points in all. A four points lying on a hyperbola in all, draw that hyperbola. Draw the mirror image of that; find the intersection between the corresponding circle and the hyperbola.

So of course, one point will be here and the other point will be here. And of course, there would be a corresponding point at the top and the fifth point is quite obvious. I mean it has to be lying here. So, you do not need to worry about that construction at all it is quite messy. So, I can I can really understand the expression on your face yeah. So, once you figure out the intersection points, as I said the number of planes that I have chosen they are not adequate. So, they have to be adequate for you to get the actual contour of intersection. That is the first one, that is second one, and if you realize if you map these intersection points properly in the top view; these are going to be shown in red. Join them; get the mirror image of these. This is how your cone assembly is going to be looking in the front view and in the top view. Now, here I am assuming that the horizontal cone is absent. So, what it has done is; it has cut away a portion from the vertical cone. And like just gone for and that is one the reasons why this part is visible. Otherwise this part would have been you know below the cone. So, that is something that you need to be a little careful about.

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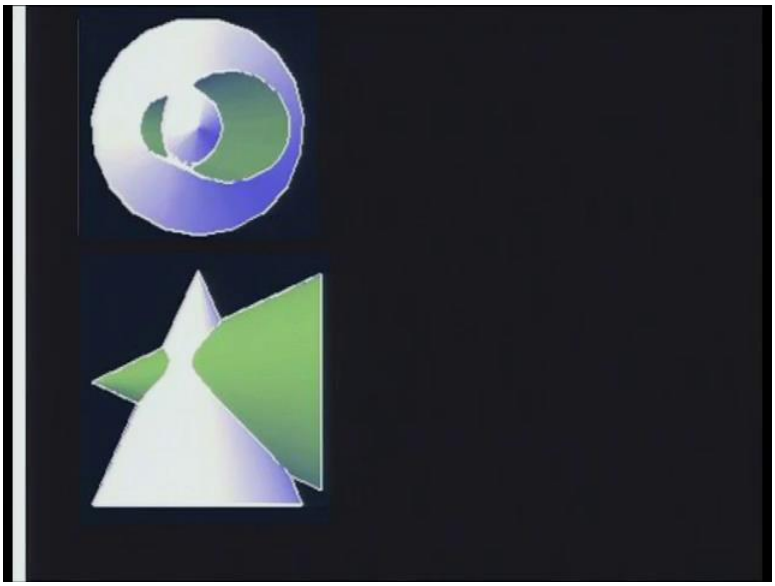

And once again if you want to compare this drawing with AutoCAD, you know work it out cone interaction place your cones properly, this is how it is going to look. Now, vikalp avikalp so I was interacting with him yesterday, right. And he was like you know I mean you show that cone hexagonal prism assembly yesterday or Tuesday. And how did you cut the cone? I mean for your hexagonal prism to be fit precisely into it. And to which I said well if you want to learn how to cut it.

First you have to figure out the intersection contour between the 2 solids, and use the information that one of the solids is developed. In fact in the example on Tuesday, both the solids are developable. Use the fact that the cone is developable. Cut the cone spread it out; you already have the intersection contour in there. Cut that part out, you know flap or fold your cone back into shape and then you have the slot. So, the first part intersection is something that is covered that has been covered today and last Tuesday. Development will involve 2 more lectures next week. And then you will learn how to cut one solid to be able to precisely affect the other one.