Engineering Graphics and Design
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Week 2: Graphical Representation
Sketching

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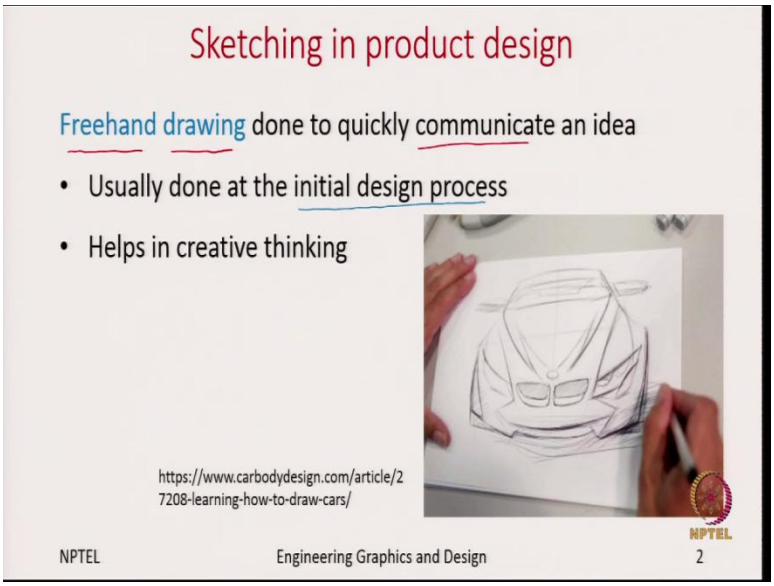

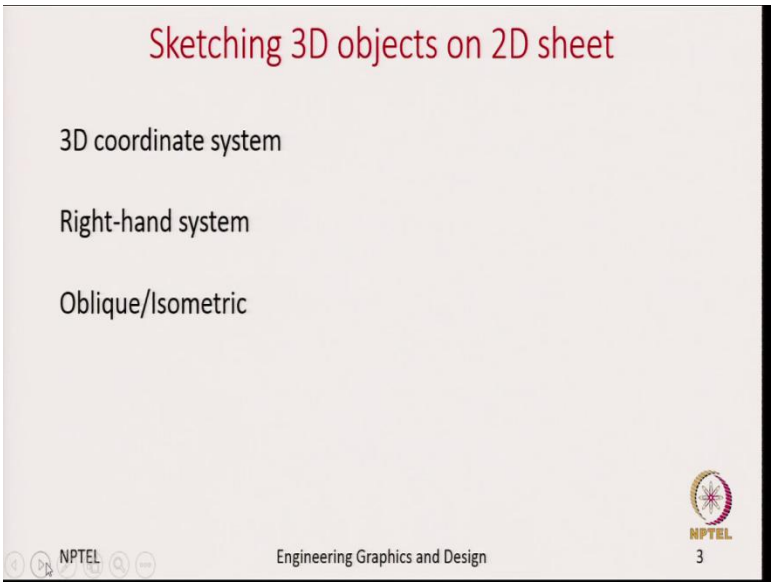

Welcome back to week 2 lecture on sketching. Today, we will be learning about sketching. What is sketching and why it is important for product designers. So, first of all, let us see what we call it as a sketch. Anything which we do with freehand we call it as a sketch. So, why do we need to draw things using freehand because we want to communicate our ideas quickly.

Usually, what happens is an engineering drawing is a very detailed and a formal exercise. But sketching here is a freehand drawing where the motive is to quickly communicate your ideas to others. So, the key point here is we are communicating your ideas using these freehand drawings. So, when do we need this sketching?

We usually do this sketching at the initial design process. So, initial design process is the time when a lot of creativity is required from the designers or the other team members to come up with new ideas. So, when they are coming with new ideas, these are not final ideas or the refined ideas. But some creative aspects of the idea. So, when you want to build up those ideas, things need to be done quickly and in a very efficient manner.

So, that at least you can show your idea to others. So, this is sketching is where you draw using freehand. So, studies have shown that. When you are sketching something, using a pencil and a paper. The creative process is unhindered which means that the creative process is continuing at a rapid pace. Here is a sketch of a car using freehand drawings. Which we call it as sketching. So, this helps to come up with new ideas and to share your ideas with others initially.

So, essentially, what we are trying to say is sketching is something we do without drawing instruments. What are the typical drawing instruments? We use, like scale, compass, or other means. So, but instead here, we only use pen I mean pencil, paper, eraser, and of course, your creative mind. So, from now on. What we will see is what techniques we can use. So that we can start with sketching and then continue with sketching such that, when you sketch something, others can understand it the way you intend.

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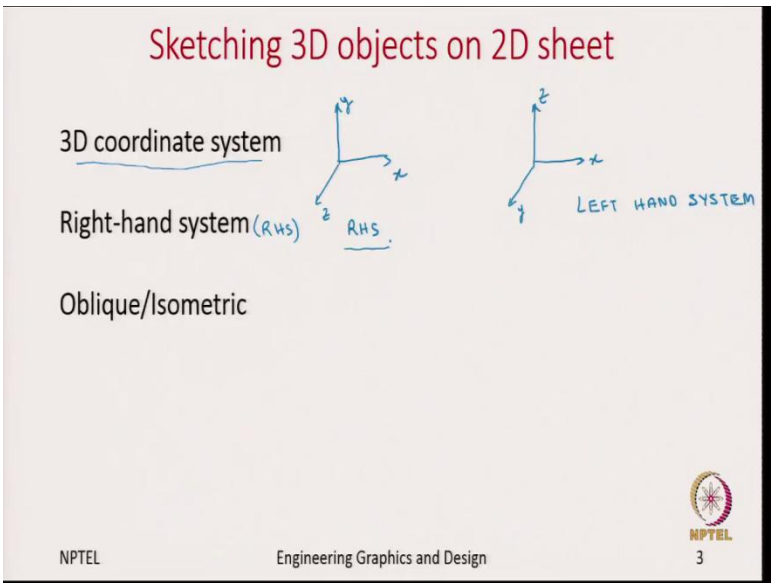

So, the first thing we need to understand is how do we show the 3-D objects on a 2-D sheet of paper? So, anything we see in the real world is a 3-D object. So, how do you capture the 3-D object on a paper is the challenge. For that, I think most of us have already know what is a 3-D coordinate system. We use a 3-D coordinate system so, that we get a sense of the 3-D space. So, for example, like if you are sitting in a room, and if you look at a corner of a room, then there are three coordinates.

So, two coordinates on the floor and one the vertical coordinate. Which is passing through the wall. So, we know there are several ways. We can show these coordinate systems like x y, and z. So, but this is not the only way. We show the coordinate systems right maybe I can choose the other. So, probably this can be x and this can be y and the vertical can be z. So, what is the difference between these two coordinate systems? The difference is one is the right-handed coordinate system and the other is the left-handed coordinate system.

For example, the first one is RHS or the right-hand system. And the other one is the left-hand system. I am sure all of you know this. But just to clarify right-hand system is when you point your fingers towards the x-axis and curl them towards the y axis. Then the direction of your thumb will be the z-axis.

So, you start with x-axis and curl your fingers towards the y axis, then your thumb shows the z-axis. If you are doing it with the right hand. We call it as the right-hand system. Similarly, for the left-hand system, now, if you take your left-hand fingers and point your fingers to the x-axis, then curl them towards the y axis, the thumb points the z-axis. Most often especially in engineering. We follow the right-hand system.

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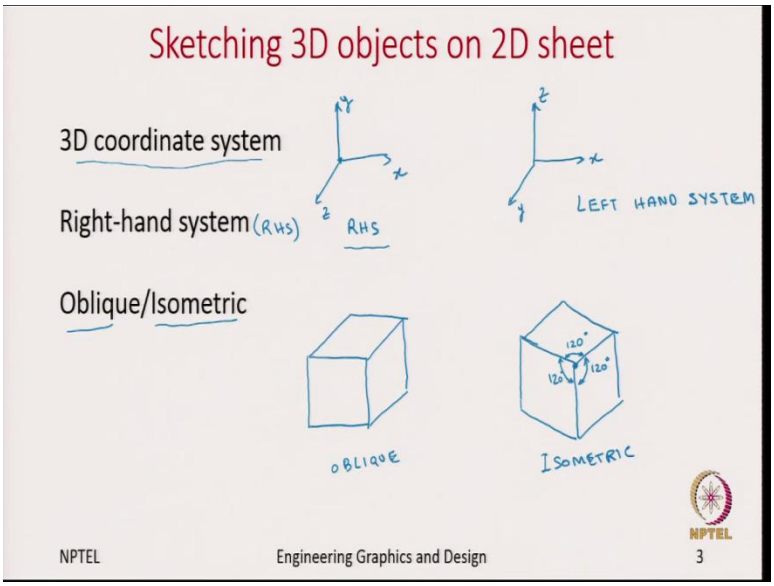

You can always follow the left-hand system. But the practice of majority is right-hand system. So, in this course, we will follow the right-hand coordinate system. So, what we have now defined is a coordinate system. So, that in using this coordinate system using the reference of these coordinate systems origin. Then we can define where the object is placed, and how does it move.

But once we start looking at how do we represent the 3-D objects on a paper. They are usually done using two methods, either the oblique method or the isometric. So, let us say we are representing a cube on a paper. So, this is one way of representing the cube. So, you show the one face of the cube which is proper. And the other direction you usually use 45 degrees line to show the depth of the cube. But there is an other method were called the isometric method.

Where we show all the three faces. And all these three faces are at equal angles of 180. I will just show them. So, this is where you will be looking at a diagonal of the cube. So, you are looking in this direction at this point along the diagonal of the cube. So, if you look at these faces, they

make 120 degrees on the paper. But in reality, in the real space, they are at an angle of 90 degrees.

So, either we can use the oblique or the isometric. So, usually, especially when we started learning maths and all. Most often we use the oblique system. But in engineering, most people prefer the isometric system. Because in this system all the three axis of the cube will have the equal length. And I will show you in the rest of this lecture. How we use this isometric system to represent some simple objects. But we will start with simple objects and then move on into more complex objects.

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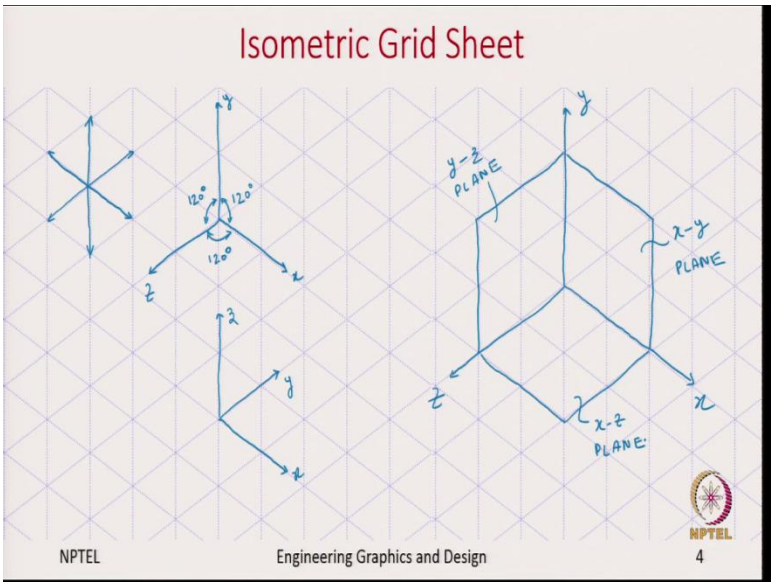

So here is a grid sheet which helps us to develop isometric views. So, if you notice this grid sheet. It has three lines in three different directions. One is the vertical direction and one along these directions. Inclined and there is a second inclined direction. So, we can use these three together to show the three coordinates. So, for example, let us say I will define this as the x-axis and this as the y axis, and the perpendicular as the z-axis.

So, as you can verify and see it is a right-handed system. Because again, if you point your fingers along the x-axis and then curl towards the y axis, the thumb points towards the z-axis. There are other ways to show this. So, another way to show the coordinate system would be like x. So, the y will be this and z is this. Again, in the right-handed system. Most often we prefer the first method because here we see that the angle between the axis are 120.

One is free to choose between any of these. So, as you can see that this isometric grid view helps us to show the three-coordinate axis. But now let us see how we can use these three-coordinate axis to represent different planes. Because that helps you to build up objects. Let us develop a coordinate system using x, y, and z.

Now, we will use this coordinate system to show how to represent the xy plane, yz plane, and the z x plane. To start with x y plane. We simply need to take these two lines and then use the x and y-axis to create what we call as the x y plane. Similarly, I can do the same for yz. and lastly the x z plane.

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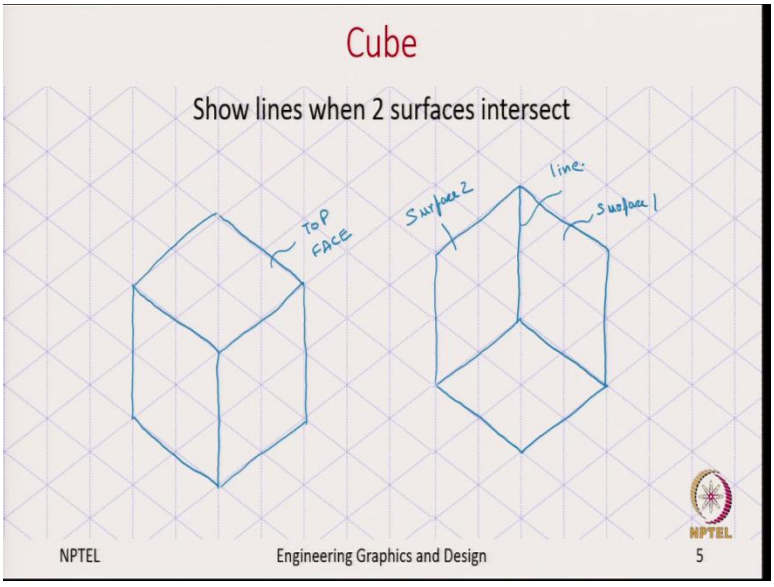


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Let us say we will develop a cube of two-unit cells. How do we develop this? So, we take two units down two units. So, now we made one face of the cube. Similarly, we will make the other face of the cube. And finally, the top face of the cube. So, this is the top face. This is one way of representing the cube where we are looking at three faces of the cube from top a an inclination from the top.

But we can represent the same cube where we are looking it from down that can be shown. Let us first show the bottom face of the cube. And these are the two inclined faces of the cube. So, essentially, what I am trying to say is. Let us say what I have in my hand is a cube. So, this orientation. Where you are looking at this point, which will show you three faces.

The top face and the two side faces. But you can also see the same cube in this fashion. Where in this orientation you will looking at the bottom face of the cube and the two side faces of the cube. So, both can be shown using this isometric grids.

So, the important point to note here is these lines represent where 2 surfaces intersect or when 2 surfaces meet. So, for example, this line represents when this surface1 and surface 2 meet. So, this is a line joining 2 different surfaces. So, this is a principle which we will be following all throughout, not just in this sketching. But also, informal engineering drawings.

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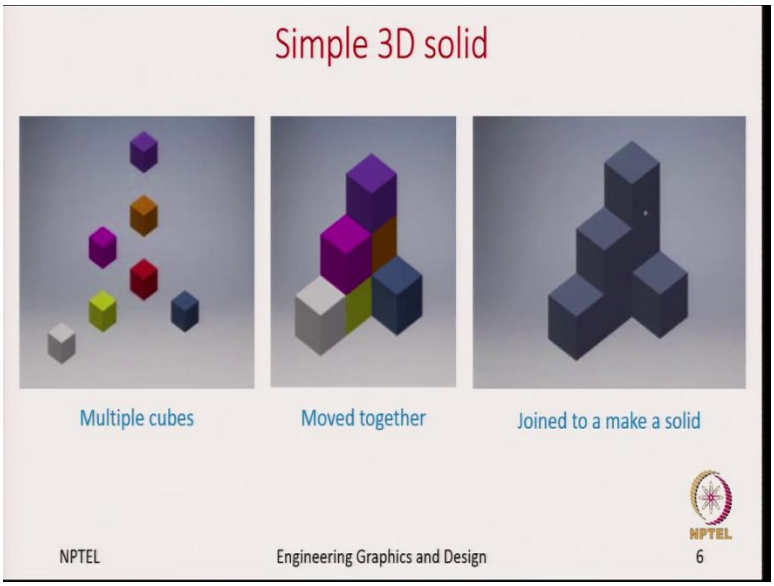

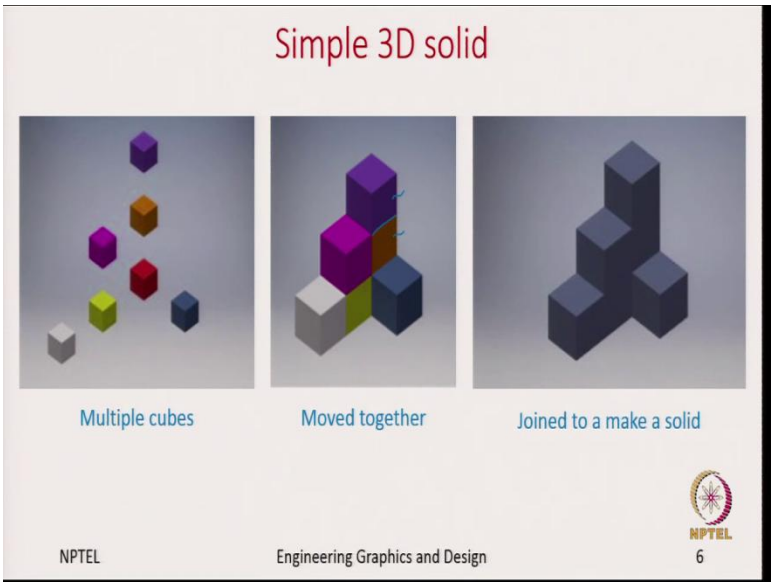

So, now let us move to slightly more complex solids. So, let us say we have multiple cubes. And we join together to make a single solid. This is mostly like the building blocks, kids play. So, here what we have done is we have shown multiple cubes. When we move them together, it forms a single solid. But since they are all together. We can join them together to make a single solid.

Once it is a single solid. We change from multi colors to a single color. The reason is for example, previously, you are able to see a line here. Line joining this cube one and the other cubes. But here, you do not need to show that line. Because both these are falling on the same surface. These are not two different surfaces. So, you do not need to show that line.

So, essentially what we are saying is, we can take individual cubes as a building blocks and then bring them together to build a simple 3-D solid or a simple object. We can use this technique to start building drawing some simple objects on an isometric grid.

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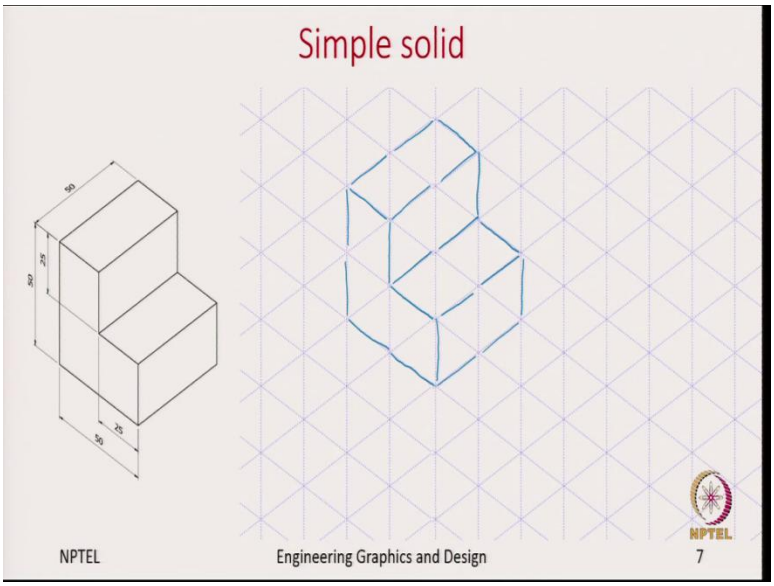


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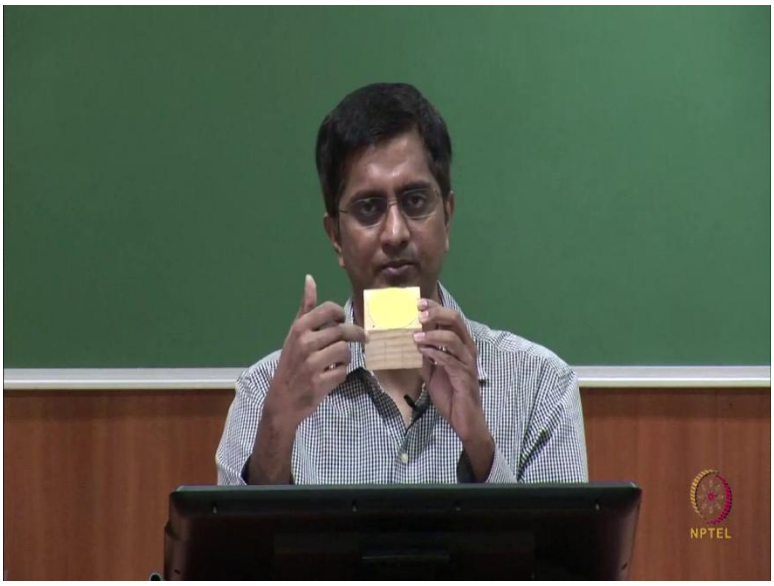

So, for example, here we have this L shaped object. Now, let us see how we go about sketching this object. So, one way of building it is to say that. These are, you can count the number of cubes and then start building them. So, for example in the first row you have two cubes. And in the second row, you have total four cubes.

Because the height is two and you have two cells. So, essentially, it is like a cube of two units. So, now let us develop a cube of two units. And from there we can develop this object. So, now what we have is a cube of two-unit cells. But we know that we need to remove two blocks out of it. So, now let us sketch the boundary where we are removed. So, we need this and vertical line by one unit.

Now, what we will do is,we can remove the unwanted lines. So, let us erase the unwanted lines. For example, since we are removing this block here. You would not be seeing these lines. Similarly, these two lines. But then instead, we need to add other lines to complete the figure. One vertical line here and the inclined here to the line joining these two surfaces need also should be shown. So, this effectively shows the object on the isometric grid. So, you can use this method not just for the simple objects. But gradually develop into more complex objects.

So, when you start sketching these cubes later. You will see that not all objects are straight-line edges. Sometimes you have curved edges and simplest of these curved edges is a circle. Here, what you see is the circle what I have pasted on a square face. So, when you look straight into it. What you see is it as a circle. But now let us say if I incline it.

So, if I incline the surface and you are looking from the front. What you see is not a circle but instead an ellipse. So, what we are trying to say is the circle when viewed from different angles. It will sometimes look like an ellipse. So, let us say for this cube here. How do we represent circles on different faces? So, we have a step-by-step method where we can show these circles using freehand sketches.

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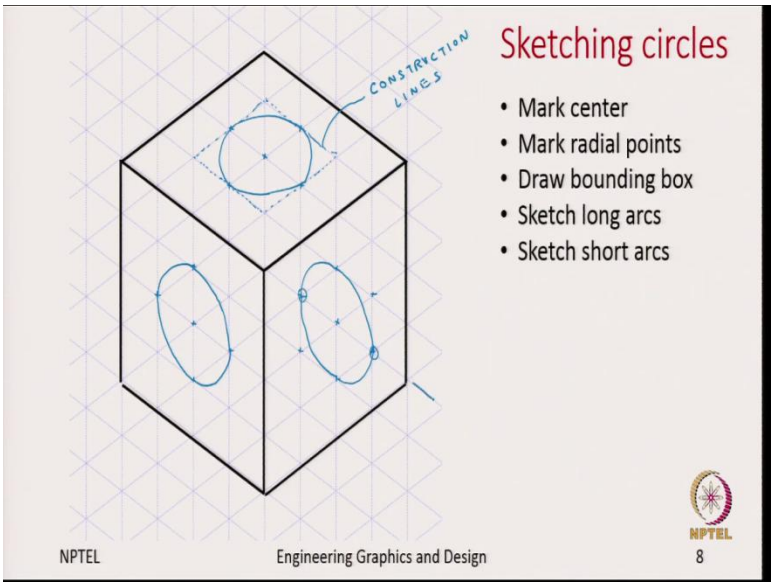

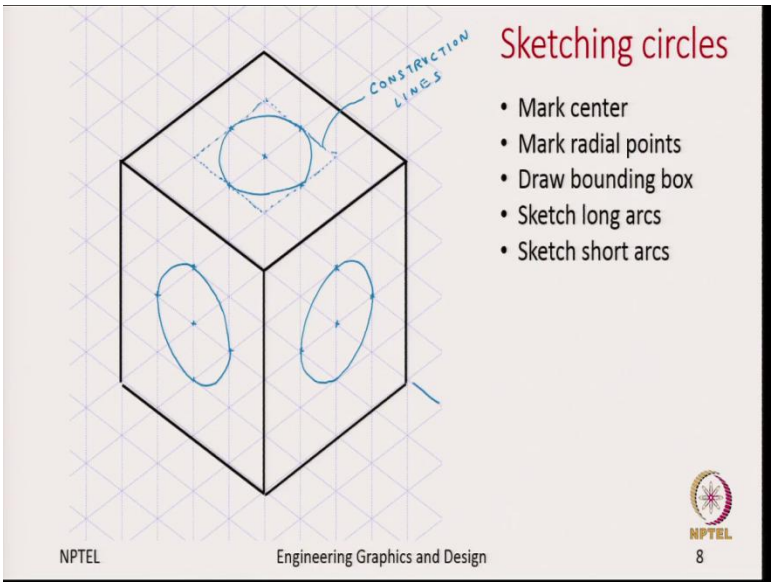

So, we will go one step at a time. First, we say we need to mark the center. Let me start with the top face now. So, we need to mark the center of the circle. Let us say we will draw the circle

with a radius of one unit or diameter of two units. The second step is to mark two radial points. So, we need to mark radial points. Next, we need to draw the bounding box.

So, bounding box is the square within which you will have this circle. So, this is the bounding. Now, we sketch the long arcs. So, we need to join these two radial points using a longer. Similarly, these two radial points using another longer. And finally, we need to sketch the short arcs between these two radial points let us start with.

Similarly, the last two radial points for the short arcs. So, what we have tried to draw on is a ellipse. So, you can use this technique to draw ellipses on the isometric grid sheet. But, in effectively what we are trying to show is a circle on the top face. Similarly, you can apply the same method on the different faces. So, for example, let us focus on this face.

So center point, radial points longer and the shorter. So, initially, when you are learning, you need to follow all the steps. But after a while, once you practice. You can skip a few things. So, for example in here. I am skipping this third step out drawing the bounding box. And one more important point I need to say is this.

What I have drawn is the construction lines. So, when you are drawing with a pencil on a paper. You can use the pencil to draw either light line or a dark line. So, you should be using the light lines for these construction lines. Because those are not the actual outlines of what you want to draw there. You are drawing them only to help you to draw the actual drawing. So, you should make sure these construction lines are drawn in light.

And then, when you are drawing your actual outline. That is when you draw it in a darker line. And, I need to also mention to you there are ways where you can make mistakes while drawing this ellipse. So, for example, let us say that we are drawing the ellipse on this face. These radial points,actually if you look at there are six options around this center point where you can have radial points. You need to choose those four very properly.

So, for example, let us say I am making some wrong assumptions. So, let us say I take these two points and then these two points and then draw the long arcs and the shorter arcs. So, then what I got is a ellipse which is fine. But that does not look like a circle on the third face. The reason is because I had chosen the wrong radial points. Instead of choosing these radial points.

I have wrongly chosen these radial points. Because you see this line represents out of plane for this face. So, we should avoid that. So, let me erase and then draw the correct way to represent this. So, the correct way to represent is these are the radial points which we need to do, and once we have those radial points correct. It will be easy. Now, we have seen how to draw circles on planar surfaces.

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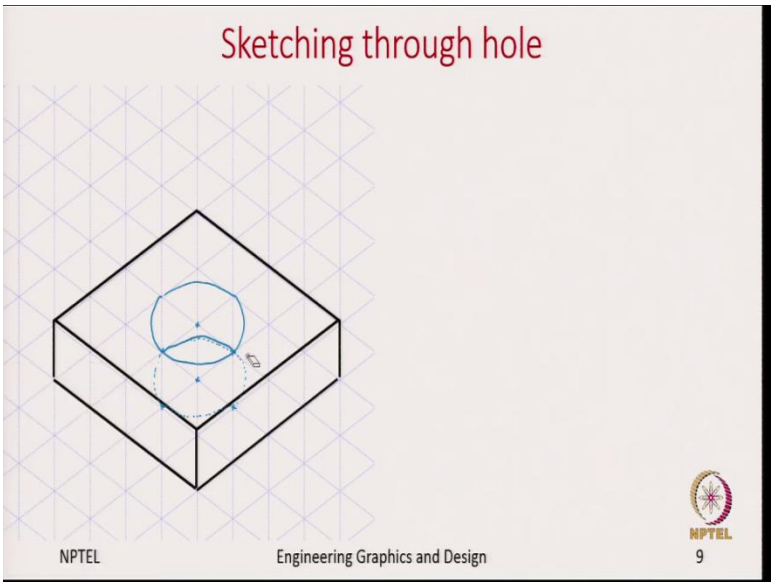

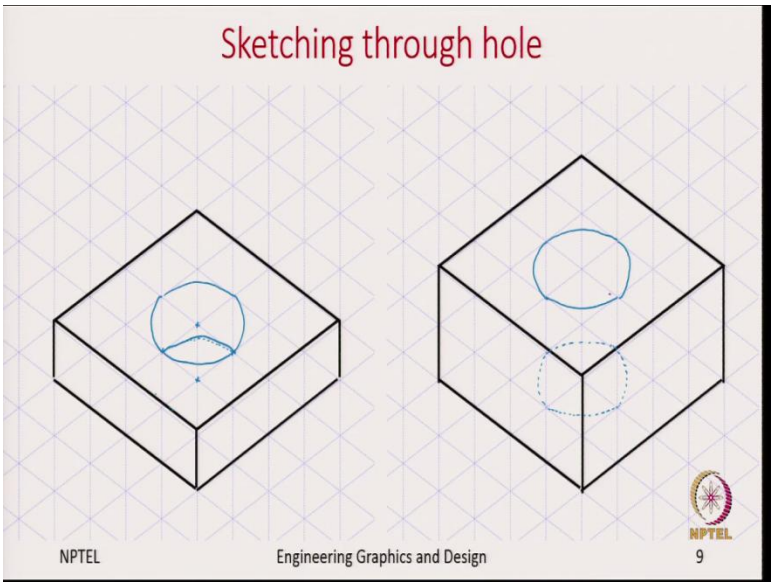

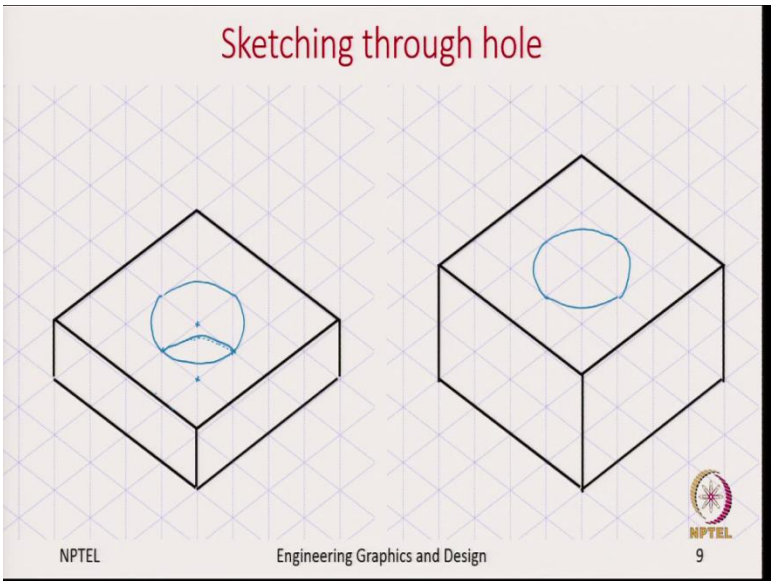

Now, let us see how to sketch through holes. What is a through hole? Through hole is you have a circular hole starting from one face and going all the way to the opposite face. So, let us again sketch a circle first on the top face, and then we will in the next step make it through hole. So, I will be skipping the drawing the radial points and directly drawing you the circle.

So, what we said is this circle will go all the way to the opposite face. So, for the opposite face now let us again draw another circle. So, that then we can if you have one circle at the top and at the bottom. You just need to connect them to show it as a complete hole or a through hole. So, now let us first identify where is the center in the bottom face.

The bottom face center is here and the radial points for the corresponding ones these. Now, I will be using construction lines. Because I do not know which of these parts of the circle. Which I will be able to see in this isometric view. So, first the long arcs and the short arcs. So, this is the circle and the bottom face. So, can we see the complete circle of the bottom face?

No, what we see is only portion of this portion of the bottom circle is what we get to see from the opening made from the top face of the hole. The rest all is invisible. So, since it is invisible lets erase those things. So now, they should show you how this through hole looks like. Where we have a complete circle on the top face and only a part of the circle on the bottom face. So, as an example, let us see if the height of this plate changes.

And we have a similar kind of through hole of unit radius. What will, how will it look like? Will we see both the top circle and the bottom circle or will we only see the top circle? So, to quickly draw the top face which we all know now. Similarly, let me sketch the bottom circle. The circle on the bottom face with construction lines. So, what we notice is we cannot see any part of this bottom circle. Because that does not fall into this top circle.

So, we need not show the bottom face in this example. So, I can remove it to be precise I should remove this. So, we are not showing any of the hidden features in the isometric drawing. That is the reason why I need to erase this bottom face. This is how a through hole looks. When the height of the plate is large. Which means when the height of the plate is large. You may not be able to see the bottom circle.

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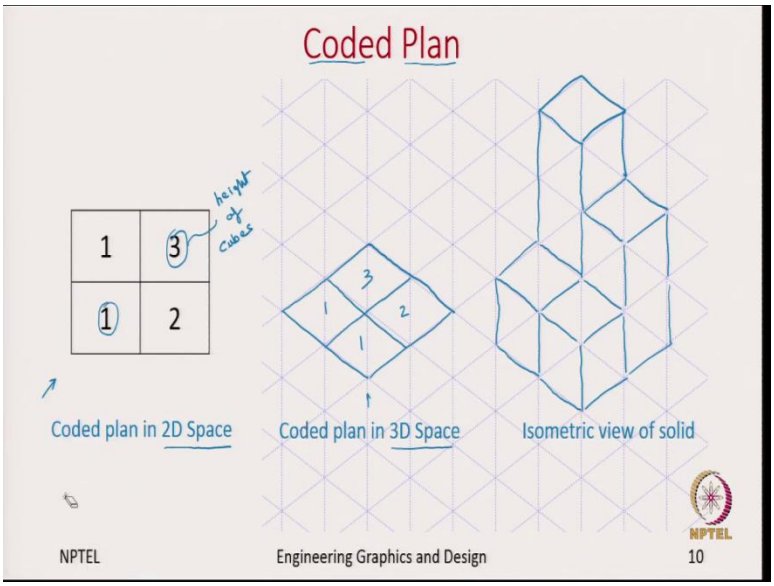

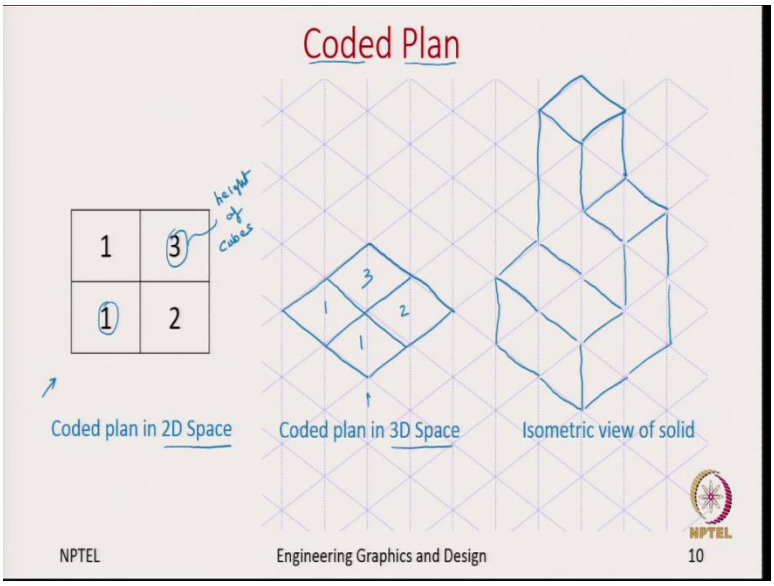

Next, we move to this coded plan. Coded plan is one way to build a 3-D object. So, what we are representing here is saying that. We will have one cube here each number here represents the height. So, this represents the height of cubes. So, which means. You will have three cubes stacked on top of each other here. You will have two cube stacked on top of each other. And similarly, one each in these two cells. So, this is how you show a coded plan in 2-D space.

But in 3-D space how do we show that. In 3-D space, this is how you show that coded plan. So, essentially, since this is a 2-by-2 matrix. The same two by two matrix we show here and then show the same numbers 1123. Here, I am assuming that I am looking at this coded plan from this direction. So, the cube closest to me has a height of 1. And to the right, I have a height of 2. And to the left, I have a height of 1. So, this is how it looks like on a coded plan.

So, this we call it as coded plan in 3-D space. But now let us try to build this object. So, now we want to show this isometric view of the solid using this coded plan. So, there are a few principles if you follow it will be easy. So, one principle is you start with the one closer to you. So, the one closer to your viewing direction is this cube of height 1. So, let us build that cube of height one. To, the right we said we have a cube of two-unit side. So, this is two units height.

And to the left, we have a cube of one unit. And at the end, we have this cube of three cubes stacked on top of each other. So, since we already have one height here. I will draw two more. So, here we have this object. But as you notice we have one principle. The principle is we only show lines. When it meets two different surfaces. So, let us say let us look at one by one.

And see where are the extra lines we need to remove. So, for example, this vertical line here that shares only one surface. So, since there are no two surfaces meeting, we have to remove this line. Similarly, this line can be removed. Because this is all one single surface the same with this vertical line here. And the same here.

I think after these we get the final isometric view of the solid. Removing all the extra lines. So, here, we are able to show in a step-by-step process. How to develop the isometric view. So, if you are beginning to practice these you need to draw these extra lines and remove them. But let us say after a while you get to practice. You know what are the unnecessary lines so, you can skip those and directly get to the final view. But actually this is a process which helps you to build this skill of growing isometric views.

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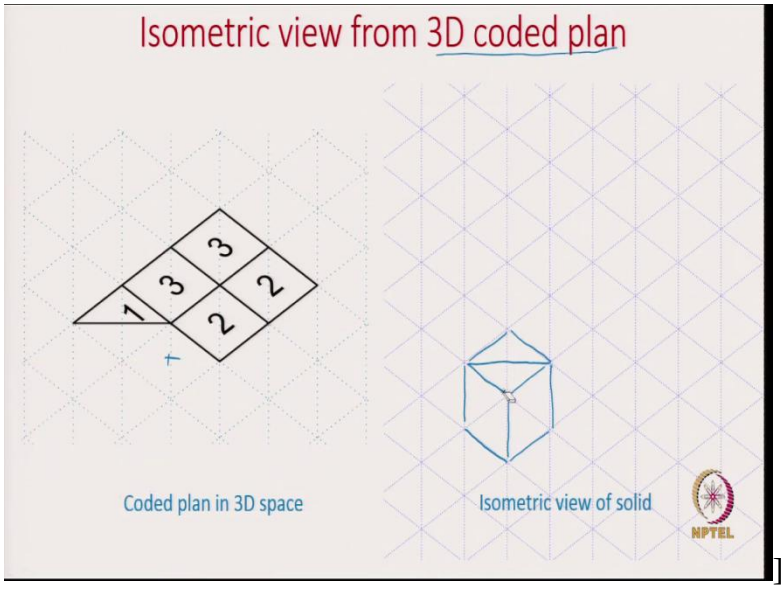

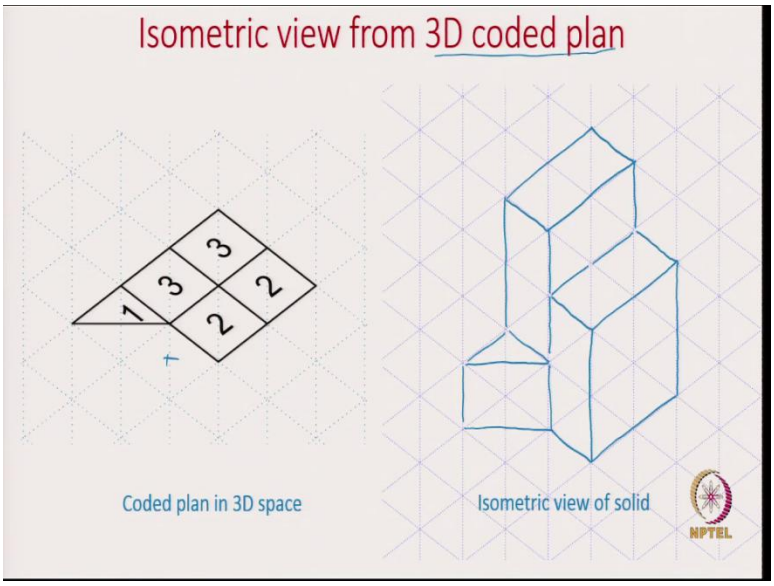

So here is another isometric view. Which we will try to build using this 3-D coded plan. So, what you notice is there is one cube. Which is not a complete cube. But you are cutting the cube at a diagonal. And you see that this cell is missing altogether. So, let us see how to build this. So, one way to build this half cube is let us first draw the full cube.

And then it will be easy for us to slice the unnecessary part. So, let us first draw the cube. Now, let us try to cut this part according to the drawing. So, the way to cut it is we have a diagonal here. So, once you cut it this front end needs to be removed which means all these lines has to be removed. So, let us remove these lines and then draw this extra inclined line.

So, now we got this half cube as per the coded plan. Now, let us build the remaining which probably is easier. So, we know that these are two cubes of height. And lastly, we have these three cube heights. So, we have already one height. So, we need to develop only the two remaining heights. I think there is no extra lines to be removed. So, this is the final drawing for the isometric view for this 3-D coded plan. So, what we are seen here is if there is a missing cube or if there is a part of the cube how to go ahead and draw this object.

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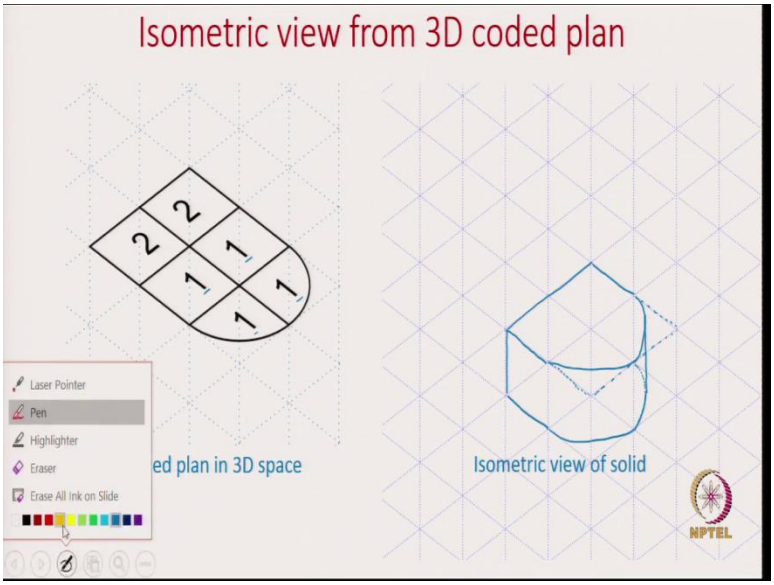

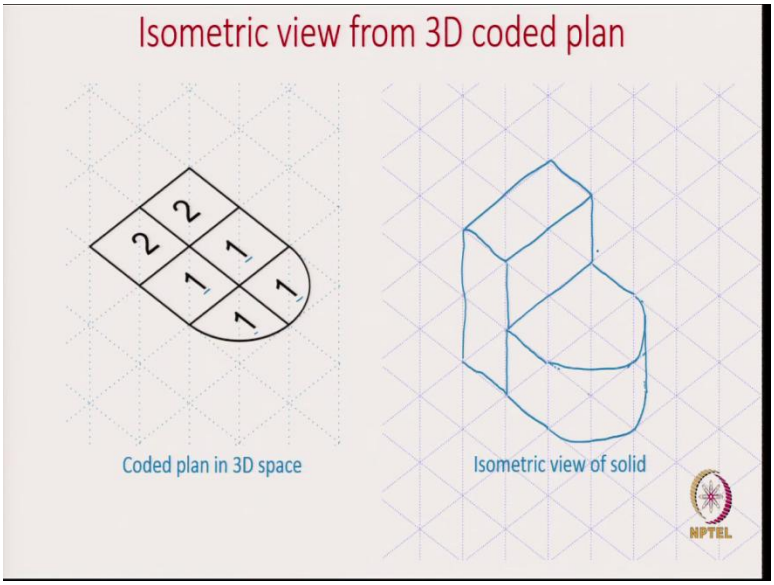

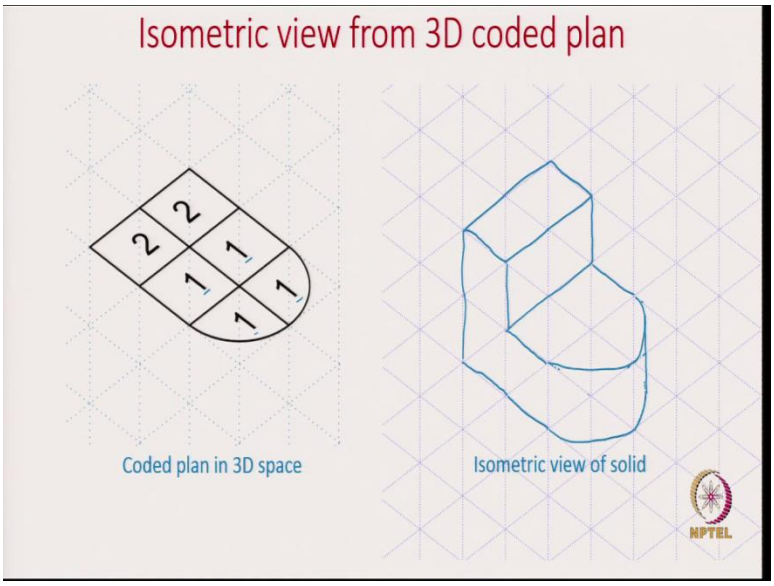

Finally, we have one final example to show. How to draw this curved things. So, previously, it was a partial cube but it was a straight cut. But again, here we have another cube with a curve cut. So, how do we draw them? So again, let us notice that these are cubes of unit height and these are also of unit height. So, let us first draw the top surface of this things.

So, initially, I can draw some construction lines which I can later remove. So, the region in this construction lines is where we have this curve objects. So, the long arc the short arc make this semicircle. So, now we have done the top surface of this now let us get to the bottom surface. Let me use a construction line for this short.

Now, what I will do is, I will draw a tangent between these two semicircles. Because this tangent defines which part of this small arc is visible, and which part is invisible. So, this part is visible. So, I will make it as a full and let me now remove all the construction lines. So, that it is clear what we have. So, now we are done with the front part and the cubes with height 2 is the most straightforward thing and which we can draw pretty quick.

So, there is one extra line which I need to remove. So, this line I need to remove because the vertical face here and the vertical face here. They both form the same surface. So, I do not need an extra line to show them. And similarly, if you notice the end of the semicircle also. I removed this vertical line. The reason is because there is a smooth boundary between this vertical face and this semicircular face. Since the edge is smooth, we need not show it. But if there is a sharp angle or something that is when we show the edge.

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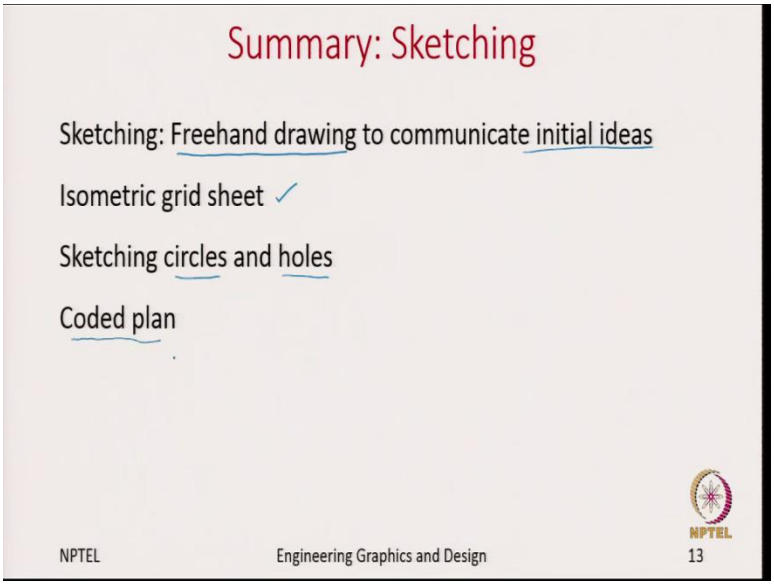

With this, we come to the end of this lecture. So, let us see in summary what we have discussed. So, we said that free drawings, sketching freehand drawings. Which are done to communicate ideas quickly. And we said we do this at the initial step of the design. Where there is a lot of creative process involved. And we also showed that. We can use the isometric grid sheets to develop the isometric views more easily using the freehand.

And in addition to the straight-line edges, we also dealt how to sketch circles and holes. So, this gives us our lets us develop some slightly more complex objects. And finally, we have seen one method of coded plan. Which can be used to develop some simple objects. So, in summary, what we are trying to do covered in this lecture, or what we need to learn from this lecture is how to go ahead and start drawing some simple sketches.

So, if you are new to drawing freehand sketches, this lecture will help you to use this grid sheet and be able to draw some decent sketches. But of course, after a while, if you develop enough practice. You can remove that grid sheet and then draw freehand sketches without this extra help. Okay, Thank you.