Engineering Graphics and Design
Professor. Naresh V Datla
Department of Mechanical Engineering
Indian Institute of Technology Delhi
Lecture 27
Pictorial Drawings

Welcome back to this course, we are on week 6 of isometric drawings. Until now we have been looking at orthographic drawings of normal positions as well as incline rotation of solids. In today's lecture, we will be looking at isometric drawings, in particular, we will be first focusing about pictorial drawings and say that isometric drawings is a subset of these pictorial drawings.

Before we go into what is pictorial drawings and all, we already know that when we show an object orthographic views only show two dimensions per view. So, if it is a front view, you will be seeing the height and the width side view will show the depth and the height and the top view will show the depth as well as the width.

But orthographic views though they are very useful in manufacturing, they are a little hard to read without some training. So, pictorial drawings show three faces of the object and therefore it becomes easy to interpret the object. So, there are many ways to show the object such that the three sites, you can look in one single view. So first, we will look at pictorial drawings in that sense and then see how the isometric drawings fit into the picture.

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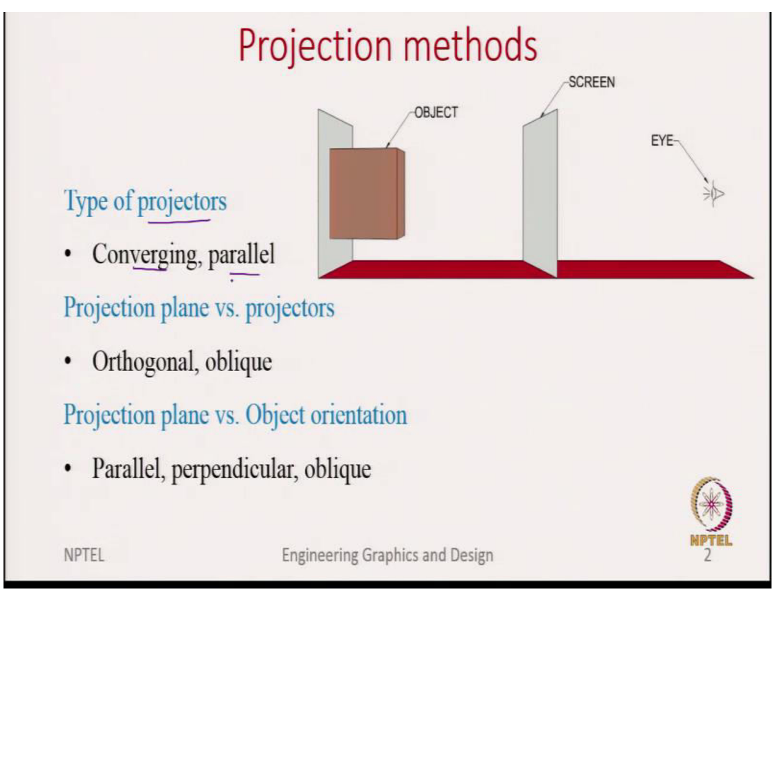

So first, let us review about projection methods that we have already discussed in week 2. So, we said we need three things, one the object, observer and then we need a projection plane and then there many kinds of projections depending on different aspects to start with, depending on the type of projectors, we have either converging or parallel. So, let us say the observer is close to the object, then this projection lines they all converge into the observer's eye.

But let us say now, the observer is looking from a very far distance, then all the projection lines are parallel to each other. So, this is one category of projections. The other is how is the projection plane and the projection lines oriented.

So, the point is, this projection lines when they pass through the projection plane are they perpendicular or not perpendicular, if they are perpendicular, we call them orthogonal or orthographic projections or if they are not perpendicular, but the projection lines are parallel we call them oblique projections.

And the last category is how was the projection plane and the object orientation. So, you can orient the object such that it is parallel to the projection plane or perpendicular to the projection plane, we can also put it in an inclined fashion, then we call it oblique and there are many other categories in this. So, as we are seeing, there are many ways to capture the different views of the object. We are more focused on the pictorial drawings, which capture the three phases of the object in one single view. So, now, we will discuss about different types of pictorial drawings.

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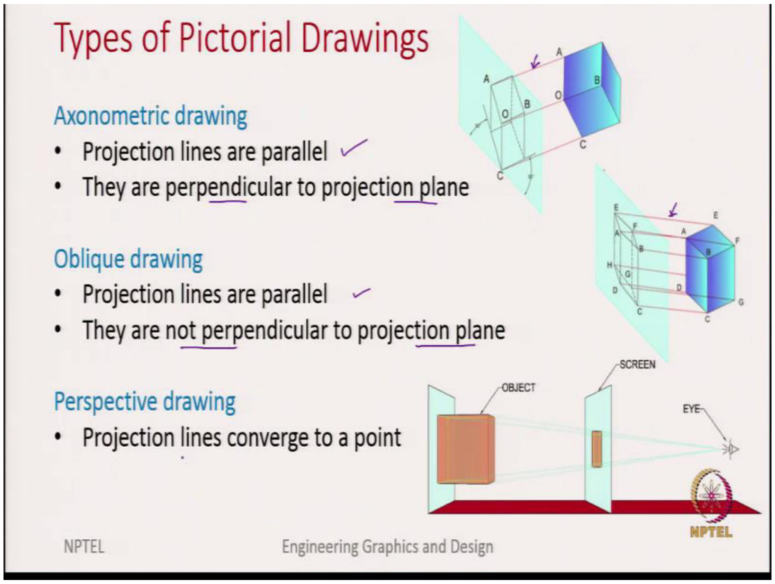

The first category is the axonometric drawings where the projection lines are parallel. So, for example in this picture, we see these red lines are the projection lines and they are all parallel. They are not just parallel, but they also intersect the projection plane at 90 degrees or they are perpendicular to the projection plane.

So, we will see later that there are three different kinds of axonometric drawings. But let us now move to the second category which is the oblique drawings. Here to the projection lines, which are these red lines in this picture, they are again parallel to each other, but the difference is when they intersect the projection plane, they are not at 90 degrees, they are other than 90 degrees angles.

So, they are not perpendicular to the projection plane and the last category is the perspective drawing. Where the projection lines converge to a point, this is the point when the observer is relatively closer to the object, such that all these projection lines are not parallel but instead they all converge to a point.

So, in real world, if you take a photo of things close to you, what we see is actually a perspective drawing, because you have the object and the observer at a relatively closer distance. So, the projection lines all converge to a single point. So, this perspective drawings give a more realistic view of the object. So, in the later slides, we will go into, in details of these three categories and see what is in which cases we used one of them.

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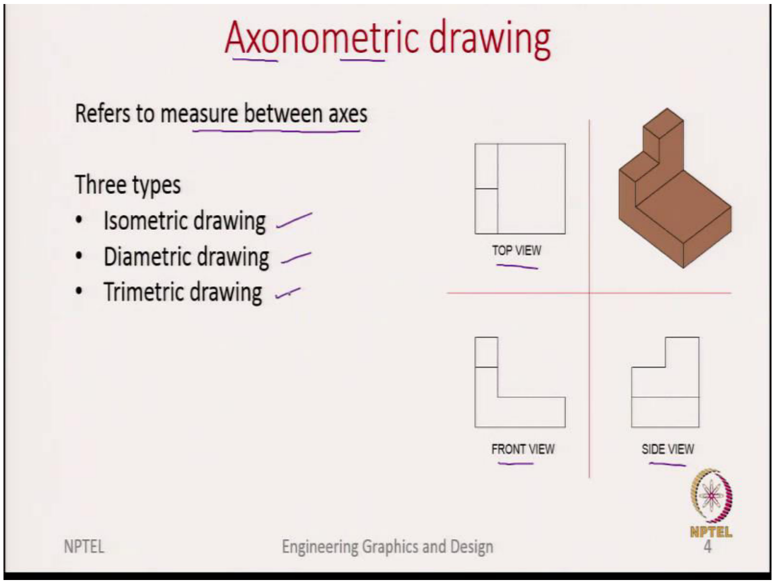

So, now let us start with axonometric drawings. Axon means axes and metric means measures. So, what do they do? They refer to the measurement between the axes. So, we all know we are working with three dimensional objects, so we need to represent it in a three coordinate axes system.

So, now the question is, what is the angle between these three axes of the system we are working with? So in truth, we usually take the Cartesian system, which means these three axes are perpendicular to each other. But depending on the view and the projection plane, sometimes though the true angle is 90, we see a different angle. That is exactly what we are trying to capture in this axonometric drawings.

So, throughout this lecture, I will be using one example because using this example, I want to show the same object, how it looks in different drawings. So, here what I show are the orthographic or the multi view projections of the solid showing the top view, front view and the side view.

I guess, based on the placement of these views, we can guess that it is a third angle projection because the top view is placed above the front view. But when we talk about pictorial sometimes what happens is, maybe you receive a drawing from another person, usually manufacturing drawings are more detailed drawings, which means they come with multi view drawing. So, once you look at the multi view drawing, one should be able to picturize how the three dimensional object looks like.

So, that is what we will also learn in this lecture and in the next lecture. But in this example, depending on these views, we should be able to get a mental picture of the object which is already shown in the slide. But coming back to the topic of this slide, which is axonometric drawings, there are three different kinds of axonometric drawings, which are the isometric, diametric and trimetric drawings. Let us, look at them one at a time.

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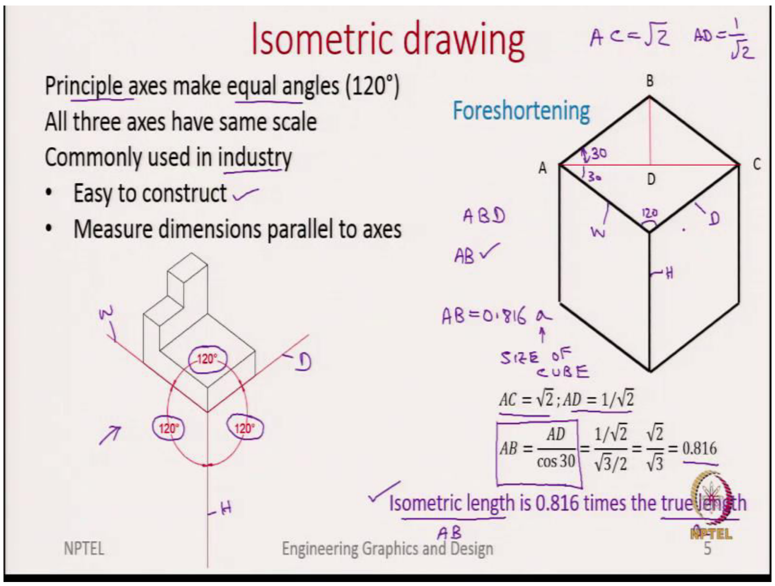

Isometric drawings are the most commonly used drawings, out of all these pictorial drawings. So, what it says is, these are principal axes, which are shown here, they make equal angles. So, as you can look, they are making an angle of 120 degrees with each other. So, you should now realize that these axes in the true sense are perpendicular to each other.

But depending on the way you are looking at it, for example this cube let us say, if I orient the cube in such a way, such that you look at all the three faces, let us say this is the top face, the front face and the side face, you can see all these three faces in this view and if I am making sure that this angle of 90 is what you now see it as 120. Similarly, this angle of 90 and this angle of 90 is what we see as 120, this is called distortion of the view.

To be precise, we are distorting these angles in the true sense this is 90, but the way we depict on the drawing sheet is 120 degrees. In isometric drawings, we are saying all these are at equal angle of 120 degrees and we also say that the scale we use for height, width and the depth is same. This actually makes drawing very easy. We will see in a while how it makes it easy. So, here is the object we are discussing, now showed in the isometric drawings.

So, as you can see, each of these axes, the ones in the red lines show things about the height, width. So, this is the height, this captures the let us say if this is the front view, so this captures the width and the other dimension captures the depth of the object. So, as I already said this is very commonly used in the industry. The reason is because it is easy to construct, because now you are giving equal importance to the three dimensions, the height, width and the depth and then you also use this exact true length of the object.

So, for example if any of these lines of the object are parallel to these axes, then we use the true length. So, let us say the width is 5 centimetres, we exactly draw 5 centimetres and similarly other dimensions. So, I need to mention here that isometric drawings we have a problem called as foreshortening. Let me explain you what this foreshortening means. So, let us focus on this cube, let us say each side of the cube is of 1 unit. This side for isometric drawing, we are orienting the cube in such a way that we can see all the three faces fine.

Now, let us focus on which of these lines will be captured as true length on the projection plane. So, for example, this length, this edge, if it is projected on the projection plane, will it be captured as true length. We have a principle, we said we can capture true length if the feature we are looking at is parallel to the projection plane.

So, now let us ask the question in this way saying that, this edge is it parallel to the projection plane? No, are they any of the other edges parallel to the projection plane? No. So, let us say this is if this is the front view, this is the width, depth and height none of them is parallel to the projection plane.

So, now, let us try to identify is there any feature on this which is parallel to the projection plane? So, if you look carefully, this diagonal from this corner to the other corner on the top face, this line is parallel to the projection plane. So, since this line is parallel to the projection plane, it captures the true length. Now, a simple question in geometry. So, let us say the side of the cube is of unit one, what will be this diagonal? this diagonal will be of length square root of 2, we know this from trigonometry.

So, this is captured as true length. So, which means this length AC, what is this length AC is square root of 2. Then what is the length AD in this figure, AD is simply half of AC. So, now we say AC = to root 2 and AD =1/2 AC. So, it is root 2 by 2 or 1 by root 2. So, this is very clear.

Now, let us do a little more geometry, let us consider the triangle A, B and D. So, let us say we are interested in the sides AB, we need to know what the length of the side AB is. So, we just showed that AD we already know saying that AD is equal to 1 by root 2. So, how would can I find AB. So looking at this geometry, can you guess, what is this angle? We already showed that this angle is 120 degrees.

So, this will be how much? So, this will be 30 degrees and since because of the symmetry we can say this is also 30 degrees. So, if we know that this angle DAB is 30 degrees, how do we find AB, we can find AB using the cos. So, AB will be AD / cos 30. So, once you identify this, we get to know the answer because we already know AD is 1 by root 2 and cos 30 is root 3 by 2 and the result is root 2 by root 3 or it is approximately 0.816.

So, what are we saying, we are saying that AB is equal to 0.816 times what, times the size of cube. We started by saying that the size of the cube is unit. So, it is we need not multiply just by 1, we can multiply just by 1 but if the side is any dimension A, then we will say where A is the size of cube.

So, essentially the statement we are trying to make is this, we are saying that this isometric length, isometric length refers to what, the AB, because AB represents the side of the cube, that is what you see it on a paper when we draw the isometric view is 0.816 times the true length. So, what is the true length? True length we said is the actual side of the cube which let us say is A.

So, though I am taking too much time to explain this, the point is, if I take a cube of unit length, and try to capture the isometric view, so these lens when you draw it on the paper should be not unit length, but these edges should be 0.816. Similarly, all three edges, edge 1, 2, and 3 which are perpendicular to each other.

But we know that there is foreshortening, which means that the sizes are slightly smaller now, then this gives us a little difficulty in drawing, because then you need to always multiply your dimensions with the scaling factor 0.816 and then it becomes a very tedious job to depict this isometric view.

So, to make things easy, what we do is though, we realize that this is foreshortened, we ignore that point and then use the true length, true length is, for example here, we said it is unit length. So, these 3, let us say this represents the height. If this is the front view, this represents the width and the depth for all these we will use the true length.

Since all sides are of equal scale, what happens is the object will look a little bigger in the isometric view, because we are scaling it out but the shape remains the same. So, the important point is the shape, it will still look like the same, only thing is the size of the cube will look slightly bigger, because instead of drawing it at the scaling factor of 0.816, we are using a scaling factor of 1 or the true length of this height, width and depth.

These are too much of information. But do not worry, we have the next lecture completely on the isometric drawings, where we will be going into details with some example. So, there should not be a much of confusion. So, now let us continue with these axonometric drawings, we said first one is the isometric drawing, we have two more categories.

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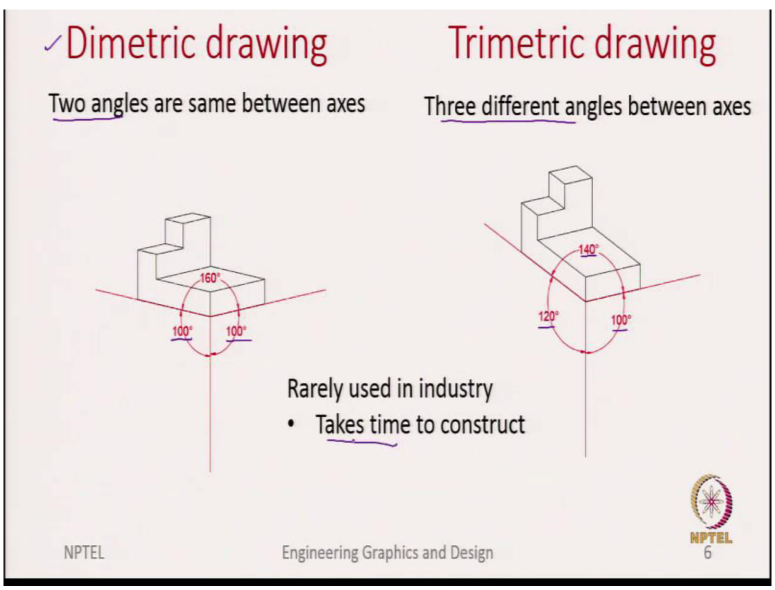

The second is the diametric drawing. Again, the difference is now only two of those angles have are same. So, for example here, this and this are 100 degrees, so both of them are equal, but the third angle is different. So, this is our solid in the dimetric view. So, as you can see, let us say the front face and the side face, both have the same dimension, whereas the height is slightly squeezed.

The difference is I will explain, so previously we were working with isometric, where all three lengths are equally proportional. But now, what I do is, I tilt it in a way that the height dimension is squeezed. So, if you are focusing on the top face, you will see by tilting of these you will see less and less of this top face, but you will see more and more of this front view and the side view.

So, what it means is you are emphasizing more on the front view and the side view and less emphasizing on the top view. It all depends on the choice of the angle. Here since it is 160 this happens, of course you can always say that instead of making it 160 you can tilt it in this fashion then the top view gets more emphasis and the other two have less emphasis and lastly, saying that that three angles are different.

For example, here we say 120, 100 and 140. So, here is our solid in this trimetric drawing. So, the point to make is isometric drawings are very common, but dimetric and trimetric are very rarely used, because essentially they take much time to construct the drawings. So, isometric is easy because now you say all three sides have equal proportions or the scaling is the same, so it is easy to draw. But here since you are now distorting or changing the angles, then you need to take care of it and it becomes a little more tedious.

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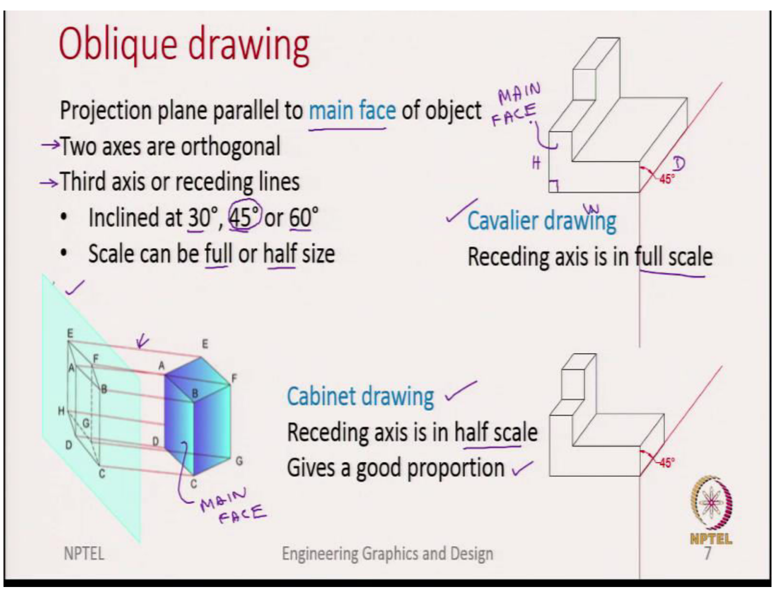

So, now we come to the second category of these pictorial drawings called the oblique drawings. Oblique drawings, as we already mentioned here, the projection lines are parallel to each other. But the only difference is, when they cross the projection plane, they are meeting the projection plane at an angle, not perpendicular to the projection plane, but at an angle to the projection plane.

So, let us look at the our solid and see how it looks like in the oblique. So, what you will notice is this first two axes are orthogonal. So, let us say the width and the height, these both are orthogonal. But when you look at the depth, this lines which represent the depth, we call them as the receding lines, they are all parallel to each other, but they are at an angle.

So, depth which we use in this example is the third axis, they are also called receding lines or receding axis. So, the point we are trying to make is two axes are orthogonal, which means they capture the true angles. So, if you see here, even in the oblique drawing or the pictorial drawing, we capture the true angle here 90 degrees, which was not possible with the isometric, there we were capturing only as 120 for any perpendicular angles.

But here, we are able to capture it in the front view let us say, but in the depth, we have an angle and this angle, you the commonly used ones are 30 degrees, 45 degrees or 60 degrees. But out of these, what is more common is 45 degrees that we have shown in this example and this receding axis, we can either do it full scale or half scale or full size or the half size.

When we use it as a full size, we call them as Cavalier drawings. But when we use them as half size, we call them Cabinet drawings. So, the only difference is the receding or the third axis, do we capture the full size or the half size. When we capture the full size, we call it the Cavalier and if it is half size, we call it Cabinet.

And point to notice Cabinet gives a good proportion of the solid, so it gives a good feeling of the solid because as you can see the Cavalier looks much longer, especially in the depth direction, but Cabinet looks more realistic comparatively. So, I think I did not mention this saying that the projection plane is parallel to the main face. So, this is the projection plane and this is parallel to the, let us say this is the main face here and even in this, let us say this is the main face. How do we define the main face? Main face is the one which captures the most important features of the object.

So, we choose the main face because we are the ones who needs to choose which of these is a main face, for a cube it does not matter, but for a arbitrary shaped object, we need to see which of these views will capture most of the features and that we say as the main face and once we do that we place the projection plane parallel to the main face.

Because now the main face will capture the true size as well as true angles. Only in the receding or the third axis we are not able to capture the true angles, there is a distortion in the angle, with this we complete the second category the oblique drawings.

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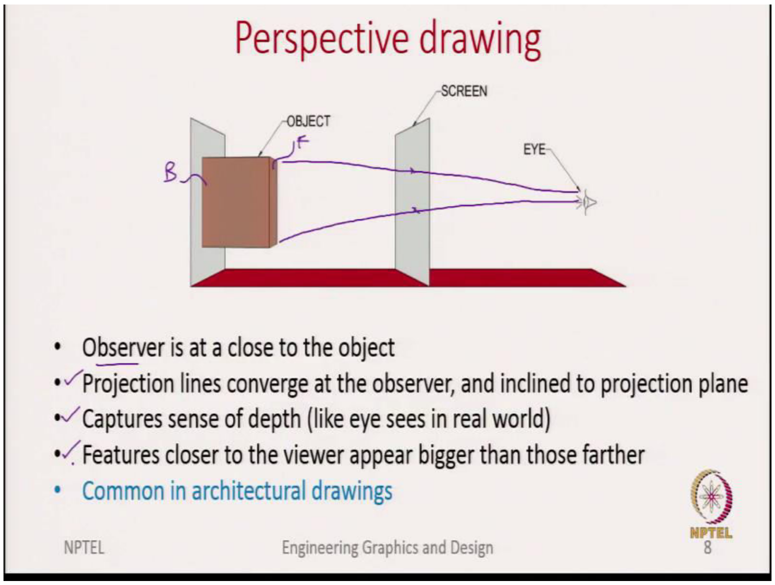

Lastly, we move to the perspective drawings. The third and the last category. As we already mentioned, perspective drawings capture the real world. So, those which you take a picture, and you see especially those items which are relatively close, your photo as well as the perspective drawings look very close, because perspective drawing capture the real world views.

So, now let us look at few more details saying that we already mentioned that the observer is close to the object, when the observer is close to the object the projection lines converge to a single point. That is exactly what the second point is saying that the projection lines converge at the observer and incline to the projection plane.

So, when these projection lines come, they intersect the projection plane, not at 90 degrees, but other than 90 degrees. So, it captures the sense of depth. The reason being I think we have already discussed in week 2 saying that if you focus on the front face of the cube and let us say the back face of the cube and then try to capture it on the screen, you will notice that the front face will be captured as a bigger square or rectangle and the back face will be captured as a smaller.

So, which means the face which is closer to the observer is shown a little bigger than the face which is far from the observer. Assuming that both features are of the same size. Features close to the viewer appear bigger than those far. So, these are most commonly used in architectural drawings, perhaps most of us have seen paintings or even proper former architectural drawings depicting how a building looks like.

So, I am pretty sure all of you have walked in a long corridor and if you remember, that corridor looks like it is all, let us say it has all parallel pillars, they are all trying to meet at some far point that is one way of perspective drawings. The other is, if you step onto the street and you go to the corner of a building, so let us say this is the building and you, the observer is standing here and looking at it.

So, he is looking at the front of the building and the side of the building and then one can draw a perspective drawing we will show that how it is, we do not go into the details, but at least we will say, what is the basic principle of capturing these perspective drawings and the third category is when you just do not go into the corner of the building. But let us say you take a drone and look at the same building from top so that you just you also look at the top of the building, as well as the front and the sides.

But now since the drone is at a reasonable distance from the building, what you get is not an isometric view, because for that you need to be very far. But from a drone, where you are relatively closer then you capture the perspective of this building. So, the three examples I told like the corridor can be depicted using something called a one-point projection.

Going to the corner of the building, you capture this drawing using something called a two-point projection and the drone example where you look at all three phases of the building from either the top or I think from the bottom is not possible, but if you are looking at the top, that captures a three- point perspective. So, let me quickly show you those three categories, and then we can conclude.

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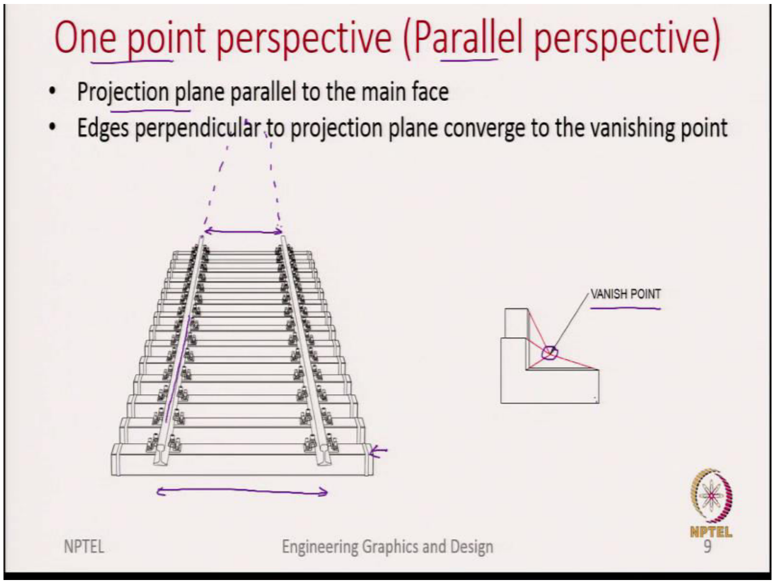

So, here is the one-point perspective also called parallel perspective. So, previously, I was mentioning about you standing in a long corridor, but you can also I think, we have all seen this. At least the picture if not in reality that looking into the tracks, which are railway tracks, which are very long, you have a feeling that these tracks are maybe meeting each other at a far distance.

So, let us say somewhere at a very far distance, these are converging each other. So, again, the point being that objects which are closer, so let us say this part, which is closer to the observer looks big, because this distance looks big. Similarly, the same thing which is farther the distance looks relatively small, though in reality both are of the same size.

So, this happens when we are looking right in front of the object. So, in this example of the railway track we are assuming that we are looking onto the railway track right in front. We are not stepping out of the railway track and looking from the side but right in the front. So, this is where we call that the projection plane is parallel to the main face. So, for example, here we depict the object we have been continuing to see in this lecture.

So, here it is hard to see the depth dimension, sorry for that, but what I am trying to say is, you focus more on the front view and the depth dimension though it is a little hard to see, basically what is happening is those parallel lines which are perpendicular to the front view, they are all converging to a point.

So, here is what I meant by converging to the point. So, all these depth dimensions, so let us say they are all converging into this vanishing point. So, the point where they are all meeting is called the vanishing point. In a one-point perspective, you only have one vanishing point.

So, here we say that the edge is perpendicular to the projection plane. So, for example in this, this is the railway track is the edge perpendicular to the projection plane. So, this is the projection plane, and this is the railway track. This lines which are perpendicular to the projection plane, they are all meet into one single point called the vanishing point.

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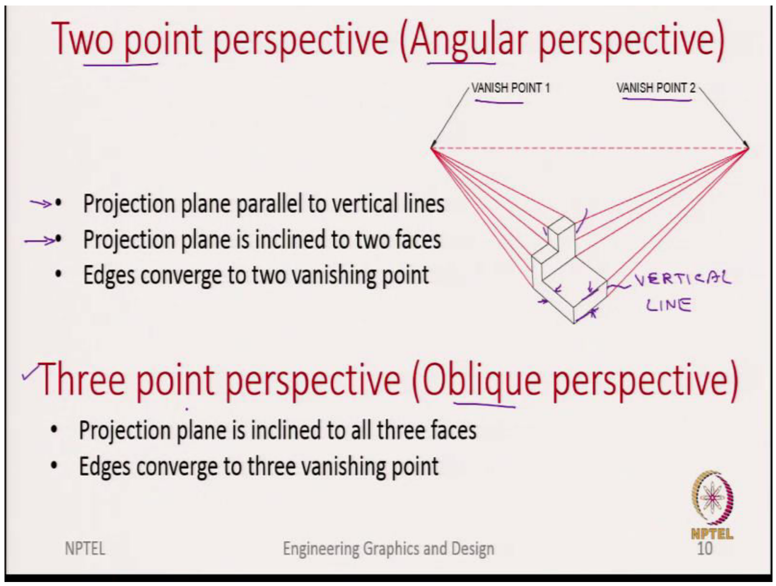

So, now let us look at the two-point perspective, which we also call as the angular perspective. So, here we show the object we are looking at, there are two important points to know. First is the projection plane parallel to the vertical lines. So, for example, if you are looking at this as the vertical line, this as the vertical line, we see that your projection plane is parallel to the vertical line.

And we are also saying that the projection plane is inclined to the two faces. The example you remember I said, you go to the corner of the building and look at both the front and the side view, this is what I meant by where projection plane will be in this direction, because the observer is here.

If we have this as the projection plane for this building, then this projection plane is inclined to this front view, as well as this projection plane is inclined to this front view, it is neither parallel nor perpendicular. So, in this case, what we see is there are two vanishing points. So, essentially, these lines, which capture, let us say the depth, these lines, they all converge into this vanishing point two.

But these lines which capture the width, they all converge into vanishing point one. So, based on how the observer is placed with respect to the object, we either have one vanishing point or two vanishing points, we have one vanishing point if the observer is looking right in front of the object, but if he is looking at from a side of the object where he can see two faces, then we have two vanishing points.

So, I am sure all of you have seen this, in architectural drawings or paintings when they depict neat buildings and all usually most of them are two-point perspective. Because it gives you an impression that you are standing next to the building and looking at it.

And lastly, the three-point perspective. Here as we said, in that example, that we now take a drone and look the same building from the top such that we look both at the front, side and top of the building, then we capture the three-point perspective also called as the oblique perspective. Here, what happens is even your height, so for example this vertical lines, in a two-point perspective, the vertical lines are all parallel to each other.

But in a three-point perspective, what happens is these vertical lines, they are all inclined and again they all converge into a third vanishing point. So, that is why it is called three-point perspective. As we said, like, these perspective drawings are more real world, they give us the real-world appearance and mostly used in the architectural drawings.

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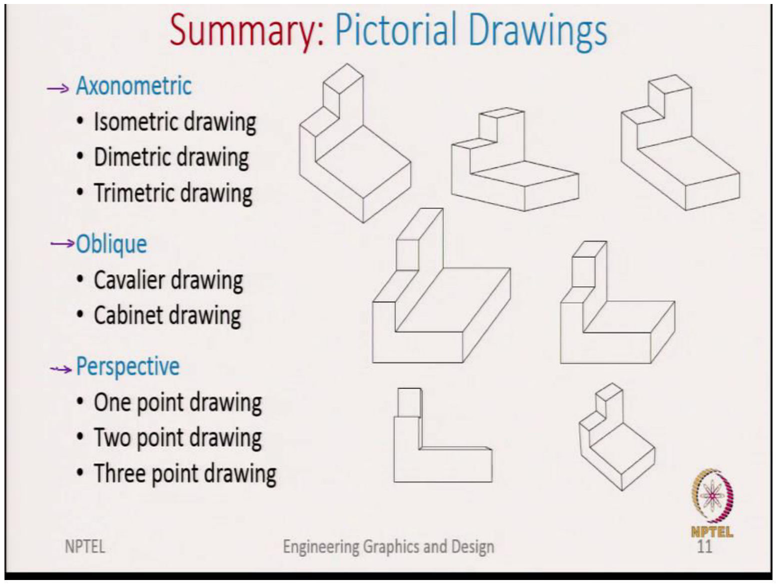

So, let us summarize what we discussed in this lecture. So, what we said is there are three categories saying the axonometric, oblique, and perspective. These are the three major categories of pictorial drawings, which show us the three sides of the object in one single view and in this there are different categories.

So, first we looked at isometric drawings, dimetric drawings and trimetric drawings. The basic difference is the angles between the axes in the isometrics is equal, in dimetric is only two of those angles are equal and in trimetric, all three angles are different. In oblique again, we said we have two categories, the cavalier drawings and the cabinet drawings.

The basic difference between them is how do you capture the receding axis or the third axis, if you capture the full scale we call the cavalier drawing and if we only capture the half size, then we call them as cabinet drawings and the cabinet drawings are more realistic compared to the cavalier drawings.

And lastly, the perspective drawings. We discussed about one point perspective drawing and the two-point perspective drawings. Though I did not show the three-point perspective drawings, we said the vertical lines to converge into the third vanishing point that is the difference between the two-point and the three-point perspective drawings.

So, in summary, we have seen there are many different kinds, different ways we can represent the object on a 2D drawings and depending on the applications, some of them are preferred. For example, axonometric drawings are the most commonly the isometric drawings are used in manufacturing or to prepare in the workshop or a fabrication facility. Oblique drawings are also used in the manufacturing.

The good thing about the oblique is, since the front view is captured as though it is an orthographic drawing, so it becomes easy to measure the dimensions of the object from the front view and the depth is only shown mostly for to give a realistic impression to help us with the mental picturing of the object.

And lastly, perspective drawings are more commonly used in the architecture because here we want to give them a perspective of as though we are taking a picture of an object, where the observer is relatively closer to the object.

So, in the next lecture, we will be looking at the isometric drawings because we said this is the most commonly used drawing. We will also with the help of examples, we will illustrate how to go from multi view drawings to isometric drawings and we will show you a few techniques how we can help you draw from the multi view drawings to the isometric drawing. Thanks a lot.