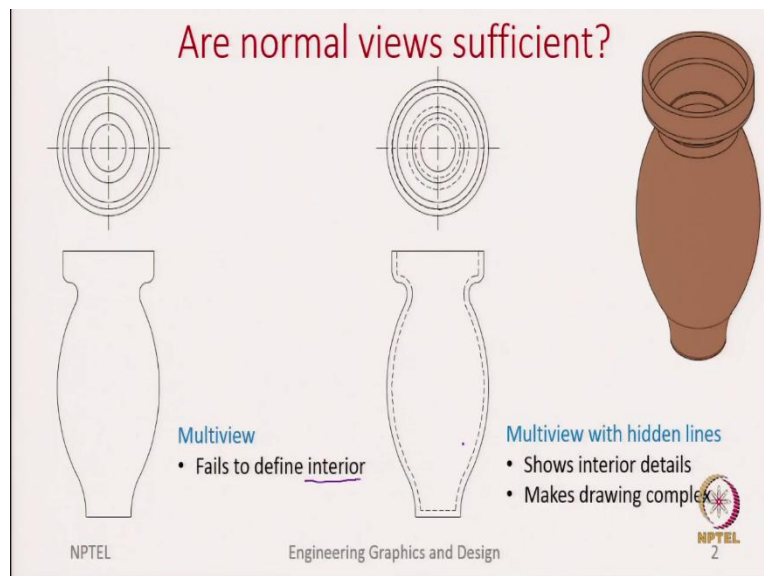


Engineering Graphics and Design
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Lecture 22
Section and Auxiliary views
W5 L1 Section Views

Welcome back to the Engineering Graphics and Design online course. We are on week 5, where we will be discussing about sections and auxiliary views. In this lecture, we will be focusing on the section views. So, let us get started and see, why we are interested in this section views and in what instances we should be using this. So, we start by saying that normal views are not sufficient.

So, what are normal views? Usually the front view, rear view, left and right-side views and the top and bottom views. Because there are instances where even with these normal views, you are not able to clearly define the object. So, let us give an example.

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Let us see it with an example. So, what you see on the screen is a simple vase. So, let us see what the ways are we can represent it, and then we can compare and see, what is a better method. So, let us first start with the normal way of doing it, which is the multi-view projections or the orthographic projection. So, we show the front view and the top view. So, is all the information captured in these two views? So, for example here, we say that this view fails to define the interior. So, what are the kinds of information we are missing in this?

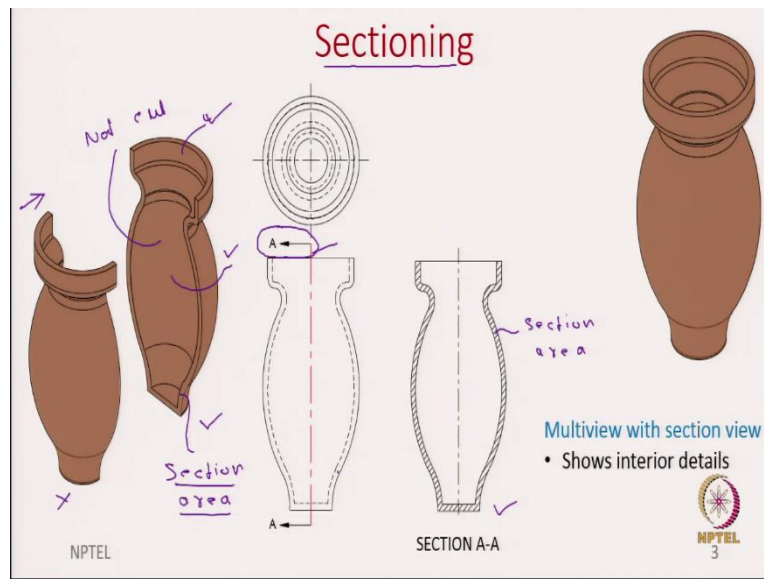
So, for example, we want to know what is the thickness of the vase, can we answer that just by these two views? The answer is no.

Because we do not know, how this thickness varies with height. So, at the top, maybe the thickness is small or big, but as you go down, maybe the thicknesses again vary. And similarly, we do not know at the bottom, what is the thickness of the bottom plate of this vase? And we also do not know what is the shape of the bottom, just by looking at this front view in the top view.

So, maybe, you will now say that, okay, one alternative is to show it by hidden lines. So, here is that option, where we are showing these multi-views with the help of hidden view. So, we previously said that we use hidden lines to show the interior details. So, features which are not directly visible, but we know, which are behind the or within the object. So, here we have shown with these dashed lines, what is the internal detail?

So, of course, all these questions which I raised previously, like what is the thickness at the top, bottom and what is the shape of the bottom, all these can be answered during these views. But the point is, the more and more hidden lines you use the drawing becomes complex, and then it becomes difficult to read. So, this might solve the problem, but it may not really make an efficient drawing or a simple and elegant drawing. So, let us see what is the other alternative we have to show these interior details.

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So, we will be discussing about sectioning, which is a technique, which will be used to show the interior details. So, what are we doing here? We say that we will section this object. In this instance, we have this vase, so we will section it into two pieces. So, then the question is, what do I mean by sectioning? And where will I do the section?

By sectioning what I am saying is, we do an imaginary cutting of the object, not the real cutting. We say that we will pass a plane through the object, about this plane, we will split the object into two pieces. So, then we need to define this plane precisely. How do we do that? So, we take one of the view. For example, the red line here shows us the plane, which we are using to section the object. Here you cannot see the plane because this plane is placed perpendicular to the paper or perpendicular to the screen here.

So, since you are looking at a cutting plane in the perpendicular direction you only see the edge of the plane not the complete plane. And then once you define the plane, we also define in which direction we are viewing. Because once you split an object, you have two pieces. You need to know, which piece you need to hold and capture the section view.

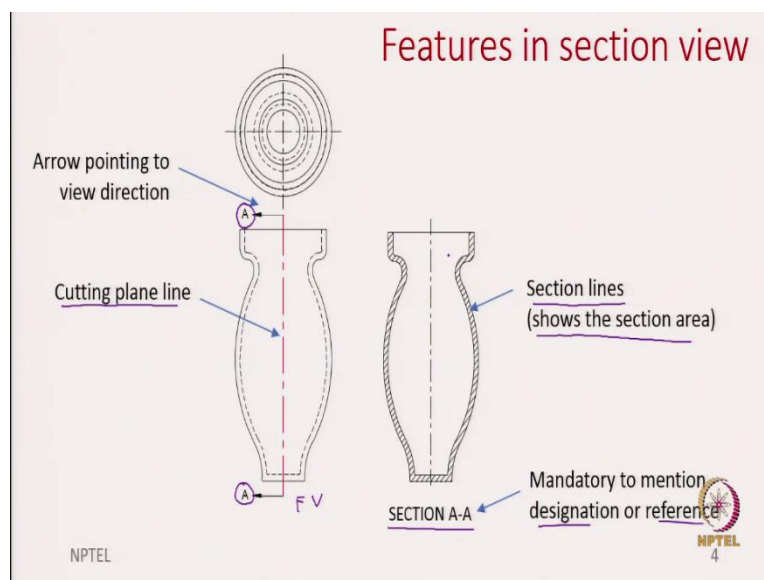
So, for example, here we are showing you that this vase is split into two pieces using the imaginary cutting plane. So, I am stressing on the imaginary cutting plane because what we are doing is a hypothetical situation where we are assuming to split the object not the going and splitting it in reality. So, now, you can see lot of inner details once you section this object. So, how do we capture this in a drawing? So, this is the view you see it on a drawing. If you look at it, this is the section area. This is again, the same area where this plane really sections it. So, what is the section area? The area, which is being cut from the object.

So, for example, if you look at this particular interior, this is not cut, because that cutting plane did not pass through this interior, but it passed through this section area. So, wherever the cutting plane passes through the object that we name it as the section area. So, that section area we represent here with inclined lines, which are parallel, we will talk more of it as we move along.

But the point I am trying to say is, wherever we cut the object where the material is cut, that area is shown differently. So, it is shown with this filling of parallel lines, but we also try to capture what is not cut. So, for example, let us say the left part is discarded and the right part is the one we are viewing. So, when you are viewing this, from this direction, you see two things. One is the section area and second, you also see what is behind the cutting plane.

So, you see this, you see this kind of information and all. So, that also needs to be represented on the sectional view. We will discuss more of it. I am just trying to give you an overview of what we try to capture in a section. And very important point, you can see that the front view and the top view are for the complete object. Only in this section view, we are talking about the sectioned object. So only here we talk about the section, but these are again, the complete object, the front view and the top.

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So now that we have seen an overview of what we meant by sectioning, let us go into a few details and terminology. So, what are the features you will see in a section view. We first represent the cutting plane line. You may recall, we said that, we have a cutting plane, which is perpendicular to the normal views.

So, for example here, if we say that this is the front view, we have this cutting plane perpendicular to the front view. Since it is perpendicular to the front view, we only see the edge of the plane and that we call it as the cutting plane line or the simply cut line. The second feature we see is, this arrow pointing to view direction. So, you can see two things. One is this arrow and one is the label.

So, we will come back to the label in a while, but this arrow tells you after you section, which part of the sectioned part are you looking at? Are you looking to the left part or the right part? At least in this slide we are asking to look at the left piece. So, it is also mandatory to mention the designation or reference. What is this designation or reference? If you notice again at these arrows, we have this capital A placed here and here.

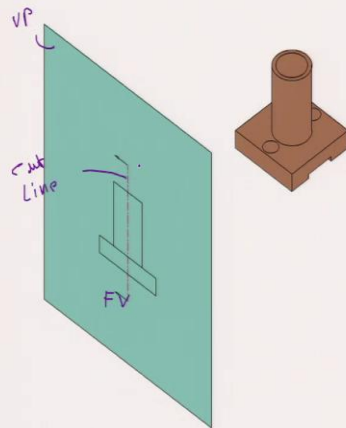
So, whenever you have a section view, below the section view, you need to mention that it is SECTION A-A, because then you have one to one correspondence between your, in the front view where you show the cut line and those arrows and to the section view. So, both of these together will complete that information about where this particular section is coming from.

And lastly, as we already discussed, that section area needs to be shown with parallel lines, which we are showing it here. As I already mentioned, we need to show the section area with a different pattern. Here we are using parallel lines, but there are different patterns one can use. For example, these parallel lines what we are using throughout this lecture is for cast iron, but different metals have different kinds of patterns to show, to differentiate between one material to the other.

Usually, this information is anyway given in the drawing sheet saying that so and so object needs to be made with steel, cast iron or aluminum or something like that. So, since it is already mentioned, we need not bother about differentiating whether it is material 1 versus material 2. So, we can simply use these parallel lines because it is more easy to reproduce compared to the others. But, of course, there are some standards, which give you a clear directions about what kind of pattern to be used for specific materials.

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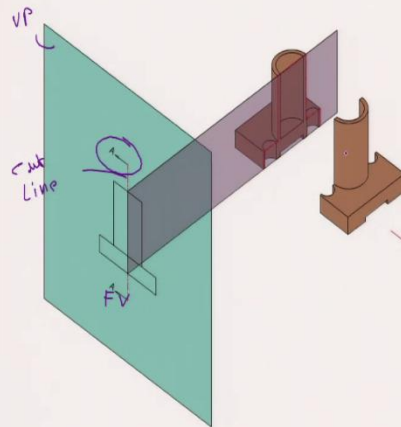
Section view: Visualization



1. Consider object and view plane
2. Draw primary view
3. Draw cutline and view direction



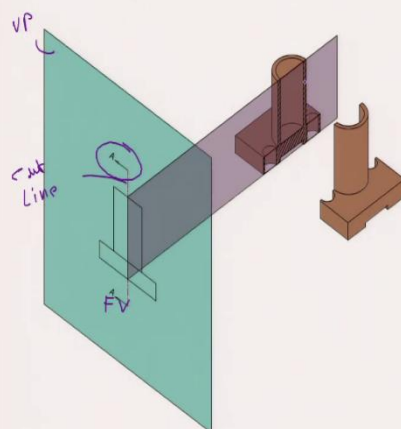
Section view: Visualization



1. Consider object and view plane
2. Draw primary view
3. Draw cutline and view direction
4. Show the cut plane
5. Retain cut piece in view direction, move away the other cut piece



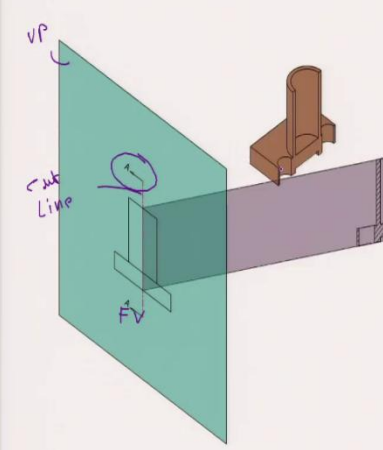
Section view: Visualization




1. Consider object and view plane
2. Draw primary view
3. Draw cutline and view direction
4. Show the cut plane
5. Retain cut piece in view direction, move away the other cut piece
6. Capture the section view on cut plane



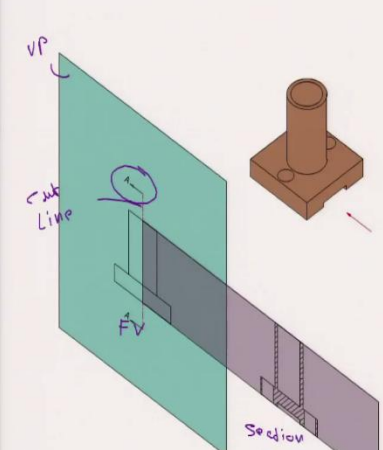
Section view: Visualization




1. Consider object and view plane
2. Draw primary view
3. Draw cutline and view direction
4. Show the cut plane
5. Retain cut piece in view direction, move away the other cut piece
6. Capture the section view on cut plane
7. Rotate the section view about cutline
(bring section and primary view in same plane)



Section view: Visualization



1. Consider object and view plane
2. Draw primary view
3. Draw cutline and view direction
4. Show the cut plane
5. Retain cut piece in view direction, move away the other cut piece
6. Capture the section view on cut plane
7. Rotate the section view about cutline
(bring section and primary view in same plane)



So, until now, we have been introduced to what is sectioning, and what are the different terminologies we are using in sectioning. But we also need to have a clear picture of what is happening during the sectioning, because that helps you in capturing the section view and also to place the section view in the right position. So sometimes you might be worrying like, wondering, where to place this section. So, to answer this, let us go through this visualization which I hope like clarifies more most of your doubts.

So, first let us consider the object and the viewpoint, and then, we will draw the primary view. So, on the, so for example here let us say this is the frontal plane or the vertical plane on which we captured the front view. Then what we are doing, so we need to identify, what is

our cut plane. So, how do we identify? We identify it by first drawing the cut line and then showing the view direction.

So, if you look clearly this red line, which is vertical identifies the cut line, and this direction is showing the direction in which you need to view. So, once this is defined, we let us show the cutting plane. So, this is the cutting plane, which is passing through the cut line and it is perpendicular to the view plane.

And what does this outline do? It is cutting the object into two pieces. And this one we, when we look at the view direction it should tell you which piece to retain and which to remove. So, in this case, since the arrow is pointing to the left, we show the left piece, we retain the left piece where it is and the right piece we move away from the location. So, we move the unnecessary piece a little bit. So, this is all visualization. We are not physically doing it, but this is just to help with the mental process of capturing these sections.

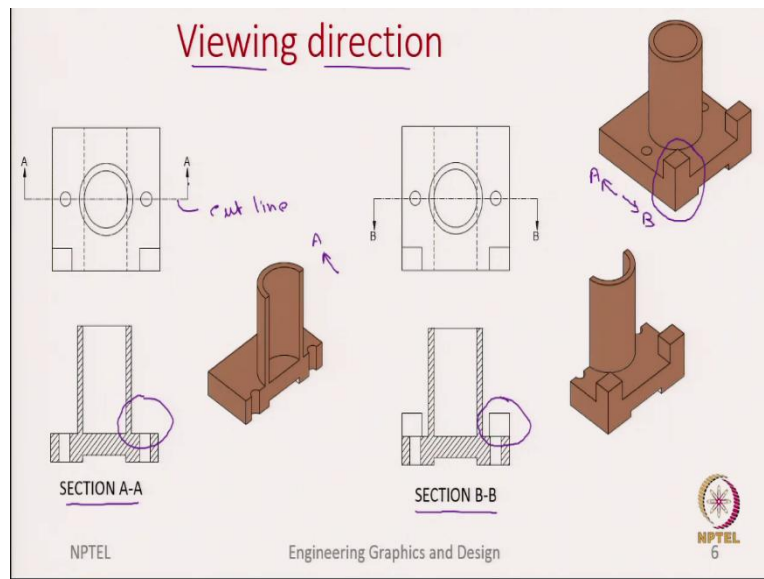
So, once we do that, then we captured the section view on the cut plane. So, if you can see here these again the hatchings are the section lines show the section area and, in that section, we are also capturing the features behind the cut plane. So, for example, this circular semicircle hole is captured as a rectangle here.

Then lastly, what do we do? We said, every time we want the views to be on a single plane, but now what we see is the front view is on one plane and the section view is on a perpendicular plane. So, for us to bring both the views into a single plane we need to rotate the section view.

So how do we rotate? We rotate it about the cut line. So, as you can see, I can go back and show this rotation again. So, we are rotating the cut plane about the cut line, and bring it in line with the primary view. So, after this, what we have is the section view. So essentially what we are showing is where to place the section view.

So, at least in this example, it worked out that the section view comes to the right. There might be instances where the section view might be coming up, depending on where you position the section line or the cut line.

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So, let us see, what is the importance of this viewing direction. We already said, it helps you to decide, which of the section parts to be, for which we will be drawing the section view. So, let us take this example. And then we are looking at the top view, so we will do two things. What we will do is, this top view and this top view, both are exactly the same, because we are both are for the same object. The only difference is, the direction of the viewing is different. So, even this cut line is the same.

Cut line is the same in both the left one, as well as the right one. The only difference is, the direction of viewing is different. And now let us see, how does this change the section view. First, let start with Section A-A. Here is the cut pace we are interested in. So, after cutting, since we are looking in a direction A, this is the direction A we will be looking at the left side piece, and the corresponding section view will be this.

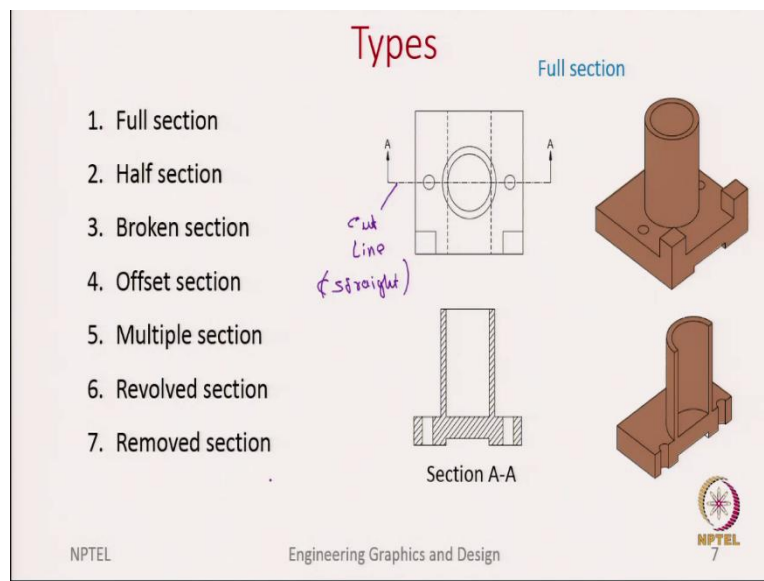
And now, let us look at the other section, which is section B-B, which is exactly the same as the previous one with a slight small difference. The difference is now we are looking in the opposite direction, direction B. Since we are looking in the opposite direction, we need to consider the other piece. So, this is that other piece and then the corresponding section view is shown here.

So, this is the first one is Section A-A and Section B-B. As I am repeatedly mentioning, both these sections are from the same cutting plane. The only difference is, the view direction. As you can see, both these view directions are different. The reason why they are different is, at least in this example is because of this feature.

So, this feature, like a step, what we have here is only present when you are looking in the direction B, but if you are looking in the direction A that feature is absent, which means, this particular object is not symmetric about the cutting plane. Since it is not symmetric, you will have a different view based on the direction you are looking at. So, this feature is present here, which we show it in Section B-B, but correspondingly here that is upside.

So, what do we conclude? We conclude that the direction of viewing is very important, and that is shown by these arrows.

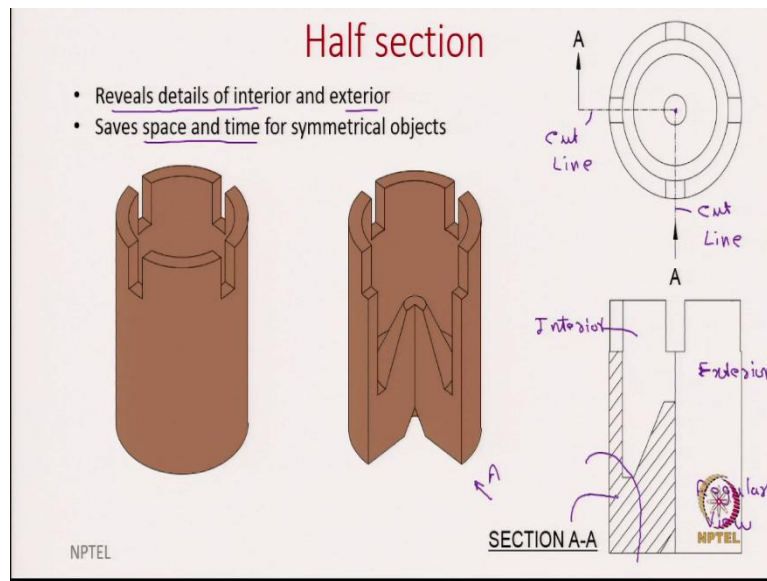
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So, now what we will be looking at are the different kinds of sections which people use in practice. So, for this course, probably we will be focusing on very few. Maybe, like the full section and the half section, but in general, there are different ways you can enhance the drawing by using this powerful concept of Sectioning.

So, the first of these, which is the full section is something, what we have been discussing all along. In the last few slides, where I showed examples, all of them are full sections. What do we call it as full section? Full section is something where when we define this cutline this passes from one end of the object to the other end of the object, so which is a continuous line, which is splitting the object into two different parts, and this cut line is straight. So, it is one single cutting plane. So, now, let us see at the other category since we have already looked at the full section.

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So, the second one is the half section. So, what you see here on the screen is this object, which we have 3D printed. So, if you are looking from the front and as well as the top view, you see that it has some little symmetry. So, for example, if I take a cut plane in this direction, the left and the right are identical. Similarly, if I take a section in this direction, both, the front and the rear are identical.

So, what it says is, we have a symmetry in this. And once we have symmetry, we can use some other practices called the half section where we only remove a quarter of the piece. So, as you can see, I removed a quarter of the piece from the full object. And then now, if I place it in this way, and draw the section in this direction, so for you to the left what you see is the regular object without a section, but to the right what you see is the sectioned object.

So, which means, when you draw you will draw half of it as a regular view, and the other half we will show it as a section. So, that is why we say it is a half section. So, we are only sectioning half of the view. So, to the left is regular and to the right is a section. So, let me show it through visualizations. So, here is the top view, and this is the way to show the half section. So, as you can see, there is only one cut line. No, actually, the cut line, there are two cut lines, which were perpendicular to each other. So, this is the cut line and the other cut line, which are perpendicular to each other, and they are continuous, they meet at this point.

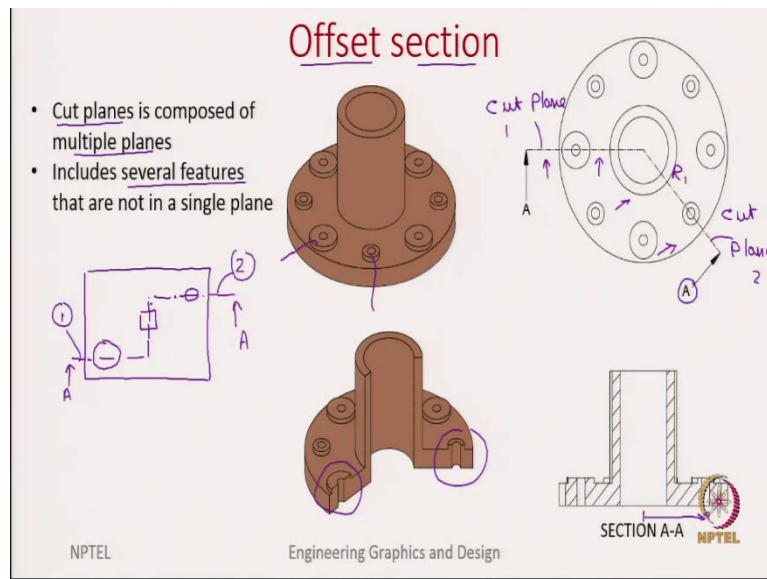
So, the cutting plane is perpendicular to this cut lines. And after you cut it using those cutting planes, this is the object we see. So, I just showed through these 3D printed objects. So, this is the quarter piece which we have removed. And now we need to focus on the arrows. Because the arrows tell us, in which direction we need to view to capture the section view.

After that, we see that, since we are looking in this direction A which is shown here to the right of this center line, we have the regular view, but to the left we have this section. So, what it does is it helps you to save time. So, you need not section the right side because this is exactly the same. You need not, there is no new information you are providing by blindly drawing the full section view.

So, to summarize, we are saying that the half sections reveal the details of, both, interior and exterior. Because here for example, the right side shows the exterior view and the left side shows the interior view. It saves, both, space as well as time for symmetrical objects. So, previously, we have seen the full section and now we have seen the half section. There is a third category called the box view or the partial section view. What we do is, it is neither half nor the full, it is a part of it. So, for example, maybe it could be a partial part of these you show it as the section and the remaining you show the exterior details.

So, because you know that the critical details are only in this partial area where you are showing the section, the rest all you need not really show the interior details because there is not much to look there. So, sometimes you can also do this third category, which is called partial section view.

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So, now, we come to a different category, where we are mentioning the offset sections. So, how do, how are these different from the previous? So, let us look at this example. As you can see there is, though there is symmetry, there are two features which we want to show. For example, there is one a bigger hole and a smaller hole. So, we want to show both these details using sections.

So, with the practices we have been discussing till now, to show these, you need two different sections. One, cutting the big hole and the second, cutting the smaller hole. But I mean, drawing two sections takes time, we need to save time to be efficient. So, what do we do? This time, we choose a cutting plane, which is composed of multiple planes. So, previously we are saying, it is one single straight line. Your cut line is a straight line and the cutting plane is one single plane. But now, we are allowing two different planes to make a single cut.

In this problem what we are seeing is, we will have two planes which are intersecting at an angle, and these two planes together will capture the features. So, let us see with an example illustration that will give us a better picture. So, here is the top view of this object, and these are the two sections, cutting planes we are talking about.

So, as you can see this is the cut plane one, let us say and this is the other cut plane. Let us name it 2. So, now, if you look carefully, we have two cut planes, which are meeting at an intersection point at an angle. So, the important point is, these are not a continuous straight line, but for example, here they are at an angle. So, the advantage of this is it includes several features. So, here, you are able to capture this bigger hole as well as the smaller hole with one single section view. Now, let us see how we draw the section view.

One thing to note, before we look at the section view is the viewing direction. So, as you can see, these directions are perpendicular to the cut plane. So, in both the cut planes, so this arrow is perpendicular to the cut plane 1 and this arrow is perpendicular to the cut plane 2. In both instances, we are looking perpendicular to the view.

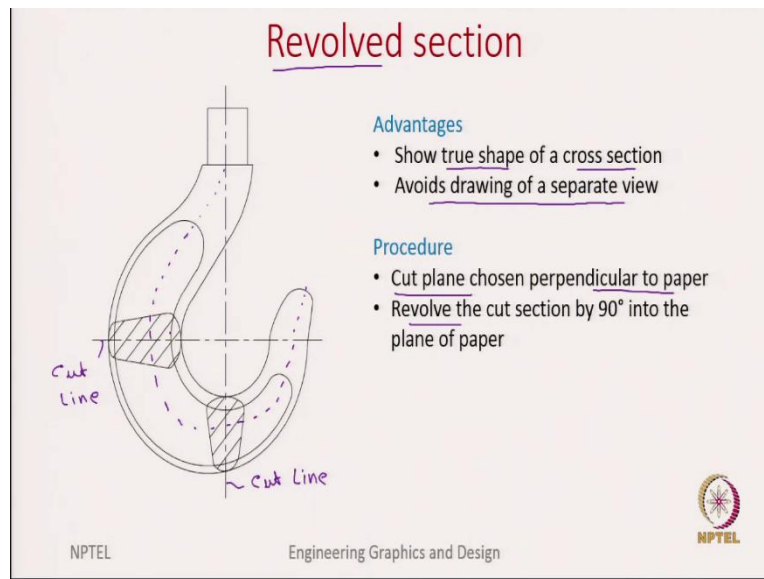
So, this is the object after the cut, where we have these two features to be shown. And the important thing is, so now we are saying let us say there are two different cuts, one horizontal and one at an incline. So, we captured the section area onto this cutting planes, and then rotate the cutting plane such that they both fall on the same plane.

So, though they are at an angle during the cut, but after the cut, they are rotated such that both fall into a single plane. This is required such that, you now see this feature at a true distance from the center. So, let us say this is at a radius of $R1$. And once you rotate it and show it though, you are capturing the view in this direction, but after you captured the view, you rotate the view such that it is in line with the other view.

So, we have two sections, sections 1 and section 2. Once you captured both these section views, you need to rotate one of it such that both of them fall in the same plane. And that way we capture the true distances from the center. And there are different other sections also. So, for example, let us say we have an object here. I am just showing the top view. Let us say there is one feature here where you have a bigger hole, and then there is some square cut here and finally there is another small hole. So, maybe now you can use the cut line in this fashion.

And then mentioned the view direction, let us say is A. So, essentially, what we are doing is, we are capturing this feature, which is the bigger hole, as well as this smaller hole using this set of parallel cut planes. So, as you can see there are two cut planes here. This is cut plane 1, and this is cut plane 2. Though there is another cut plane, you do not see that in the viewing direction, so essentially, we are focused only on these cut planes 1 and 2. And in this instance, both of them are parallel.

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So, now let us look at the revolved section. So, we need this to show the true cross section of an object. So, let us say what we see here is let us say a hook of a crane, which is used to carry heavy objects. And as you can notice, the cross section of this is varying along the axis. So, let us say, this axis is running in this circular fashion or the curved fashion.

As you go along this curve, the cross section keeps changing. But how do we convey that information? We have to convey that information on a drawing sheet, that can be conveyed, when we can show the, how the cross section changes at different locations. So, there are multiple ways of showing it. We will, in this slide, we are showing the revolved section. In the next slide, we will see another method.

So, why do we call it as revolved? And what are the advantages of this revolved section? So, the first thing is, it shows the true shape of the cross section. What do we mean by true shape? So, when we make a card, and then, we see we are looking normal to the cut, then we see the true shape of that cross section.

And second is, it avoids drawing of separate views. So, ideally, the way we draw it like front view, top view separately, what we are doing is, we are placing different views at different objects or different locations, so we need more space and sometimes an extra time goes into drawing those things. But here, since you are drawing these cross-section on the object itself, you save space and some time.

But let us see, again coming back to the question of why are they called as revolved sections? The reason is, so after you cut, so let us say this is the cut line, the cut line is perpendicular so

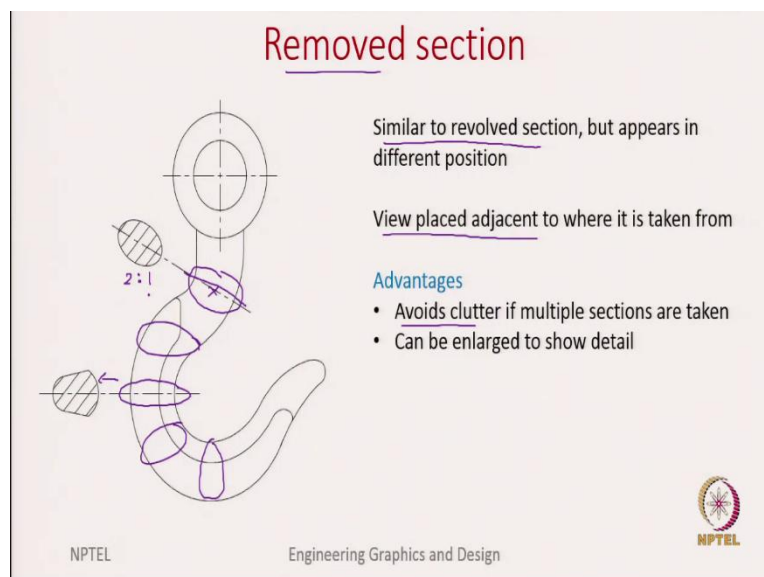
you capture the section area on this cut plane. But after you capture on the cut plane, you have to rotate the cut plane, so that now it is in line with your primary view.

So, let us say this primary view is a front view. So, initially, when you are cutting, your cutting plane is perpendicular to the primary view plane. But after the cut and capturing the section view, you rotate it, that is why it is called revolved sections. So, whatever you capture, you are revolving it and showing it at the exact same location.

So, you are not moving that section to a different place, you are rotating and showing it on the same position. So, here we say that the cut plane is chosen perpendicular to the paper. Here what I meant by paper is the primary viewing plane. For example, here is the front view, let us say, and then, you rotate the cut section by 90 degrees to the plane of the paper.

So, here is one section we are showing. Similarly, I can have another cut line here. And after my, after I do the sectioning and then capture the section area, I rotate it again by 90 degrees, such that, this cutting plane is now in line with the front view plane. So, these are the revolved sections. So next what we see is a slight variation to this, which we call as remote sections.

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So, as I already said, this is similar to the revolved section. The only difference is, previously after you rotate you do not change the position of this section. But now what we are doing is we are placing it a little away from the object. So, previously it was placed here, but now we are moving it a little away such that it does not interfere with the object.

So, views are placed adjacent to where it is taken from. So, the first one is taken from this position, so it is position next to the cut line. And similarly, here, this is the position where you are taking it from but you show it here next to where it is sectioned.

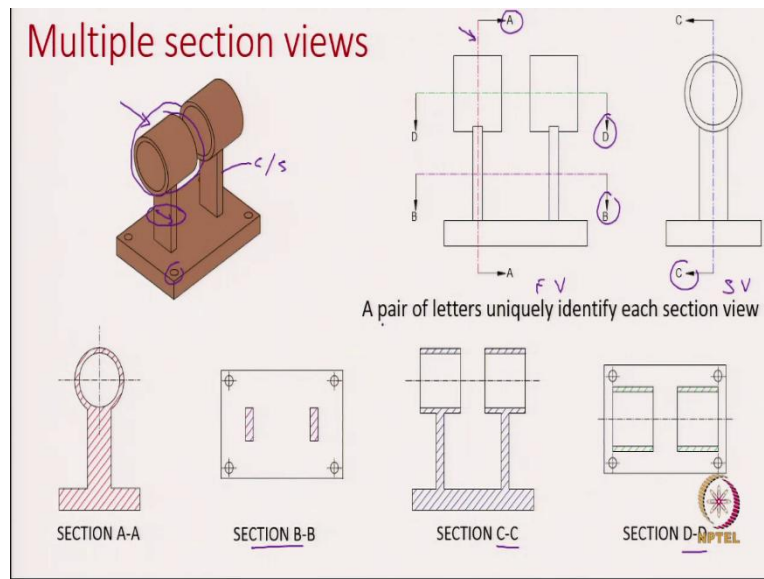
So, the advantage is it avoids clutter. So, let us say in this example, we know that the cross section of this hook is continuously changing. Here, we only showed two sections, but let us say we have to show four or five sections. If there are four or five sections, and you use the previous method of revolved sections, then it becomes clutter because then you will have one section showing here, maybe one here, one here, and the other one here and here.

Then what will happen is suddenly this drawing becomes very complicated. We do not want to have these complex drawings we need to make it simple. So, moving these sections a little away and placing them adjacent to the view helps you to make the drawing look simple and neat. And the other advantage is, let us say, this section is too small. Here instead of using a scale of 1:1 I can draw a scale of 2:1.

So, which means, I can enlarge the screen. I am free to do that, such that, now I can show the details more clearly. That I cannot do with the previous revolved sections because I need to match with the object because it is already sitting on objects, I cannot make it either enlarged or smaller, then you lose the correspondence one to one correspondence.

So, now, we see there are a few advantages of these remote sections, and when we use this. We use this when there is a need to show these sections at multiple cross sections. So, since there are multiple cross sections we want to avoid clutter and then we move these sections a little away from the object and show it.

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Finally, the last category we will be discussing is the multi-section view. For example, if you look at this object, to show the complete details, there are too many features to show. So, for example, I may want to show what is the diameter of this hole or the interior of this hole. I may also want to show what is the cross-section of this handle, and then the details of this upper ones.

So, as you can see, there are many features. How can I show it elegantly? One option we have is, multiple sections. So, for example, here, I am capturing the front view and the side view. And as you can see, I have four different sections chosen So, one is Section A-A, then B-B C-C, D-D. So, you can use multiple sections. The only difference is, you need to label them uniquely, so that they are not confused.

So, now let us look at this Section A-A. So, once you are looking at this particular cutline, which sections this so, you get to see the entire inner details. Like, what is the thickness of this circular rim, and then the thickness of the width of this feature and other details like that. Similarly, when we go to Section B-B.

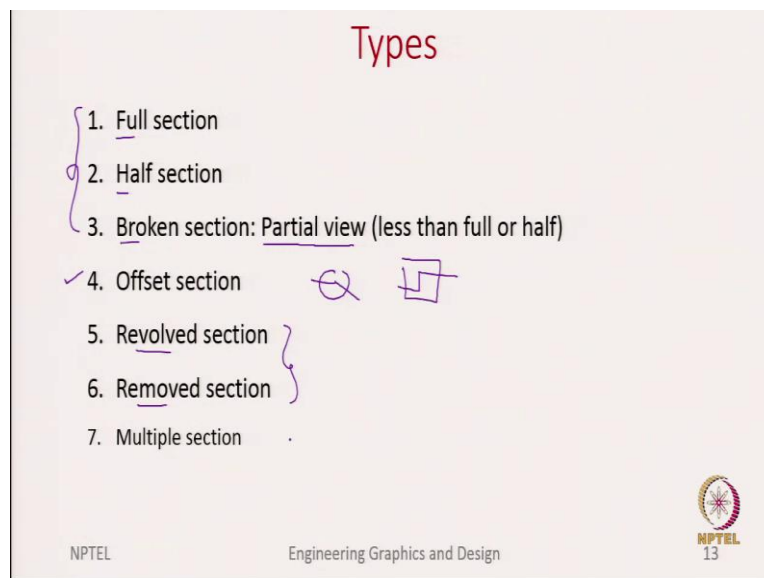
Section B-B will help you to see what is the cross section of these objects. And section C-C which is from the side view will again show the circular rim but at a different view. And lastly the Section D-D. So, here you see that alignment of the views is different. Previously we had a perfect definitions for alignment when we are drawing the multi-views. We said, depending on the first angle, a third angle projection, if it is a third angle projection, your top view is placed above the front view, and left side view is placed to the left of the front view.

So, these are perfectly oriented views where we say where to place the front view, side view top view.

But in this section views though sometimes we present the section views also in a perfect alignment, so saying that depending on the kind of section sometimes you place it to the side of the front view or to the top of the front view, but you are also free to move out of those regular elements. You can place the views at different positions.

So, for example, here, these are not, these sections B-B, C-C and D-D, these are not aligned with your front view and side view. Because, since there are too many views, you cannot fit them all in one particular alignment saying left, right, top, bottom. So, with this, we summarize the different kinds of views. I think, this we already mentioned saying that the pair of letters uniquely identify the section view. So, this A-A, B-B, C-C and D-D.

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So, in summary, what we have seen is, the different kinds of views. The first three are basically, how much of the section you are showing? Are you showing the full section, half section or the broken section? In the broken section I think, we did not show with too many details or the drawings, but we said, we are only showing the partial view because we need not spend too much time into showing the complete object in the section view. Because the details what you want to show are good enough in this partial view.

And then we also looked at these offset sections where we had the cutting line at an angle and we also said there are places where we can have it at the cut planes or the cut lines are parallel to each other.

Then we looked at two different ways to show the true cross sections. One is the revolved section and the remote section and lastly, the multi-sections, because that helps you to show elegantly or neatly, the interior details where the features are a little more.