Engineering Graphics and Design
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Lecture No. 05
Introduction (Sketch to engineering drawing)

Welcome to this course, engineering graphics and design. Today we will look at certain aspects of sketching, which end up in an engineering drawing. So, this is the last lecture of the first week.

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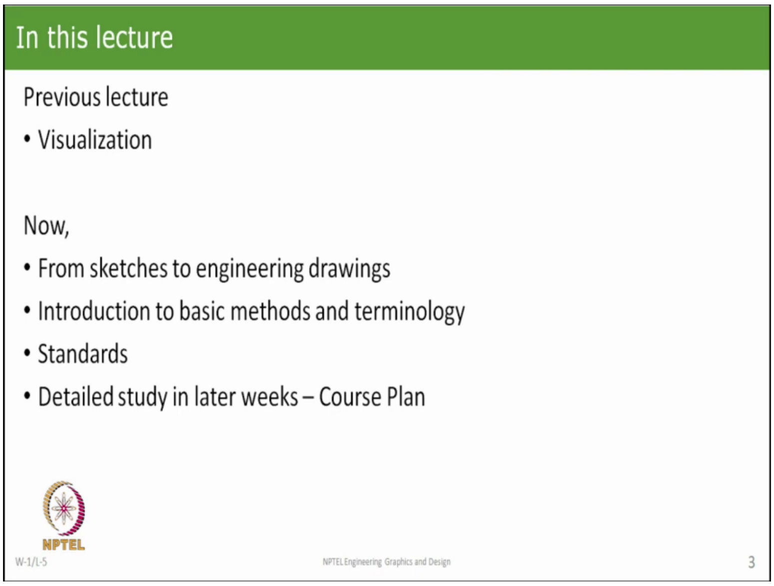

And in this we will look at from where we left off the visualization in the previous lecture. And now, we will see how we get to an engineering drawing from a sketch. We will see some very basic aspects of making a drawing. I will briefly introduce the standards and all of this will give you an overview of what you will be learning in the rest of the course. So, in a way, this is a very concise way of presenting to you what is the course plan.

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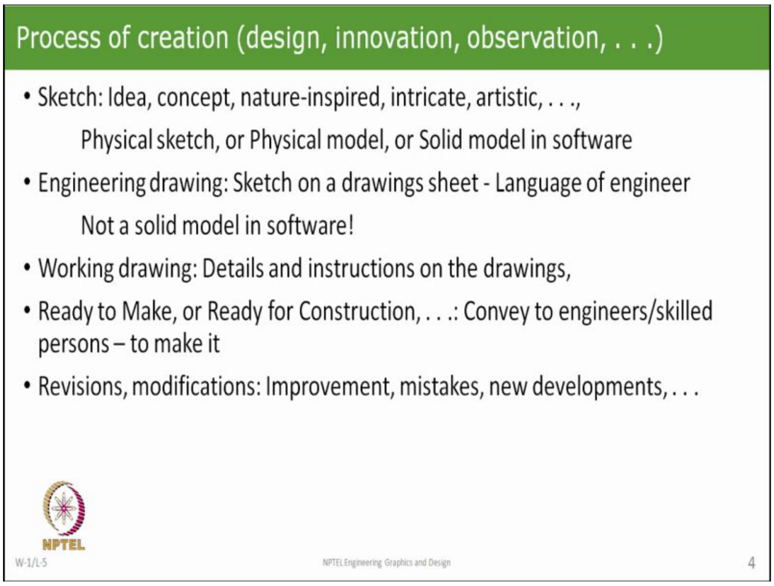

So, to go back, we started off with the idea of sketching. And we said that here we make a drawing either physically or with a physical model or with the solid model in software. And this is largely an approximate concept that there in our mind, it is not something that can be immediately taken for making it. But the person who will make it needs to know some information in a particular format or a particular style and that is what starts the need for an engineering drawing.

So, in an engineering drawing, we always express it on a drawing sheet. And this is drawn in a way, which is what we will call and learn in this course as the introduction to the language of the engineer. And this is not the same thing as making a solid model in software. It is something more than that. In many cases, we can have the solid model. But from there we extract information and present it in such a way that we go ahead with what we call the language of the engineer.

The next thing is, while we have made the drawing, we need to add some more information before somebody can take the drawing and start making it. So, you ultimately want to take the drawing and something physical word comes out of it. It does not just remain as a sketch or a drawing, it is a medium to make something. So, we add more details, we add more instructions to the drawing, we add more information, some do's and don'ts.

And then we have reached a point where we are ready with a drawing which we can give it to somebody, an engineer or a skilled worker who can make it or who can make the construction out of it, who can fabricate it. And that could be a mechanical part, could be a civil engineering structure, could be an electronic board, could be anything. So that is what we have here.

And finally, the last point I have on this slide is the drawings once they are made or not made for life. Some of these drawings will get used over many years. And as time progresses, the engineers who made the product will modify it. Maybe there were mistakes made there are improvements, there are new developments have taken place, so they modify that part. So, this is what we have as a complete process of all the types of drawings that we will work with.

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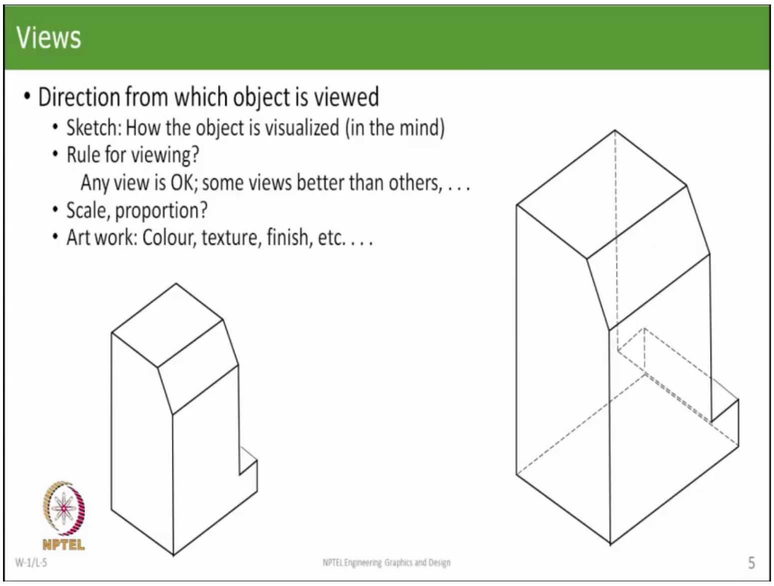

So, let us start with the important parts of what the drawing sheet will have. In the previous lecture, we saw that drawing sheets have certain sizes, which is dictated by certain standards. So, that is one piece of information we have. The second piece of information, we have made an object or we have an idea of an object. And we want to present some information or pictures about it.

So, we do not just take a photograph and make a wireframe out of it. We actually make the drawing. So, what do we have? What we call as 'views', which is basically what is the direction from which you are looking at the object. So, what we are doing here is, we have an object say, a picture that I have shown over here, this is an object that is referred to again and again in many of the standards that you will come across, so, I picked it up.

So, you can see that this is this part of it a sort of rectangular block, whose one of the edge has been chopped off. And on this side, it has a small protrusion, which runs the full length on this side. And this is one of the views of the big objects. That means, if we see this object from this particular direction, we would see this. So, that is one thing, which is a view. We could view it from this side, we could view it from that side.

We could view it from here we can view it from the top, we can view it from the bottom everything is perfectly fine. Except that as an engineer, you have to decide which is the best view to put, some view may look very clear, some may look very cluttered, some may miss out on some things, and maybe one view does not even give everything as we will see in a few minutes.

What you also do not see is that what we are shown on this block are only the edges, edges where 2 surfaces are meeting. Otherwise, everything here like this one is a plane surface. So, we are saying that these are surfaces, which although on the drawing look white are actually opaque. So, we do not know what is behind it.

So, like this, we have one surface here, one here, one more here, one here, one little here, and then there are others which are not coming out in this view. So, let us see what is not in the view now. So, this is that same object and what we will do is any line which I am not able to see on this, I will put it by a dotted line that denotes that this particular line is behind the surfaces that we have seen.

So, on the object it is at the backside, which is there, but I cannot see it. So, here is one part of the line, which is an extension of this particular line it goes back up to some point and then there is this surface, which was like a rectangular surface projecting out and this completes that we are saying that there is the surface there hidden from our view, which is like that and then we say that well what is happening below it?

And then we get the surface on the right side which we cannot see fully. In fact, this surface that we are seeing now, this particular surface in this picture that we have drawn, it is not visible at all is completely shrouded by this surface then there is a line from there to the edge of the top of the edge and one line from the bottom edge which completes the object. So, if I draw all these lines together, you need to accept that dotted lines means something that I cannot see which is behind it.

And if I show all these lines, I can see the surface I can conceive the object but the picture has become a lot more involved. And could be such object could be much more complicated than this, in which case there will be so many more lines that you actually start getting confused. So, we need a systematic way to make drawings simple neat and easily understandable. But what we do not show engineering drawings is that what is the surface?

So, first thing that we have to think of presenting an object is that the way we put it we have produced what we call is a ‘view’. Simply, it means we have taken the object and viewed it from a particular direction and the way that I saw it, we made that sketch. So, that is simply what we call the viewing direction. And there is no restriction on which side we can view it from.

We can wait from any side top, bottom, left, right at any other angle, everything is perfectly okay. It is just that we will decide. So, what we are looking at is that we are going to present our object as a combination of views. So, the first technical term that has come out is the word, ‘view’. And view means how does the object look like when we look at it.

Now there are infinite number of directions from which we can look at an object. And that would mean that you could present lots and lots of aspects of the picture. That could make too many drawings. And that is not possible. And so we have to decide, which is the best way to convey all the information about the object and have a small set of views, maybe 1, maybe 2, maybe 3, maybe more.

What scale or proportion should we use? That is another issue, we will come back, we had seen it in a previous lecture. If the object as a drawing sheet size is fixed, if the object fits into it nicely used that size, if it is too big, we have to present it on a large scale. If it is too small, we have to enlarge it and present it. And finally, in engineering drawings, we do not show artwork, colour, texture, or finish.

There might be notes added to it. But the drawing is always in black and white. In CAD drawings, we could have some more colours. But by and large, all drawings, irrespective of the type of drawing is always black and white. So, let us take an example. Here is an object which I have taken from the Indian standard, which is referred to time and again. So, if you see the standard, you will see this object coming up in various contexts.

It is basically a rectangular block whose one edge has been chopped off, and on the side, one small little edge has been added. So, what you are seeing here is that this thing, which is plain white, is actually the surface, which is opaque, we have not coloured it, we have not shaded it, but it looks same as the sheet outside. But in this drawing, everything that is enclosed in these lines is a surface.

And in the view that we have drawn, this surface is opaque. Which means that when we viewed this object from this direction, we do not know what is behind something is hidden. And so, we do not have the full information about this object. Although in this case, we could assume that certain things are there, and we can proceed to complete this object. And let us do it here, the same thing has been enlarged.

And now let us say I want to show all the lines which I cannot see. And by lines I mean the edges wherever 2 surfaces are intersecting. So, basically all these lines that we are seeing here in this drawing are lines where say this flat surface and this surface intersecting I see this line between this and this, this region, this is flat, it may even be curved. And whatever geometrical curve, it is, we will there will be no line in it, though if it is a very defined curve.

So, let us see now what are the hidden lines in this. So, that is the first thing we say, well, you have this edge actually goes back all the way. So, that is a dotted line, then we say that since this is a rectangular strip, which we will see from the top, it will have this all these lines, which completely tell you that there is this surface on the backside of this object. Then we complete the vertical face looking on the other side. And that completes back view.

And then we say that look, this is all part of this bigger object. So, there is a line that goes from this edge to the top and the line that connects the bottom right edge to the front left edge. So, you have this line there and this line there. And with that, we have the complete object coming up. So, now we had full information about the object. There is no ambiguity. There is no guesswork left in this, but we have done it at the expense of making the drawing more complicated.

We have added many more lines. And things already are beginning to look a little confusing. And it could well be that engineering objects which are far more complicated than this one will get so cluttered that making the entire sketch or conveying that full information in one picture is just too much of an hassle. Our objective then is how can we make simpler sketches which are clear, clearly understandable and if one view does not give all the views, maybe we will get two views which together can be combined to get the full object.

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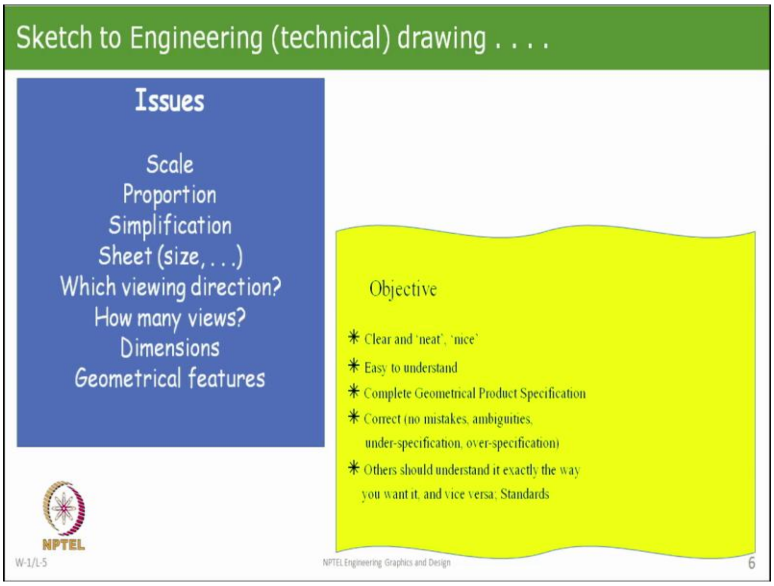

So, what does what do we what happens in a technical drawing? So, from a sketch, we want to make what we call an engineering drawing or a technical drawing. And there are many issues we have to deal with. And the person who makes the drawing has to put in consider all these aspects with the view that not only is the drawing complete, but somebody else whom you do not know who you will never meet should unambiguously clearly understand what you have made.

That is a fundamental requirement of engineering drawings. So, here are some of the issues that go into deciding how to make a drawing. So, first is of course, what shape size should I use? What should be the scale on which I should show the object? What should be the proportion of sizes or different directions? How can I simplify the views? Which would be my viewing direction?

How many views should I give? One view is not giving all the information, can 2 views give it? Do I need to give 3 views? We also have to understand that when we give views that is where we specify all dimensions. And when we are saying views, we have to clearly and completely specify what are the geometrical features. Cylindrical it's spherical, it is something else, it is a flat surface, whatever that may be, though, that is all that goes in to make a complete engineering drawing.

And our objective in making drawings is, first, our drawing should look clear, it should look neat, it should be nice. And of course, we are presuming the drawing should be legible. It should not be too light should not be too dark, it should not be too cluttered. For example, if you made a drawing, but the photocopying process made the lines very hazy, you can say I made the drawing I photocopied it, but it has lost its goodness.

So, these are very qualitative characteristics of every drawing, it should be clear, neat and nice. Very simple to say takes a lot of effort to make it that way. Second attribute of a drawing should be easy to understand. Not just for you, but for everybody else. So, either you have to think the way the other person thinks or the way this communication becomes clear and unambiguous is by the use of standards.

So, the person who makes a drawing follows certain standards and the person who is reading the drawing follows the same set of standards, there will be no confusion. The next is what we call geometrical product specification. Our objective of making engineering drawing is to convey the geometry of a product component and specification gives you all the values like the size, the curvature, all of that. So, GPS, in this context is what we are looking at.

The next attribute of all engineering drawings is that engineering drawings have to be 100% correct. Almost correct drawing, not acceptable. Just a mistake, just something missing. Not acceptable. If a drawing has ambiguities. The person who is making the drawing will not proceed with making the drawing that person is not supposed to decide what is correct, what is not correct.

The drawing will come back to the person who made the drawing, you clear it up. There should be no under specification. For example, if I have to give dimensions, some dimension if it is missing, that completes the drawing, cannot be made. No over specification. There is no need to give the information over and over again, it could actually lead to conflict. So, all the information required to make the drawing complete has to be there nothing less, nothing more and everything should be correct that is another attribute.

And lastly, remember a drawing is made for reading by somebody else, not by you. So, others should understand the drawing exactly the way you want them to understand it. And vice versa, if you are using a drawing to make something, you must know exactly what the drawing contains without knowing who has sent it to you. And there should be no ambiguities, no mistakes and very clear concise interpretation.

This is where this last aspect standards this comes in very, very important. All engineering drawings are made to certain standards. As I mentioned in the previous lecture, there are Indian standards, drawings go all over the world. So, there will be international standards and

Indian standards are harmonized with international standards. So, that the drawing made in India can be read exactly, unambiguously anywhere in the world, and vice versa.

So, all throughout this course, whatever we are learning, we will go as per standards. Standards are not hard cast, they also give us a lot of flexibility, but tell you how to get the flexibility in unambiguous way, so other persons can interpret it.

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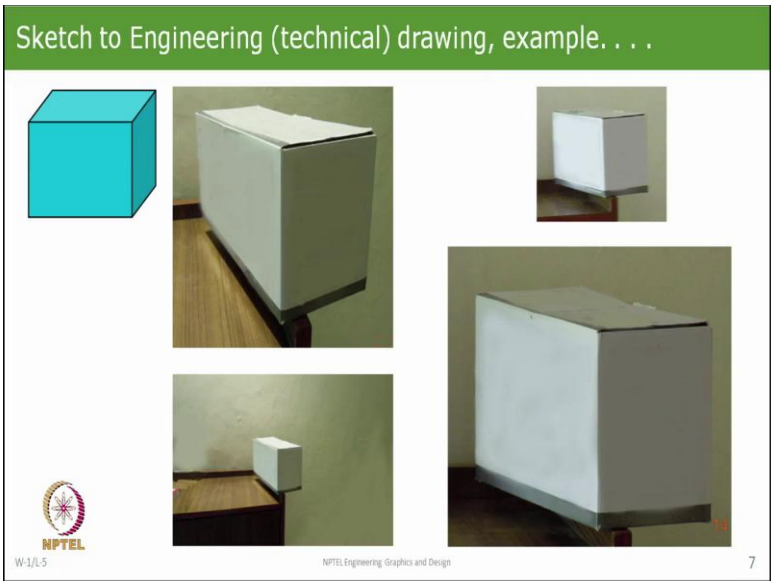

Now, what happens when you take a sketch, and you want to make a technical drawing of it. And this is something you can do. Let us take the case of a rectangular box. So, if you use a CAD package, and I have done this in one of the software itself, it makes this drawing where it tells you that there is a box with this dimension is this much, this dimension is this much, this dimension is this much.

And it tells you that this is a rectangle, this is a rectangle, this is also a rectangle with the way we are depicting it, they all look at different angles. To the rectangular box, all angles are 90 degrees. This is an idealization of a box. But now if I, take a box and see it from different distances and different directions. The box does not look like this. And here is what I have shown some views.

And you can do it yourself. Just take a box, look at it through a glass, look at it through a camera. And you will see various things happening to the box. So, look at this picture. This photograph was taken from very close to the box. With not much of zoom. And what do you see, this edge has got certain length in this picture. The backside, this length is much smaller. The actual box was a rectangle.

In this picture, it is changed its dimension. This line is no longer parallel to this line. But we are viewing a rectangle. Similarly, this line is slightly off and not parallel to this line. On the top this edge and this edge are not only not parallel, but the lengths are also different. The thing is that from this viewing point, this is what we saw. And what we saw is not exact box that it was we saw something else. That is the way our brain has interpreted it.

Although in this case it is the camera, our brain does the same thing. So, in our mind, if you want to do the reverse and create this impression, you would have to make a drawing so that as you go further away, things keep getting smaller. The similar thing here by zooming out, we see the same issues, but to a lesser degree, these lines are still tapering this distance is more than this distance.

So, we are not seeing what we may call the true picture, which is what we started off wanting to visualize, which is this picture. Here we give the true shape, the true size, the true geometry of the cuboid. Here there are different views. So, what I have done here is go far away from the box. So, I went to the other end of the room and said, well let us see now what happens.

And from there, if you take a photograph and trim it, this is what I see. Object has become smaller, the whole picture was much bigger, and I have trimmed it. But what we see here is that this line is pretty much parallel to this line, this distance is pretty much same as this distance. The amount of distortion we were seeing here is much less in here. But we have gone far away from the object.

And from that faraway distance, if I zoom in using the camera, the eye cannot zoom in. But a lens or a camera can do that. So when we do that, this is the big photograph that comes out. And here you begin to say, you know, this is almost the same size as this, this looks almost parallel to this, this looks almost parallel to this. And they are the same size. Even the top biggest to look like is almost a perfect rectangle or viewed in a certain direction.

So, what we have done is this picture begins to look more and more like this picture, which we called in the first place as the ‘true picture’ or ‘the true view’. So, these are issues that are coming up in the drawing.

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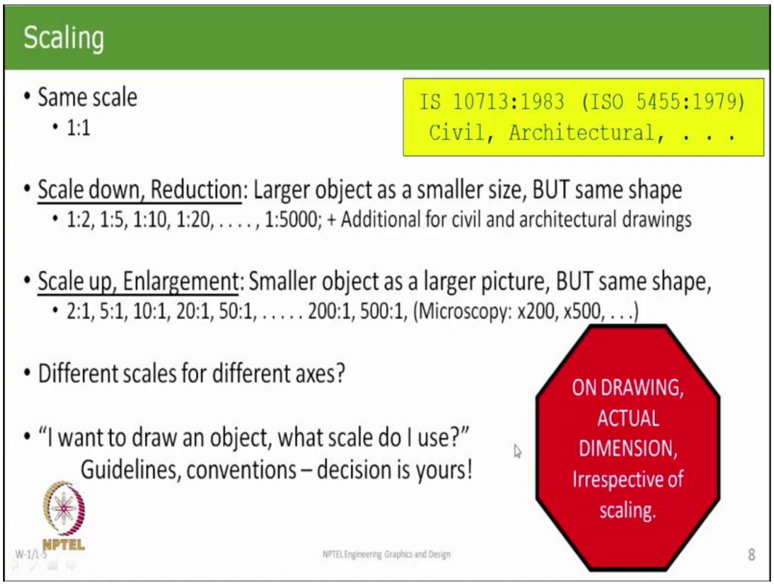

So, to review, what we have done, we can scale it as we saw in this picture also. And the Indian standard that deals with scaling is IS Indian Standard 10713 which is identical to International Standards Organization, ISO standard 5455. And there are similar scaling requirements for civil drawings, architectural drawings, and some other drawings. But for mechanical engineering drawings, we have the following options of scales, theoretically we can have any scale, but the simplest one is scale 1 : 1 that is on the picture, we show every dimension exactly the way the real object is.

And this is a true view. If you looked at the earlier slide, the tapering view is not used. It is good for visualizing, but is not good for engineering drawing. Then we can do scaled down, which is reduction. And here we can use 1 : 2, 1 : 5, 1 : 10, 1 : 20. So, it goes in this ratio 2, 5, 10, 20, 50, 100, like that. So, we do not have the option of scaling down by 1 : 3. Not down.

There are some more ratios available for civil and architectural drawings. But you do not have an infinite number of ratios at which you can make an engineering drawing. Certain numbers are specified. When you want to blow up an object, enlargement scale up and again we have these ratios, you can double, 5 times, 10 times, 20 times, 50 times, 100 times and like that.

And different types of microscopy produce pictures, which are denoted by x200, x500 and so on. That denotes that the object you are seeing is say in this case, x500 means the object you are seeing is 500 times you are seeing something which is 500 times bigger than the real stuff. Can we use different scales for different axes? As we have seen 3 dimensional axes up there, there are certain conditions under which we could do it. We will come we will learn about it later in the course but by and large, let us not worry about it too much at this point.

So, now we have reached a point where we say I want to draw an object, what scale should I use? And what is the best combination of scale and the sheet size, which will do everything that I just put there are the objectives of the drawing. This decision rests with the person making the drawing.

There is no hard and fast rule that you must draw this as per this. Or if you have seen assignment or tutorial sheet, draw this to this scale, but you are being asked to do it. In the real world nobody tells you what to do it. Your decision, and you have to be very well aware of how that decision should be made. An important thing about dimensions of scaling, is that when we make a drawing, it may be scaled up, it may be scaled down.

But the dimensions that we show on the drawing will always be the actual dimensions, not the scaled down dimensions. So, irrespective of the scale on the drawing, we will always show the actual dimensions of that particular object. We may scale down the drawing by a factor of 20 and so 20 meters may look like 1 meter, but on the drawing, we will write 20 meters, not 1 meter. So, that is an important thing to keep in mind all throughout this course.

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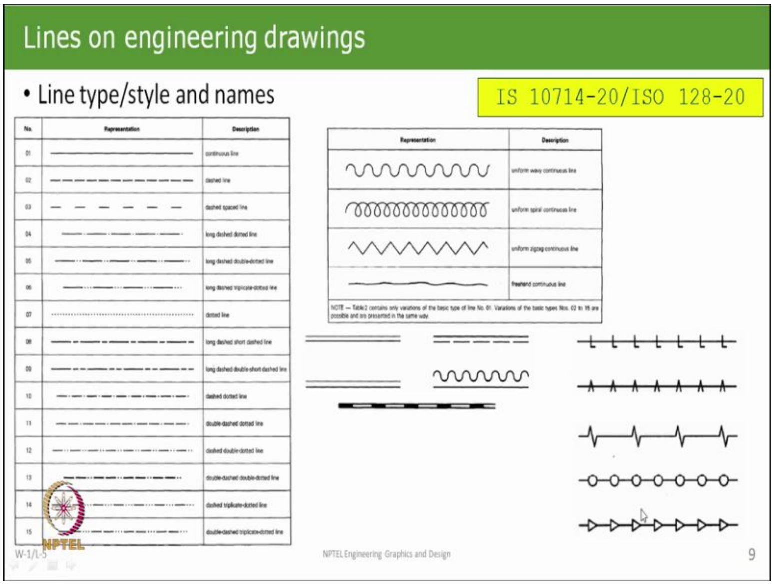

The next thing is to show a view or an object, I need to use lines, everything is done by lines. And we are not thinking of shading and shadows. In that sense, they are separating. They are also very important in visualizing architects, various types of visualizing peoples they do it in engineering drawing, mechanical engineering drawing, and many architectural drawing, we do not do that.

So, Indian Standard 10714 part 20, identical to ISO 128 part 20 gives a list of lines, which one can use. And it also tells you what the name of that line is. So, in this case, the first is a solid line, and it just says a continuous line. We have not said whether it is thick or thin, but those are again variants within that then you could have a dotted line, a dashed line, there is a dashed and a space plane then you go down you have a dotted line here you have a line which is dotted and with a dash.

So, like this, you have a whole variety of lines, which have which can be used. And as you go through the examples, each one of them actually maps to a particular meaning then here it said there you can even use these type of lines, this looks like a spring, this is a zigzag, this is just a freehand line. And then we can use double lines of different types or you can use double lines with tick dash between in between them.

Then there are lines on which you can put this type of symbols you can put L, you can put this, you can show this which tells you that this is a long piece which has been broken down then you have circles you can put anything else. So, there is flexibility in this, but they all have a certain expected interpretation.

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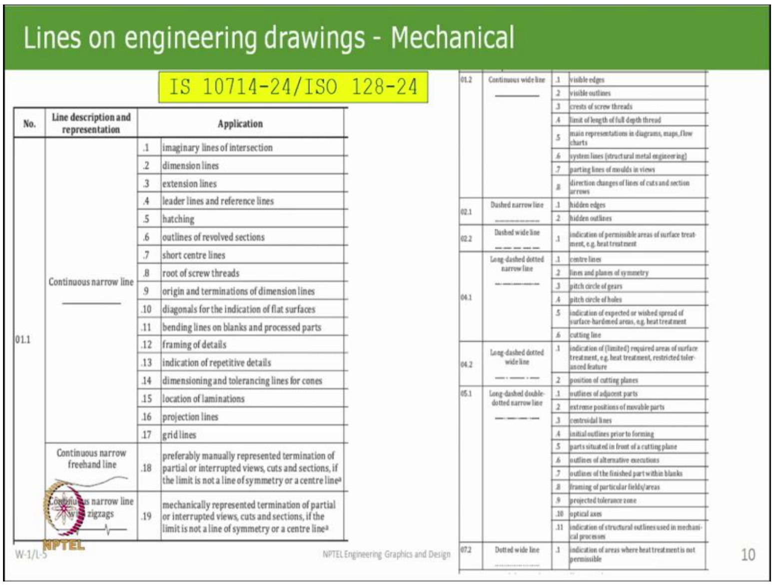

No.	Line description and representation		Application
01.1	Continuous narrow line	.1	imaginary lines of intersection
		.2	dimension lines
		.3	extension lines
		.4	leader lines and reference lines
		.5	hatching
		.6	outlines of revolved sections
		.7	short centre lines
		.8	root of screw threads
		.9	origin and terminations of dimension lines
		.10	diagonals for the indication of flat surfaces
		.11	bending lines on blanks and processed parts
		.12	framing of details
		.13	indication of repetitive details
		.14	dimensioning and tolerancing lines for cones
		.15	location of laminations
		.16	projection lines
		.17	grid lines
	Continuous narrow freehand line	.18	preferably manually represented termination of partial or interrupted views, cuts and sections, if the limit is not a line of symmetry or a centre line[a]
	Continuous narrow line with zigzags	.19	mechanically represented termination of partial or interrupted views, cuts and sections, if the limit is not a line of symmetry or a centre line[a]

01.2	Continuous wide line	.1	visible edges
		.2	visible outlines
		.3	crests of screw threads
		.4	limit of length of full depth thread
		.5	main representations in diagrams, maps, flow charts
		.6	system lines (structural metal engineering)
		.7	parting lines of moulds in views
		.8	direction changes of lines of cuts and section arrows
02.1	Dashed narrow line	.1	hidden edges
		.2	hidden outlines
02.2	Dashed wide line	.1	indication of permissible areas of surface treatment, e.g. heat treatment
04.1	Long-dashed dotted narrow line	.1	centre lines
		.2	lines and planes of symmetry
		.3	pitch circle of gears
		.4	pitch circle of holes
		.5	indication of expected or wished spread of surface-hardened areas, e.g. heat treatment
		.6	cutting line
04.2	Long-dashed dotted wide line	.1	indication of (limited) required areas of surface treatment, e.g. heat treatment, restricted toleranced feature
		.2	position of cutting planes
05.1	Long-dashed double-dotted narrow line	.1	outlines of adjacent parts
		.2	extreme positions of movable parts
		.3	centroidal lines
		.4	initial outlines prior to forming
		.5	parts situated in front of a cutting plane
		.6	outlines of alternative executions
		.7	outlines of the finished part within blanks
		.8	framing of particular fields/areas
		.9	projected tolerance zone
		.10	optical axes
		.11	indication of structural outlines used in mechanical processes
07.2	Dotted wide line	.1	indication of areas where heat treatment is not permissible

And examples of lines on mechanical drawings are given the standard IS 710714 part 24 and it says number 01.1 continuous narrow line. And within that there are various things for which this line can be used. 17 things which can be used to denote with a continuous 10 line.

Dimension lines, extension lines, you will learn all this as we go in the course and it could be even this type of a line then zigzag line which is still a thin line and then there are lines which are continuous wide line.

So, that means this is thicker, what all it can denote? What does a dashed line denote? What does a long dashed line denote? What dashed and dotted line denote? So, like this there are many examples. As we go along in the course, we will use many of these.

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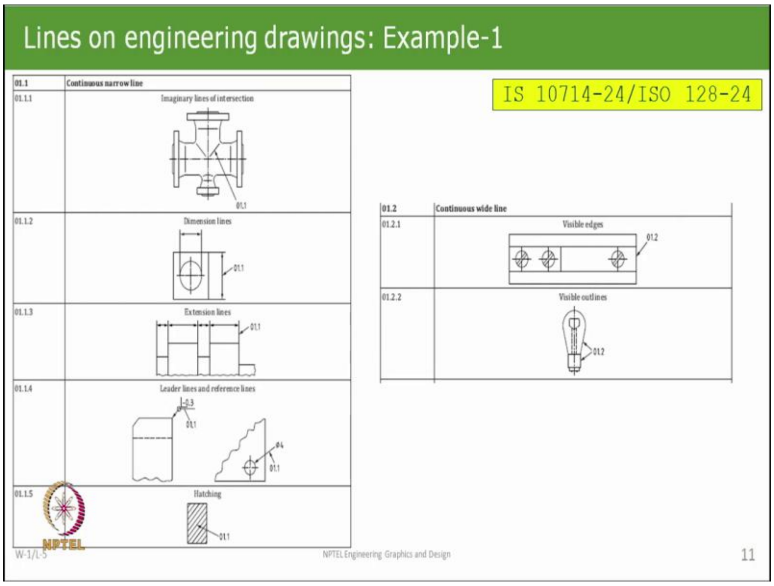

Then there are some more examples given here of objects to show how those lines come and what type of line would be there. So, like in this case, this is a rectangular part with a hole in it, it has got these lines there, it has got these lines and it has got this thing which is what is called here as a dimension line. Same thing here this is the dimension line and said this is line type 01.1, a thin continuous line.

So, like this, there are many things there this is what is called hatching and this is what is called a visible outline. So, this is a typical say a bulb, which has got this glass envelope. And what this line shows a continuous line, a thick continuous line is that this is the outline of the object. And that is what I have shown in that first example that I gave a few slides back. The object lines were shown at the outlines were shown by thick continuous line.

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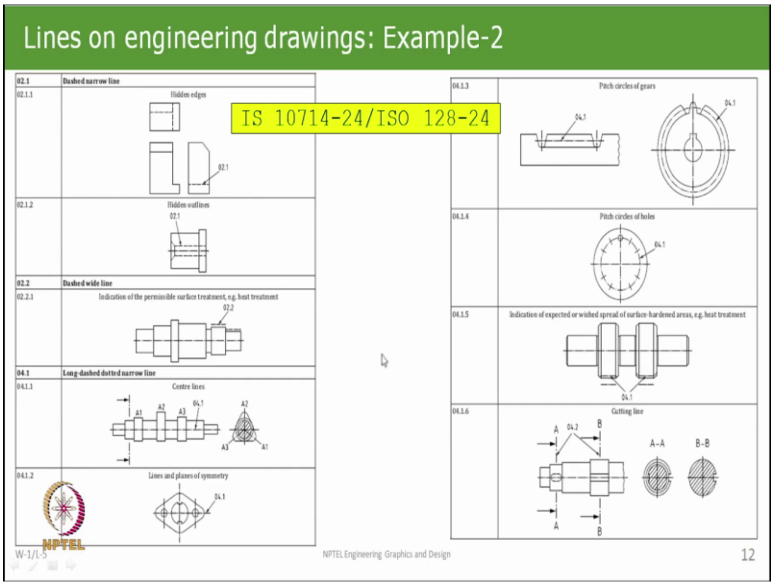

More examples are there. And we will see this later on, I will show you that there are so many types of objects that are there. And where each one of those lines comes into application. As you go along in this course, we will come back to this, one I have already introduced is a hidden line, a line which is not seen. So, in that same object that we had, if we viewed from the top, this edge and this edge were hidden, so they are showing as dotted lines.

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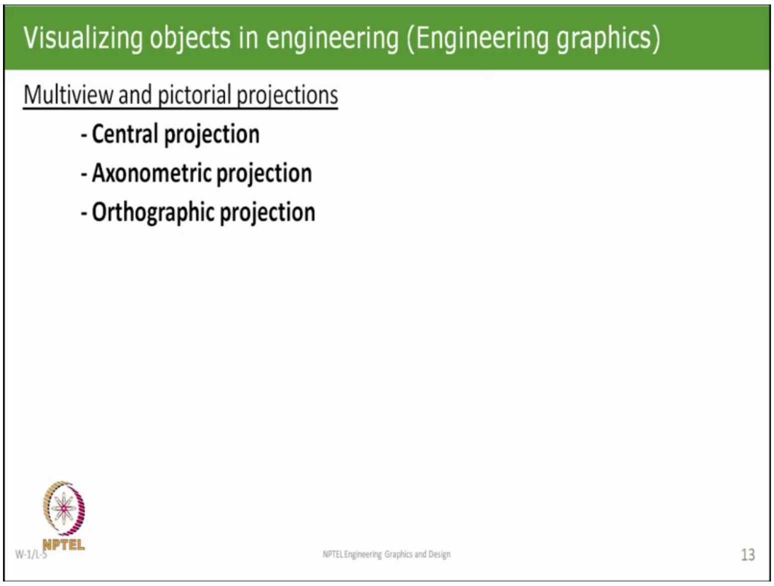

We now come to another aspect of showing up object and this is what is called as a projection. 3 broad classifications are there. The first one is central projection. Second one is a set of predictions called axonometric projections. And the third one is orthographic projections. And it is not that there is only one view that you are giving, we could give multiple views using this, this, this type of projection.

So, let us very quickly go through what these three things tell us so that you get an idea as to what is it that is the big picture is making drawings. And the course which subset of these we will be making.

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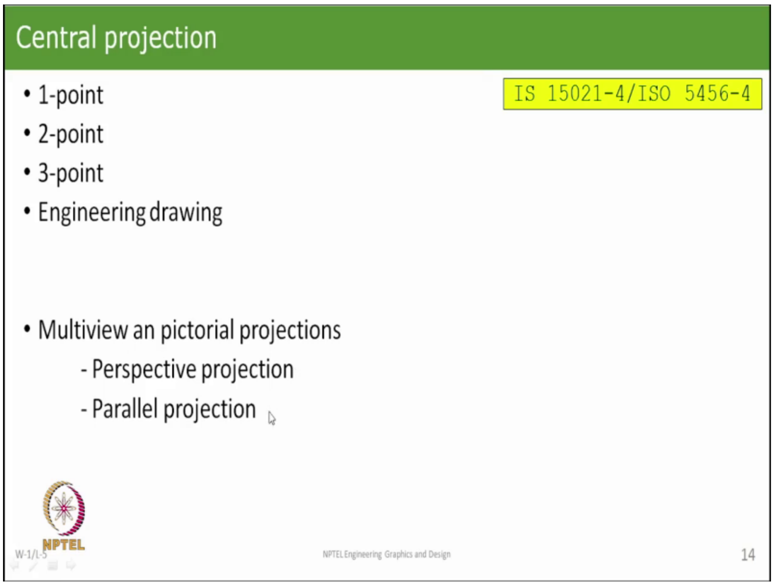

The first one is central projection. And here we have 1-point projection, 2-point projection and 3-point projection, all of the details are given in IS 15021-4, which is ISO 5456- 4. So, we are rethreading again and again that whatever you learn in engineering drawing course, you must know that this coming from a certain standard. So, we get what we call perspective projection and parallel projection.

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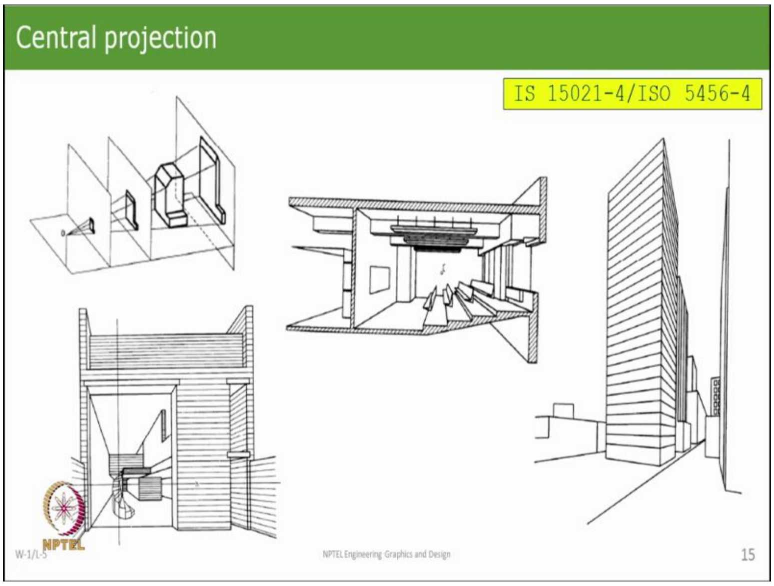

And here are some examples of that. So, what we are saying here is that this is the object, we are seeing the object from this point. And we could say, put between us and the object, we can put a sheet of glass, which could be this one. And then we say, I will keep seeing it with my head stationary. And I will sketch the outline of the object on this screen, which is say a glass.

That is how you will see this object, you will make a drawing, and you will find that this drawing certain lines of the object come here, and all of them seem to have become smaller. If you keep the screen closer to the eye, it becomes even smaller. If you put the screen at the back, you will see and draw there, you will see a much bigger thing. So, what you are doing is, you are seeing that from 1-point, I am seeing this whole object, and everything seems to be joining together.

Everything is converging on there like this. That is called a 1-point projection, 1-point perspective, or 1-point central projection. Here are examples from buildings and architecture. So, here is a 1-point projection of say, a lecture room. So, when you have cut out one wall, and then you are looking at it, as you see further down, the benches get converged. The roof ceiling is also getting converged.

The blackboard looks like it has converged. The floor is getting narrower as it goes deeper. So, that is a single point projection of this on the opposite thing is you can go outside and say well, what does it look like? And you can see looking from the outside, this is the door and you see what is inside, things look smaller and smaller inside. All of this comes under various types of computer graphics, and then you use it in animation and what not.

The thing is that when you do these things, they begin to look very realistic to the human eye. But these are not the true pictures. So, it is good for visualizing, but not good for an engineering drawing. In this picture on the right side, you see a building where you are seeing that this side of the building from here is going down and tapering that way but this face of the building this one is tapering and going that way.

So, you have two taperings taking place two points and you are seeing it from one side that is what the real thing would look like when you look at a building standing on the road. And then there is a 3-point also projection will not go into the details of that. But all of this is done here just to show you that something called central projection, which we call perspective drawing. And this is as per this Indian Standard and this is what things play out. This is what it shows. This is what is limitation, this is what it is strength.

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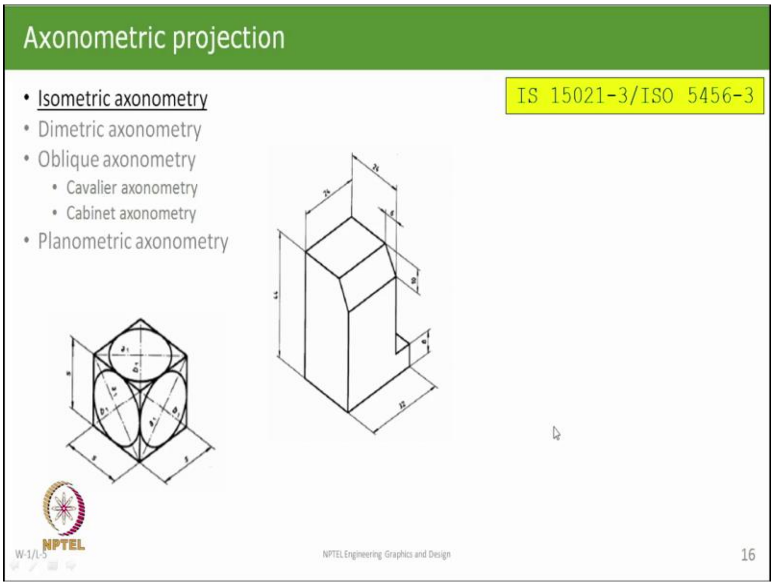

We now want to do other type of drawings, which is called the axonometric projection. Beginning with the first type, which is called isometric. What it does simply is that, you have 2 axes, which are like this one here, one here, at 30 degrees to the horizontal line, and then a vertical line. And a cube is placed on this so that its dimensions, the way it is drawn, are equal in all three directions.

So, you are drawing it 1 to 1 scale, but in 3 dimensions, so this is something that the human eye will not see at close quarters, if you take a cube. But as you saw in the box example, if you go far away and take this picture, this will begin to look something like this, but chances are the scales may be off. Simply because the depth of field is very. But in isometric projection, this is what we do.

It gives a lot of information about the drawing, it is in a way, giving you the true shape. And the same object that we saw just now, this is shown in isometric axonometry or the isometric view. And on this, we can say that I can show these dimensions. So, you are seeing here to show this length, we draw 2 lines, which are called extension lines, then we put another line which is called a dimension line, we put arrows at both ends and drag the number there, which is the size of this line, the length of this line.

Let us very quickly what is how do you put a dimension on a picture? In a sketch, we did not put a dimension it approximately it was something, now we are being very, very specific. So, that is isometric.

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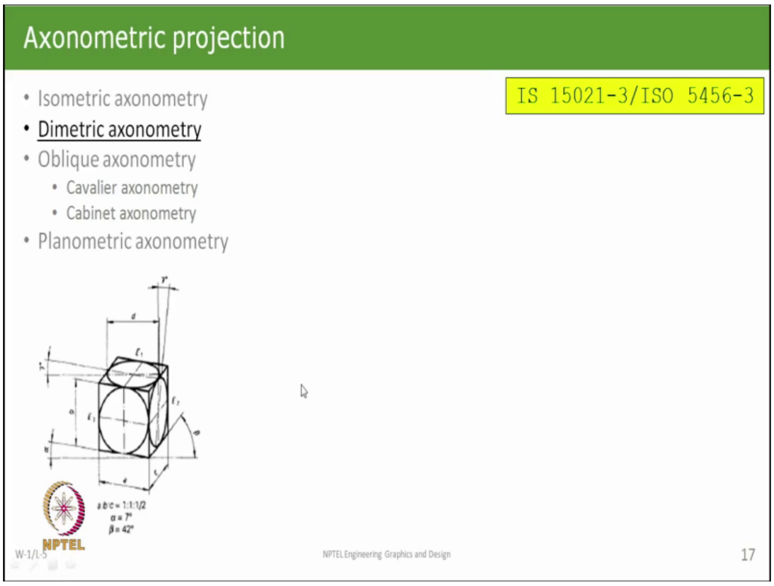

Then you have diametric axonometry, we will not be using this, but it is good to know that it exists. What it does is that you have viewing a 2 axes, which are like this one is 7 degrees, the other is 42 degrees, this scale and the vertical scale are equal 1 : 1 whereas, this scale in this direction is half. So, this dimension of the cube is half the dimension that you see over here. And that is how you would fit circles and other shapes into this. This is diametric.

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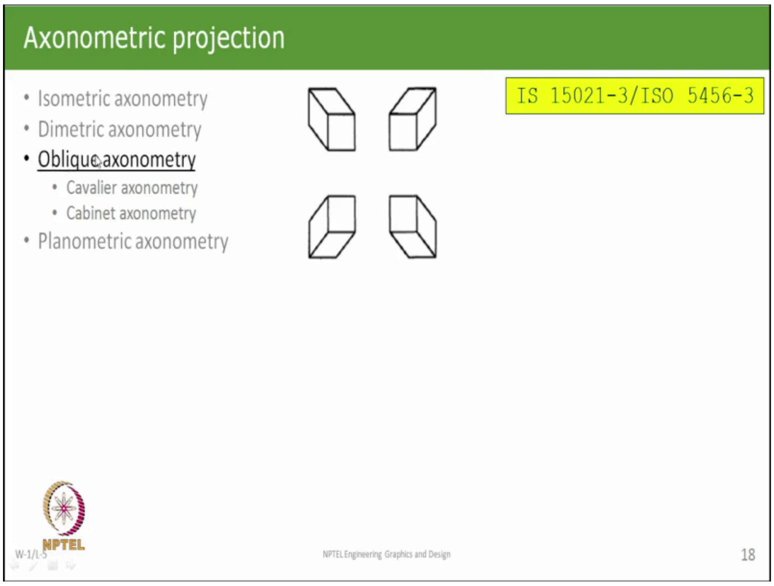

Then there is oblique axonometry where what we do is we have 1 axis which is there one which is vertical and one which goes at 45 degrees to them and one has a choice that this could be 1 to 1 scale, this is also 1 to 1 scale, this is also 1 to 1 scale. What this and this this and this are equal to one another same scale, but the scale could be different.

That is oblique axonometry, we will be making some sketches like this or when you look at you can look at from the top you can look at from the bottom, all types of these are all oblique axonometry. There are 2 subdivisions within that, we will not worry about it at this point. And then the last one which will we have is the planometric axonometry, which is seeing things in various planes. We will not worry about it at this point of time, but good to know it is in this course we will use isometric projections, and oblique.

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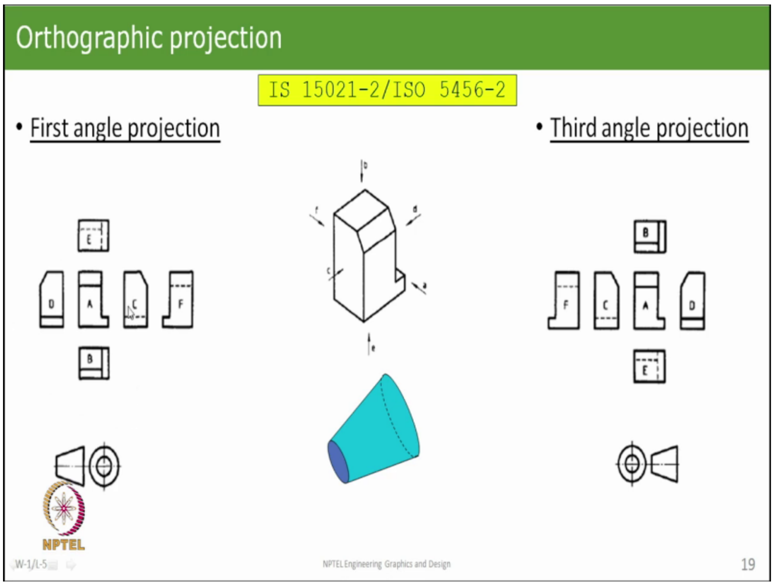

And then we will always use orthographic projections. This is a very important thing. We are all working drawings engineering drawings finally, will always be made as an orthographic projection conforming to IS 15021- 2, which is same as ISO 5456- 2. Here is the example and I illustrated with this example. This is the same object which we had just drawn and what we are seeing here is that arrows and looking at it from different object sides, and there are 6 directions all are mutually perpendicular to one another.

That is what makes it orthogonal. So, we have these are labelled as A, then there is A and there is B, then there is C and D and there is E and F. So, we are saying that any object in a reference frame can be viewed from 6 orthogonal directions and like you have learned in mathematics, orthogonal vectors, which means that if you know information about one, you cannot say anything definitively about the other.

In this case, it is the same thing. Knowing this view does not give you a complete information about what you will see the object looking at from this view or from this view. So, there are 2 basic techniques called first angle projection and third angle projection. So, look at first angle projection and what we are doing is we are making the true view as you would see from different directions.

So, if you the view that comes from this direction A is shown here in the middle as A. What you saw from D is drawn on the left of A, what you see from C is drawn to the right of it, what you see from the top is drawn below it and then the remaining 2 views also are there. That is the standard convention and this is called first angle projection.

In third angle projection, we view it slightly differently, the view at A is same here which we have kept here this is A, looks the same as the first angle projection, no difference, but what you saw from D this direction is placed on the right side. What you saw from C is placed on the left side. So, what you see from the right side is placed on the right, what you saw from the left side is placed on the left, what you saw from the top is placed on the top, what you saw from the bottom is placed on the bottom, that is third angle projection.

Another way that the symbol that we use when showing on drawings is how you view the frustum of a cone and the pictures of that are shown here. In first angle projection, we put these two pictures together there are 2 views. So, this view comes by looking at it from the front direction which is this. So, this circle shows completely the back circle also shows completely so 2 circles when what you see from the right is what you draw on the left.

So, what you saw from the right was that the larger diameter is here smaller diameter is here. And it looks like a cone this symbol is the international symbol which tells you that the drawing is in first angle projection. Nobody will write first angle projection they will only make this sketch and it means this, it means this is how the views have been placed. For third angle projection, we put the first view over there, but what we saw from the right we have drawn on the right.

So, this 2 pictures put together as a single composite picture convey the information on the drawing. This drawing is everything in third angle projection. Nobody will write on any drawing first angle or third angle. Just looking at these we should know how to read the drawing. There is no ambiguity once we know what projection angle is used. Globally, corporations everywhere designers.

Both projections are used in equal measure. So, as someone who is making drawings, we have to be familiar with making drawings in first angle, making drawings in third angle and interpreting others drawings, the way they have made it first or third angle. So, that is another important thing. And the orthographic version means I am seeing the object from a very far distance, there is no distortion in the geometrical shape.

I see it exactly as it is, and I draw it as it is, and put all the dimensions on these drawings, we do not put dimensions on any of the others, which is your oblique views or the perspective views, all dimensions of drawings are always put on orthographic projections.

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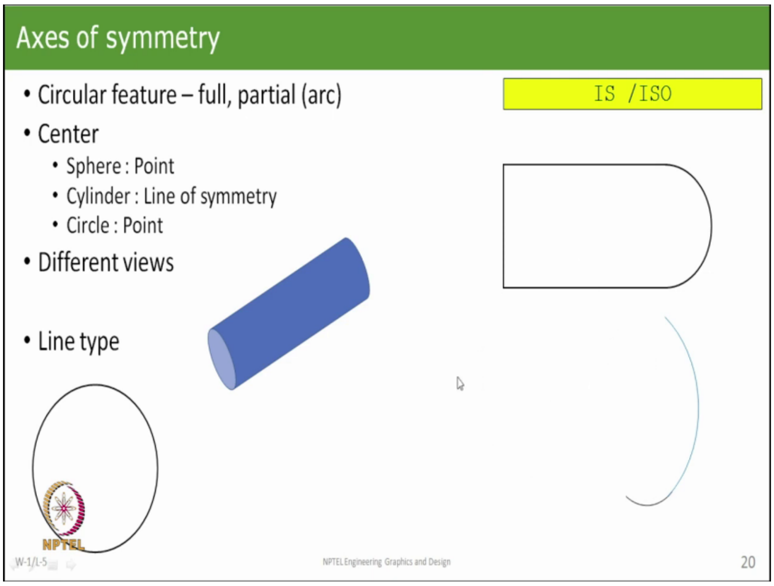

Another important thing is axis of symmetry. And what happens here is that just by looking at this is not enough to say that this is symmetric, or that this has this axis of symmetry or there is some symmetrical feature in this drawing or these curves have some other symmetric features.

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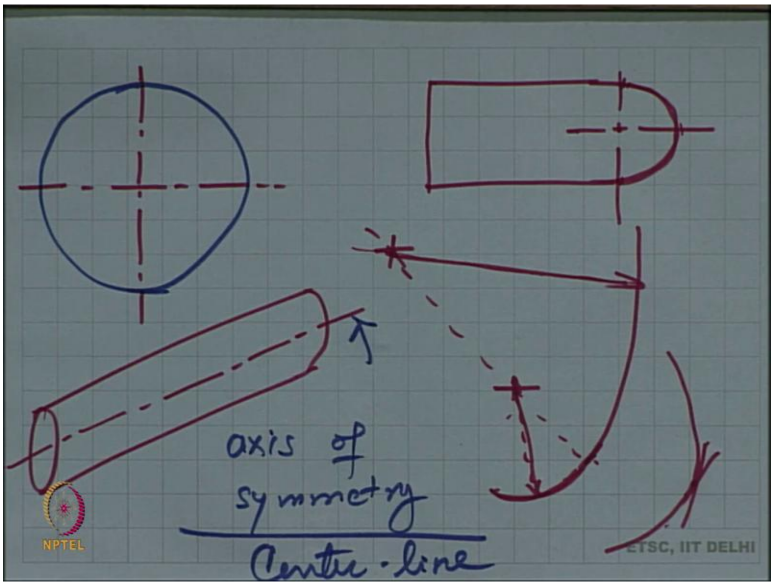

So, what we do is we have a circle and to show that this is a circular feature, we draw a line like this. And this tells us clearly that this thing is a circular feature. If it was like pipe the axis of the pipe is the axis of symmetry, and we will then draw this as this image it tells you that about this axis, the shape is same everywhere. In the case of that object, which has a curve at the top this particular feature from here to here, this is a semicircle.

So, only this much symmetry is there about this line, which is normal to the paper. And on this view, we will show it as this. To tell you that from here to there, this is like a semicircle. And this could be a piece of cloth which has been cut in this way, or it could be any other object which has thickness as well. And the last one that I have shown on the slide there is that I have one circle there and then I have another circle there they meet here.

So, that the tangents are the same, but what has happened is the centre of this curve, assuming that it is same normal to the plane of the paper, this lies centre lies here, which we show by a small cross whereas the circle of this, this lines somewhere over there, and we showed this by a cross there. So, the curvature of this is this much curvature of this is this much. And here they are going smoothly has the centres lie on the same line.

But that may not have been the case, this could have been like this, this could have been like this, in which case, this tangent and this tangent, are not necessarily the same. So that is the important thing, here what we are showing is this line axis of symmetry or we will call it the centre line. And without the centre line, we cannot say anything about the shape. So, showing the central line on any symmetric feature is absolutely essential only then the drawing becomes unambiguous.

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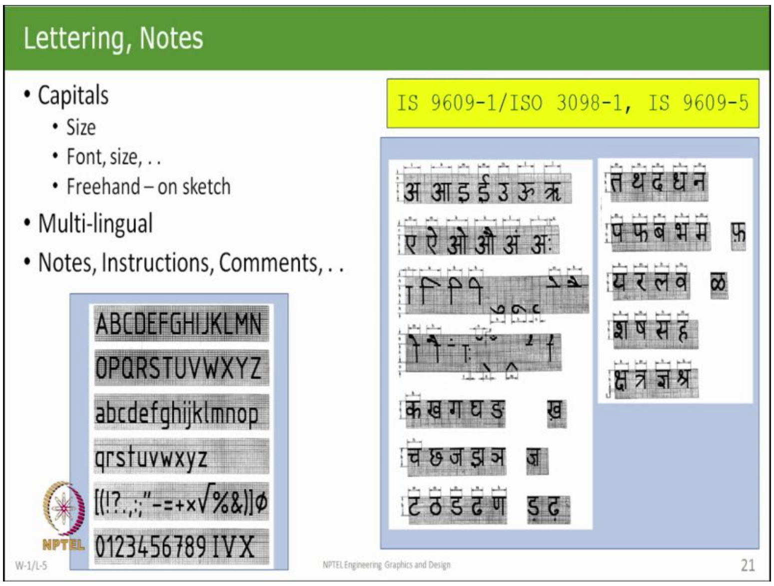

The next thing that a drawing has is lettering, we put numbers for dimensions, we write notes, we write instructions to the person reading the drawing, and that could be in one language or multiple languages. That is governed by Indian standard 9609 part 1 and this part, the Devanagari script is covered by Indian standard 9609 - 5, 9609 parts 1 to 4 are same as ISO

3098 and they tell you the shapes size and font of drawings, which are preferably to be used on engineering drawings.

So, largely you will see that being followed. Although if you are doing some word processing, you will find your hundreds of fonts well on engineering drawing, you do not use that many fonts there are certain set of preferred fonts. So, size sketch that is decided, and you can pick up from there. By and large, when you are writing titles and everything, one generally uses only capitals.

One generally does not use lowercase letters. Dimensions decimals, they are all numerals like that. And if we have to specify it in a second language, say English and say Devanagari. So, we will write information in English and accompany it with the same information in second language, it could be Devanagari, it could be any of the Indian languages, you can be any of the languages in the world.

And quite often, you will find that the drawing comes from another country, you will have English as well as their own language written on it. But by and large, English is now the language for global communication on engineering drawings. But it is good that in many cases where the people working with the drawing, are more familiar with their own native language, it makes sense to write it in that language also.

So, there are bilingual drawings. And a drawing does not mean that there is only a drawing on it. We could also write notes, which is writing something about the part or the something about the drawing or instructions, even for say, manufacturing, that do this while in this process, do not do this, while doing this, all of that could be there. And there could be also thing which is called comments.

So, these are things which are written in words, which supplement the information on the drawing and drawing and this written information together, make the information complete, the drawing becomes unambiguous, complete, it is not over specified, not under specified should not be ambiguous. And all of this information has to be read together.

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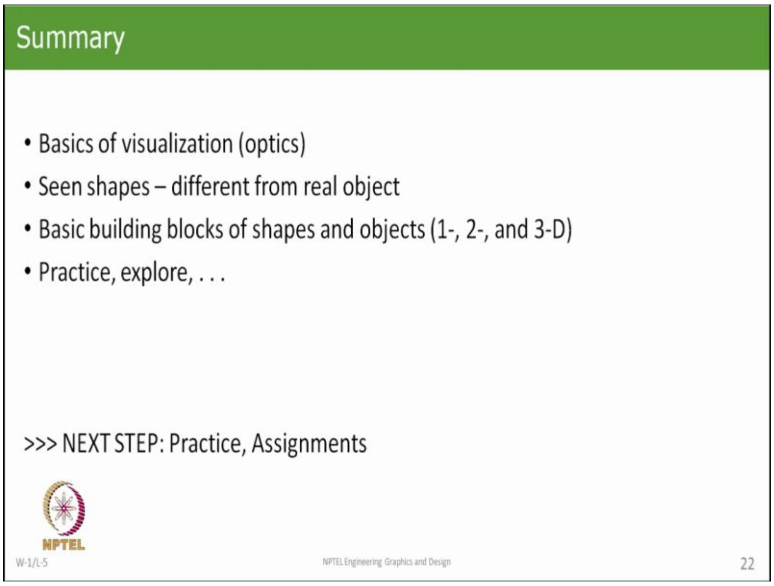

So, we will end on that, that I have introduced some basic things that we will learn in this course, which is that we have a sheet, how you will make a drawing? What are the basic techniques by which we will show the picture of a drawing, the object, Visualizing it, and recognize that all of this derives from very basic fundamental principles that you would have learned in optics in a physics course, we have seen how we can get shapes from different from a real object.

We saw that the real way of looking at things distorts the view. We also learn that for engineers, for construction, for making, for fabrication, for manufacturing, we have to give the true view it may be to a lower scale, it may be to a larger scale, but the geometry, the dimensions have to be preserved the way the real thing has to be made. These are what are the basic building blocks of shapes and objects in 1, 2, 3 dimensions.

We will learn about all of these in detail in the course week by week we will keep looking at different aspects. And the next step now is that you can practice some of these in the first assignment that will come up. Remember in visualization practice means everything you have to have a lot of practice.

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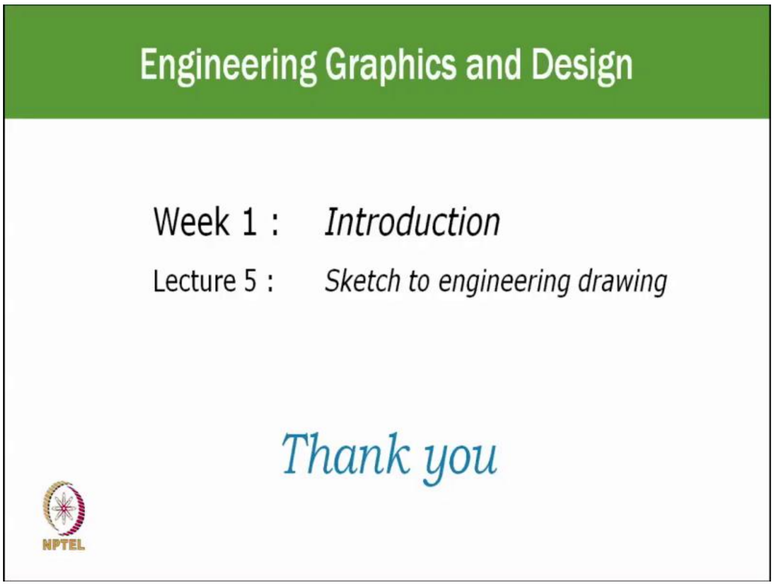

On that note, we will conclude this lecture where we have seen starting with the first lecture of why we need to visualize now we are seeing how do I do it and then having visualized we are now saying how do I present it as an engineer's language. Thank you.