Engineering Graphics and Design
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Indian Institute of Technology, Delhi
Week 2: Graphical Representation
Visualization

Welcome back. We are on week 2 of graphical representations. In today's lecture, we will be discussing about visualization. In the previous class we discussed about sketching. Sketching helps us to using freehand drawings, we can quickly come to the ideas.

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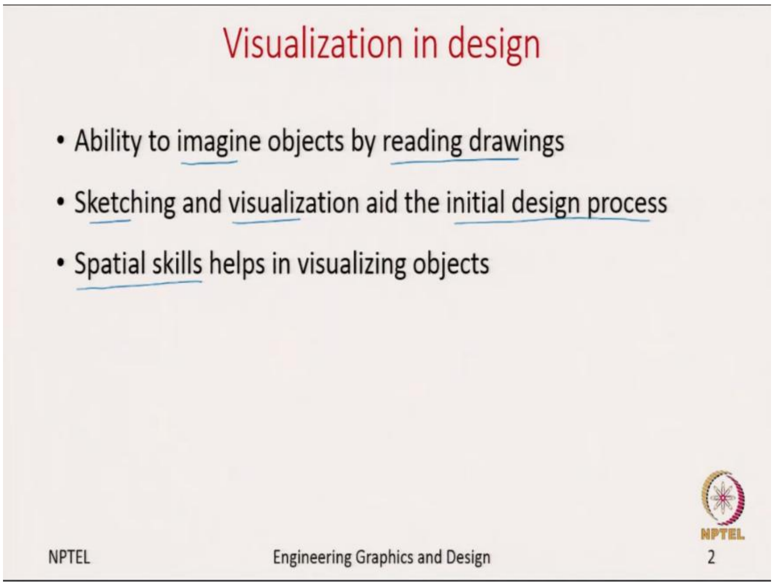

But visualization is the ability, where we imagine the objects by reading the drawings. So, if you're reading a drawing on a 2D sheet. Are you able to visualize the 3D object is the question? So, visualization is all about you being able to imagine the object without it being in front of you. So, you should be able to visualize the object, or make a mental picture of the object in your mind, just by reading the 2D drawings.

So, the question to answer is why do we need this visualization. We need this visualization because then you have a better understanding about the idea we are discussing about. Let us say you got a drawing from your colleague, and you want to understand his idea. So, you should be able to visualize and when you are able to visualize it should match with what the designer has visualized, or the person who has sketched this or drawn these drawings, his idea and your ideas should be the same without any ambiguity.

So, what we are trying to say is, sketching and visualization help in the initial design process. So, the initial design where there is a lot of creative ideas coming so, if you are working in a team. So, one team members, quickly draw a sketch of his idea and passes on to you, and you should be able to visualize his idea by looking at those sketches. Not just the sketches, but in the later part of the design once you get to a more accurate description of the design, and you have an engineering drawing, one should be able to read the drawing, and have the ability to visualize it or make a mental picture of it in the mind.

It will help you in successfully completing your design process or coming up with new products. So, the key skill which is required is the spatial skill. Spatial skill means you should be able to see this object in 3D space. So, as we said, any object in the real world we try to describe it, using 3 dimensions x, y and z. So, one should be able to visualize this object in the 3D space, not just in the same orientation but let us say I describe you that there is a L-shaped object and then I rotate this object, about some axis let us say x axis.

So, without you having that real object in your hand, you should be having a mental picture of, this is the original object before rotation, and how will it look like after rotation. That is one way of visualising. The other way of visualizing is let us say, I look at this cube from this view, from this angle, from this direction. But how will this cube look like, let us say I am looking from behind. So, if I have the real object, I can go behind the object and then see how it looks like.

But we do not have this object in the real world, we are just imagining it, or we are making a mental picture of it in your mind, then you should be able to imagine by going behind the object and trying to see what you can see from what are the features of this object you can see, if you are looking from the behind. So, these are the visualization skills we are talking about. And as I mentioned, spatial skill becomes very important.

So, in this lecture, what we will do is, we will be looking at techniques, where we can use to develop our visualization skills, so that gradually we will start with simple objects and simple activities. And hopefully, after certain practice in these visualization activities, then we should be able to better visualize some slightly more complex objects.

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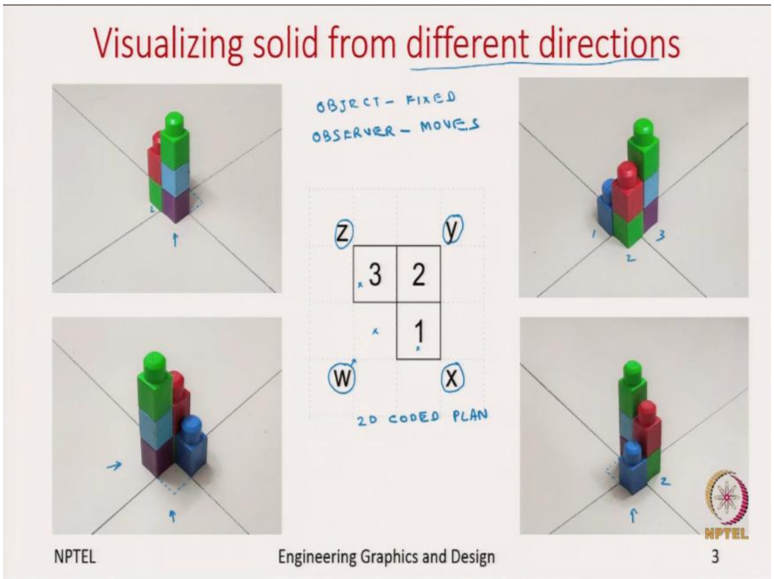

So, what we will first do is, we will try to visualize a solid by looking from various directions. So, here is a 2D coded plan. And these letters w, x, y and z tell us from which direction we are looking at. So, let us focus on this first at W. So, when you are looking from W, we see that there is a missing cube here, and to the right you have a cube of unit height, and to the left we have 3 cubes stacked on top of each other.

So, now let us see how it looks like. So here I have used building blocks to show you how it looks like when you are looking from direction W. So, here is your missing cube and to the right you have one cube and to the left we have 3 cubes stacked on top of each other. And at the rear, you have 2 cubes stacked on top of each other. Now, let us see how this looks like, if you're looking from x direction.

So, from x direction, the closest one will have a height of 1, and to the right you have height of 2, well to the left, there is a missing cube. So, this is how it looks like. So closest one you have one cube to the right, you have 2 cubes and to the left, we have this missing cube. Now, once we look at from y-direction we see the closest one has 2 cubes and to the right 3 and to the left one. And here we see that the missing cube, you can't even notice whether it is present or not in this direction.

And finally, from the z direction, you start with 3 cubes and this is the location for the missing cube to the left we have 2 cubes, and we are not even able to see the single cube, which is present. So, here what we are doing is the object is fixed. But the observer keeps moving. So, in this activity we are trying to visualize how the same object looks when you look from different directions.

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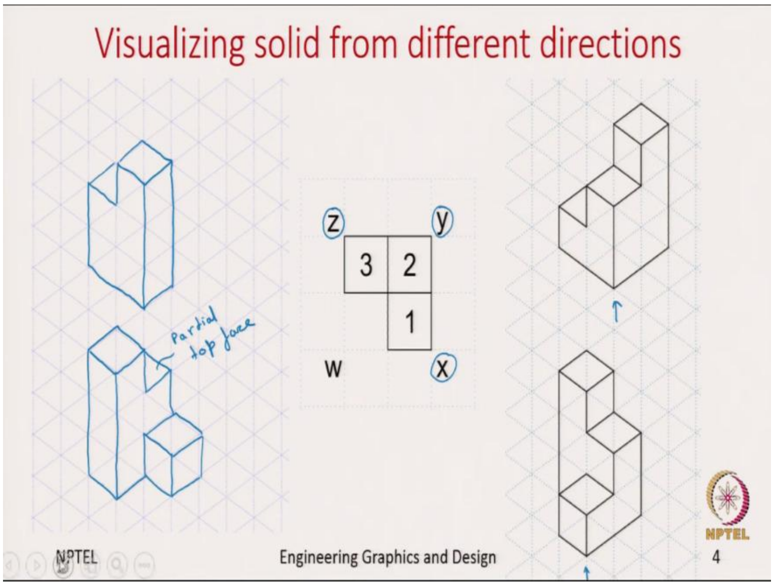

So, now let us try to sketch this. So, we know that there is a missing cube. So, let us start with the right side we have a single cube. And to the left we have 3 cubes stacked. And then behind we have these 2 cubes. If you notice we are only able to see the partial top face because it is being blocked by this cube of 3 cubes.

So, next we will look at how the same thing looks from z-direction. So, as we said from the z direction, the closest to the observer will be this 3 cubes stacked on top of each other. To the right, there is a missing cube, but to the left we have these 2 cubes. 2 cubes stacked on top of each other. So, we are not in a position to look at this single cube because the 3 cubes blocked the view and the rest are here.

So, looking from x direction, we have this cube of 1 height closest to the observer, and looking from the y-direction we have these 2 cubes closest to the observer. I noticed that there are some extra lines in this figure, so let me fix it. So again, going by the principle saying that we only show lines when 2 surfaces meet, and they have an angle with respect to each other. Here too there is an extra line I need to remove.

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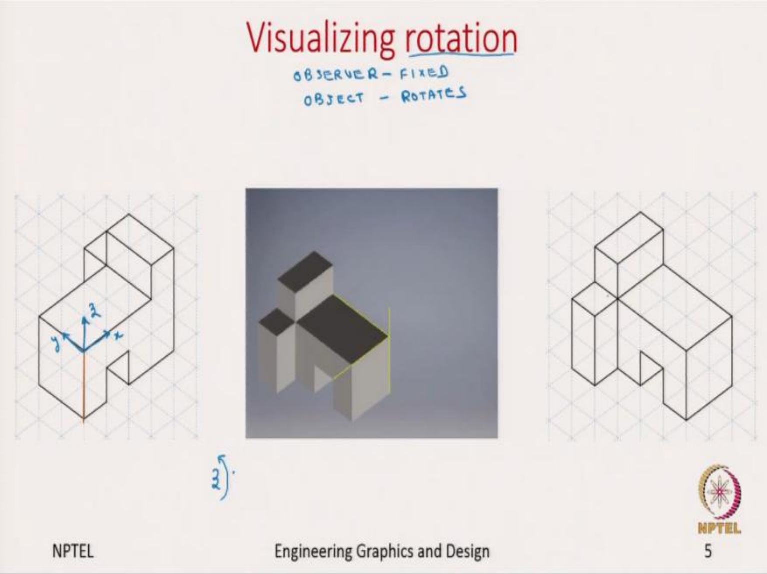

So, the second visualisation activity, we will be looking at is rotation. So, previously we had the object fixed and we are looking from different directions, but now what we will have is the observer is fixed. Observer is fixed and the object rotates. So, let us see. So, we are rotating this object about this axis shown in red here.

So, as you can see, after rotation, the view is entirely different. The isometric view is different and which can be shown like this. So, here what we have done is we have made this rotation about one axis. So, let us define that this is x-axis and this is y-axis, and this vertical thing where we actually rotate it, we will call that as z-axis.

So, essentially what we have done in this slide is, we have rotated about z-axis and did we rotate clockwise or anti clockwise? So, in this case we have rotated in the clockwise direction. Was it clockwise or anti-clockwise? So, we have rotated anti-clockwise. So, this is the direction we have rotated.

So that needs to be shown. This is the way to represent saying that the axis of rotation is z and the rotation is anti-clockwise. So sometimes what you can do is you need not stop with one single rotation. So, you have the original object and once you make one single rotation you can keep continuing this. So, you can pick any other axis and continue with the rotation, so let us look at that.

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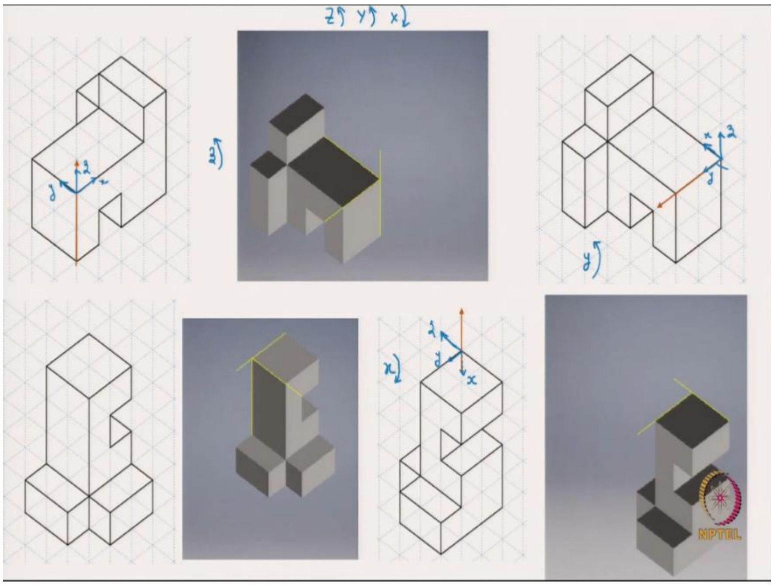

So, like previous slide, I rotate about this axis, after rotation this is the isometric view. But now let us rotate about another axis. So, let us pick this red shown here as the axis. And let us see how it rotates. So, this is after rotation and now let us see how it looks in the isometric view. So, like this we can continue the rotation. So, I pick the another axis, the third axis about which I want to rotate this, and in this video, this video shows the rotation about the third axis. And here is the isometric view after the final rotation.

So, what we notice here is we have used 3 different axis to rotate. So, probably let us define the x, y, z then we can see what we can give names to these axis. So, let us say this is the x axis, y axis, and the z axis. So, in the first step, we have rotated anti-clockwise about the z axis. Now let us see where are those x, y, z axis after rotation. After rotation this is the x axis, this is y-axis. And this is the z-axis. So, in the second rotation we are rotating about y-axis, and which direction are we rotating?

So, we are rotating in the anti-clockwise or the clockwise direction. So, we are rotating again anti-clockwise direction. So finally, after this rotation about y axis let us again sketch where are our x, y and z, because that will help us to show what is the final rotation axis. So, the axis' after rotation will be this is the z-axis. This is the y-axis and x-axis is something we cannot see, but let us show it here as this.

So, the object is blocking the x-axis. So, for the final rotation we have picked the x-axis. And since we are rotating in the opposite direction, it will be clockwise. So, here is the final one. So, for us to show all 3 together we can show them as z-axis anti-clockwise. Y-axis as anti-clockwise and x-axis as clockwise. So, this should help us to do all these 3 steps one after each other.

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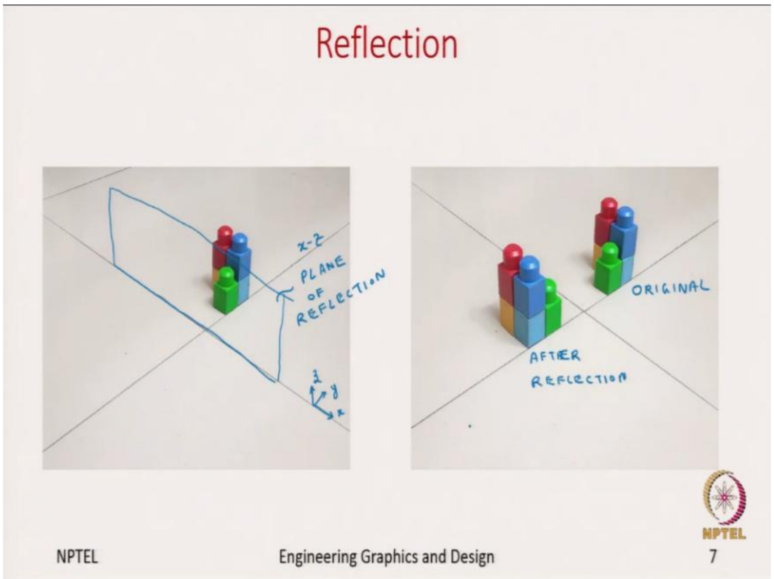

So, after looking the object from different directions we looked at rotating the object, but there are other possibilities also. We can also look at reflecting the object. So, let us say, here is my object and I can pick a plane of reflection, so let us say for example, I pick this as the plane of reflection. I can give names to these axis.

So, let us say x, y, and z. So, this is what I am calling as plane of reflection. So, which is the x-z plane. So, after reflection what you see is this is the object, original object before reflection and this is the object after reflection. So, since we have shown this plane of reflection, we see that the closest to the plane of reflection is a green cube here, and even in the reflected one the closest to the plane of reflection will be the green cube and rest continues.

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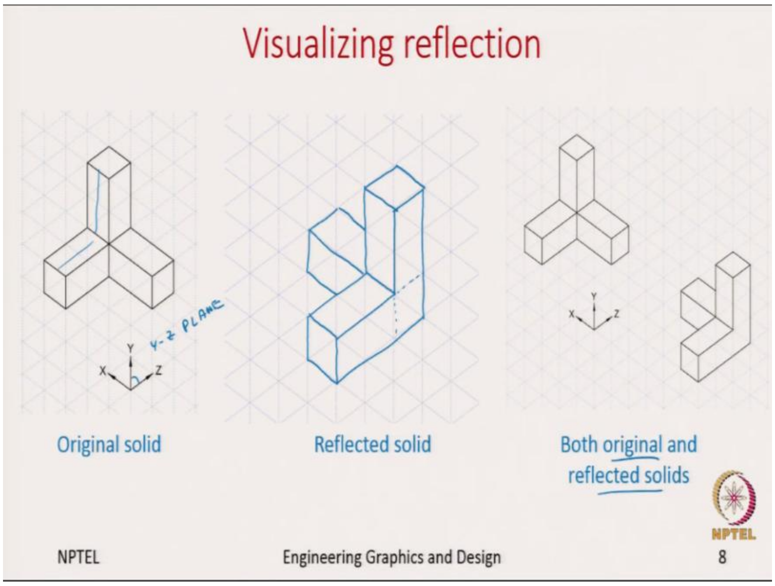

But now let us see with an example how we can develop these reflections. So, here is the original object shown here and there is a coordinate system. Now, let us pick the y-z, y-z plane as the plane of reflection. So, I want to develop another object the reflected object, which is reflected about this y-z plane.

So, how will that object look like? So, first, these L-shapes. We will be looking at them first. So, what are the dimensions of it? It has length 3 and height 3, so let us depict the L-shape first. Now, what is remaining is this horizontal along the x-axis cubes is what we need to represent. So, will that to be right of this L-shape or to the left of the L-shape?

They will be to the left of the L-shape, because that is when it becomes closer to the y-z plane as in the original object. So, if we take this corner cube, we need to show it in 3 units. So, one unit is already here so let us show the last 2 units. So, with this we complete the isometric view after reflection. So, here is showing both the original and reflected solids. So, basically this forces our mind to make a mental picture of how the object looks once it is reflected about a plane.

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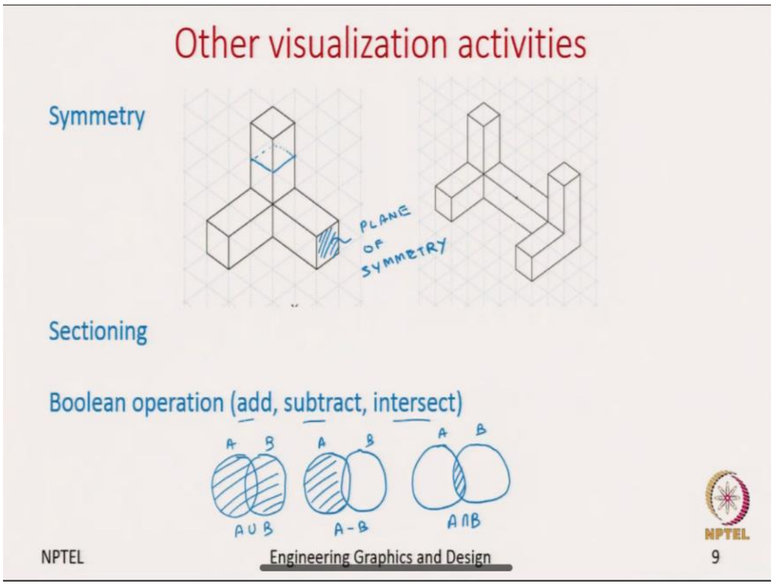

So, there are other visualization activities one can do to improve the visualization skills. These include first the symmetry. So, in the previous slide we showed you reflection right but let us say what happens if that reflection happens in one of the planes of an object. So, let us say if we want to reflect this object about this plane, then both the original and the reflected object will be meeting each other.

So, if you join these 2, then you have a one single object, which is asymmetric on each other about the plane of symmetry. So, this is the plane of symmetry. So, essentially what we are done is about this plane of symmetry, we created one reflected object, and then join them together to make it one single object.

So, you can use this plane of symmetry on any surface of this original object and then you will get a symmetric object. Other thing you can do is, one can section the object and see how it looks like at that section. So, maybe I can make a cut here, and then see how it looks like. Of course, this being a simple object I know when I make that cut, it will be a simple square.

But you can also choose to make a cut, not at a plane which is parallel to the coordinate planes, but let us say an inclined plane, that is when it becomes a little more complex. But if you choose a cut accordingly it can be possible for you to sketch it out. One more activity you can do is try the Boolean operation. So, take 2 objects to start with. Need not be the same objects, it could be 2 entirely 2 different objects, and then we can do either this adding these 2 objects or Boolean operations are like add, subtract, and intersection.

So, just to review what probably you might already know, let us say these are A and B. When you're adding or A union B you are considering all these areas. This is A union B or N. But let us say now you are doing subtraction A and B, and you want to do A minus B. So, which only in A, but not in B. So, this area. And finally, intersection is place where both A and B exist. This common area between A and B.

So, here I am showing it with simple circles but what I am trying to say is, when 3D objects come, and when they join together like A union B, or you are trying to extract only parts of one object, where the second object does not overlap or maybe you are interested only in the overlap between these 2 objects. You will see later when you work with software, these are the basic operations which we use in the CAD software to build complex objects. So, we start with some basic building blocks like cubes, spheres or some very basic geometrical objects, and then we use these basic geometrical objects to develop more complex, by using these Boolean operations like, add, subtract and interact.

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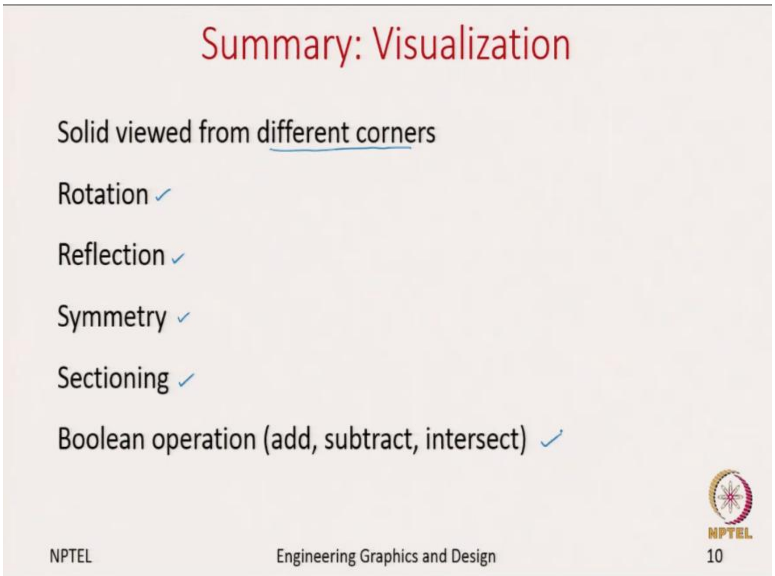

So, with this we come to the end of this lecture where we summarize. So, we said that visualization is a very useful tool, an engineer or a technologist need in the design process. So, these are the various activities we have covered here saying that, if you look from different corners, will you be able to imagine this object?

And then we say, if we make the observer fixed, but the object is rotating, how do you visualize that object? And similarly, reflection and symmetry are when you have a plane of symmetry, or a plane of reflection. How does the new object look like? So, we also said we can use something like sectioning as a visualization tool saying that if you take any object and cut it. Will you be able to imagine how it looks like after the cut and before the cut?

And finally, you can take 2 different objects and either add them together, subtract or intersect to make up new objects. So, these objects can be, we said that the Boolean operations are the common techniques we use in the CAD software to develop some complex objects. Thank you for joining we will meet again next lecture.