

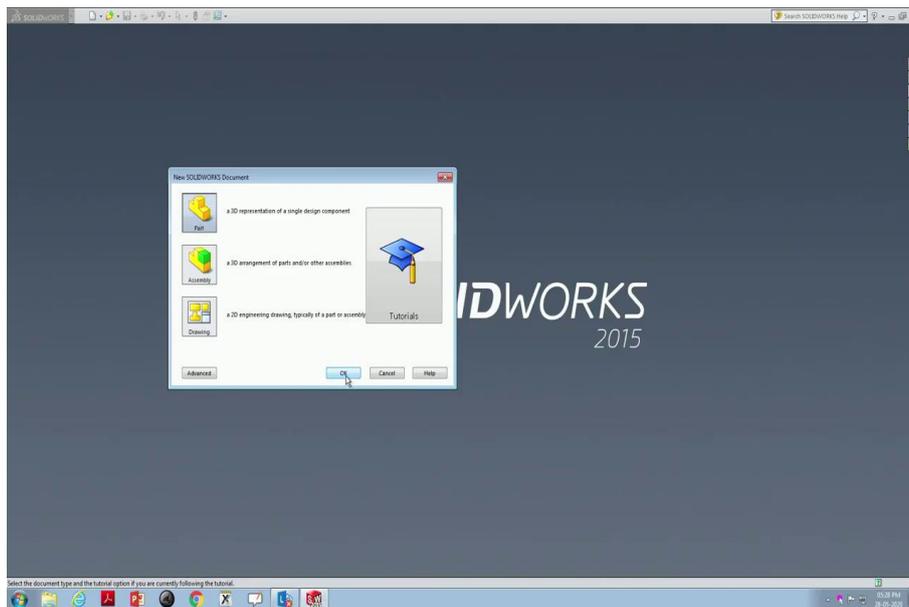
**Engineering Drawing and Computer Graphics**  
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**Department of Mechanical Engineering**  
**Indian Institute of Technology, Kharagpur**

**Lecture – 57**  
**Solidworks (Contd.)**

Hello, everyone. Welcome to our online NPTEL classes on Engineering Drawing and Computer Graphics. In the earlier classes, we learned about manual drawing and after that, we have introduced surface modelling then went try to learn about Solidworks software.

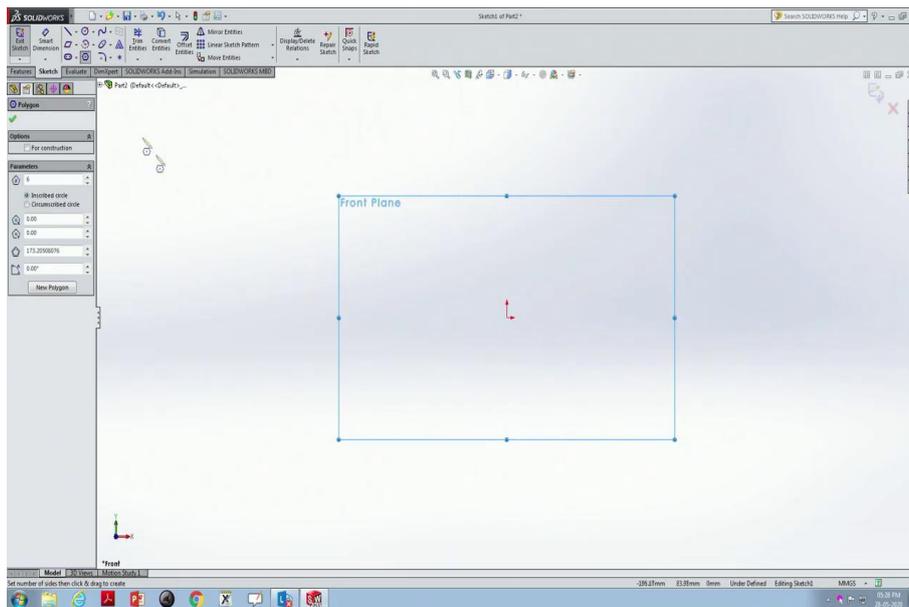
In the Solidworks software, in the last class especially we tried to learn 2D sketches, how to draw them. In today's class, we will learn more about 2D sketches and then go ahead to construct 3D sketches. Thereafter we will learn about how to view sections. Let us begin our session. After double-clicking the Solidworks icon, we will have this kind of window.

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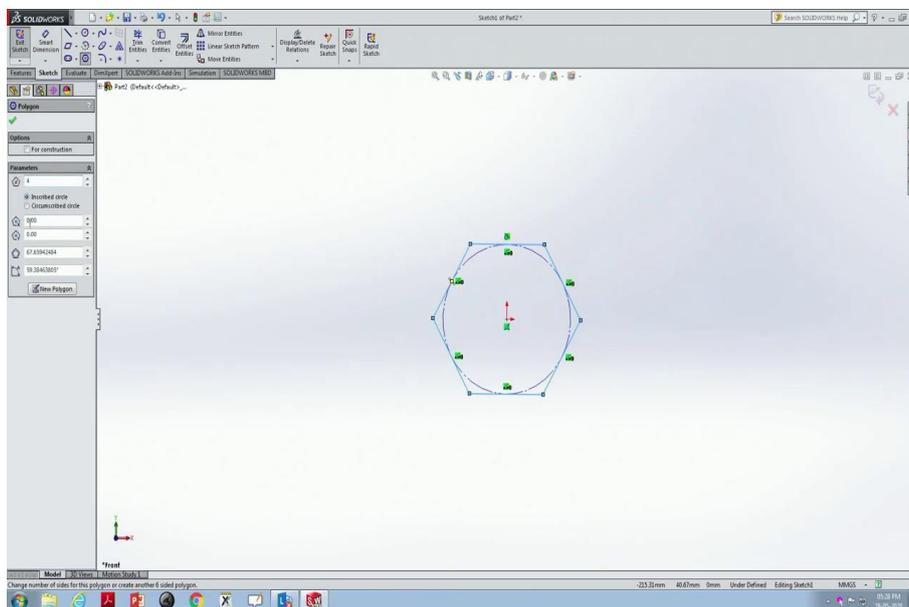
Then the first one what we are learning is opening a New drawing. In that we are learning about Part, then click Ok.

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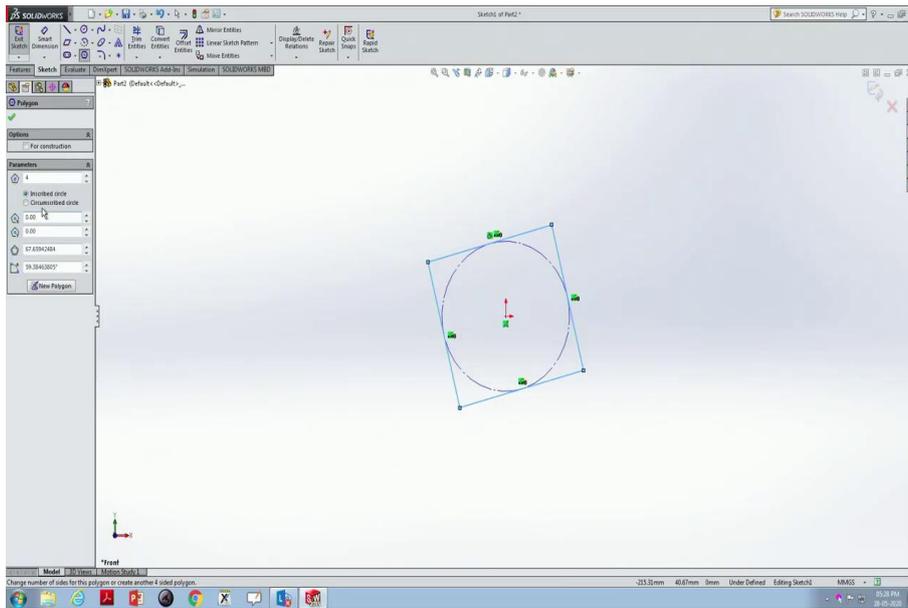
Then this page opens up. Now, any sketch we would like to draw that we begin it on the front plane. There is no particular preference why front plane we have to use, but this is a custom what we are following for today's class. Now, we have learned about arcs and other things.

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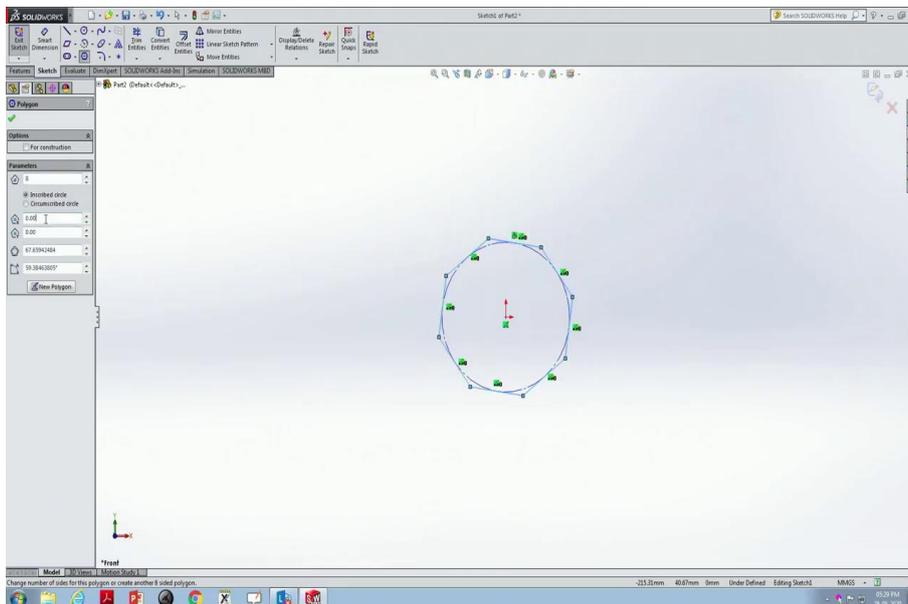
Now, if I would like to construct a polygon for example, here polygon having 1 2 3 4 5 6 sides are there.

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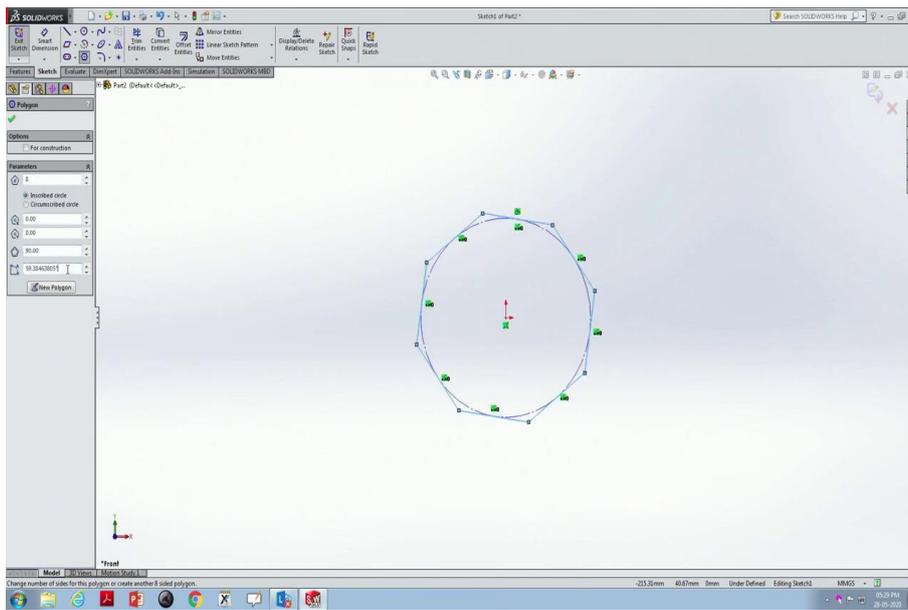


Now, instead of 6, if I would like to have 4, it construct a polygon of 4 sides here square. So, it is all the time construct a circle around which on the periphery the polygon will be constructed. For example, if I am going to construct octagon by keeping 8 number there, we will construct octagon of that size.

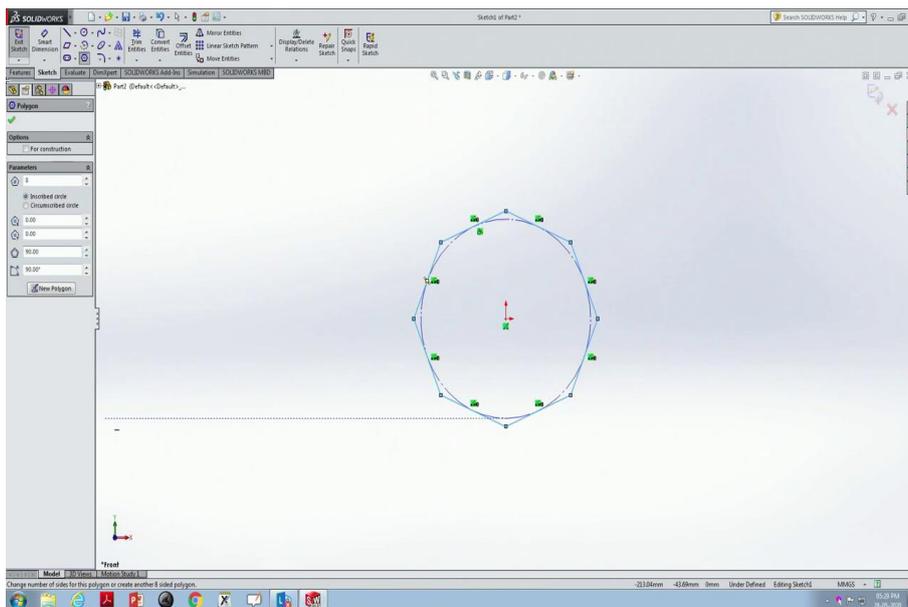
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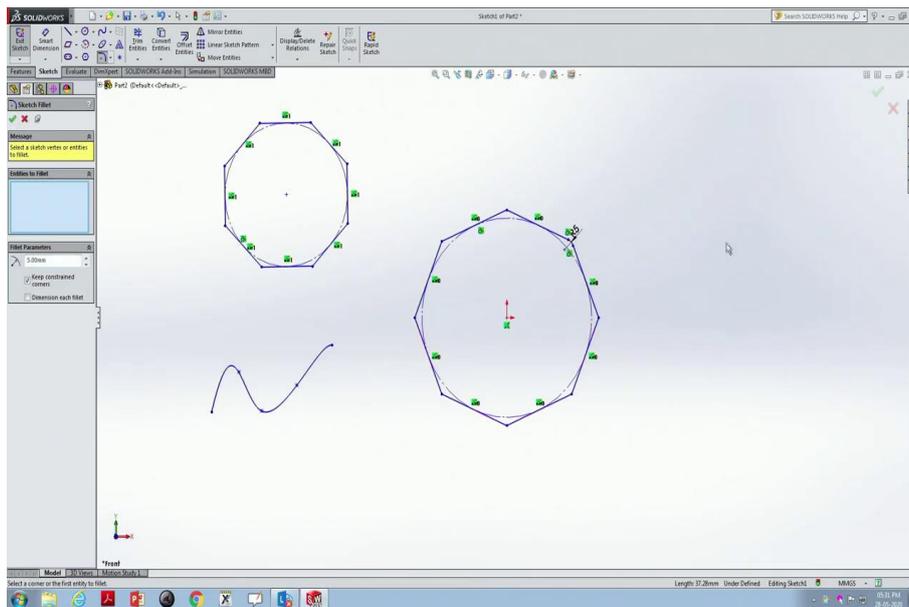


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Now, here we have certain angles I can always make 90 degrees and this one also 90 degrees. So, it will be rotated in such a way that everything will be aligned. This is the way we construct any polygon.

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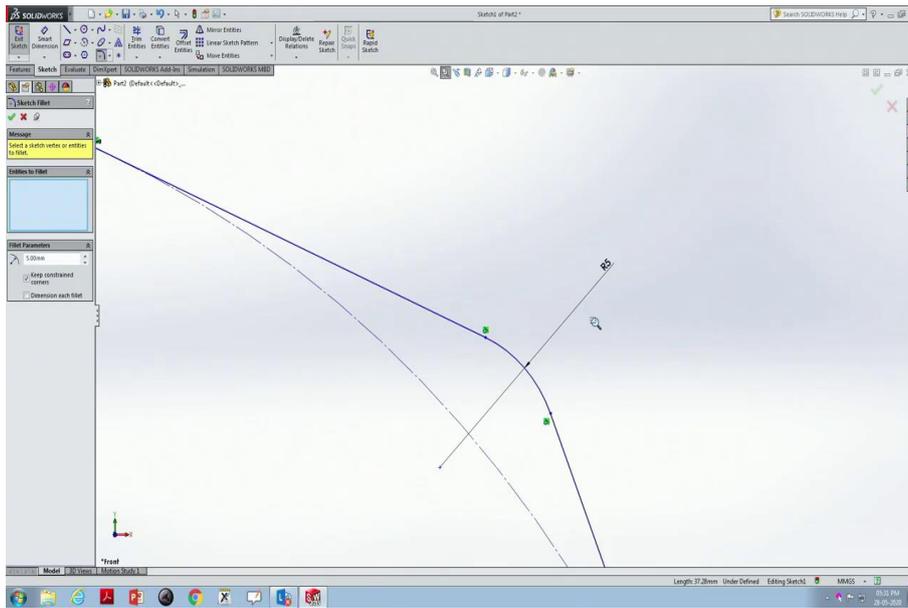
Now, if I would like to construct multiple polygons, what I have to do is pick the point, just move my mouse to some other location, press Escape button, then we are done with that another polygon.

Now, let us move on to construct a Spline. So, for spline, you pick that button, next point from next point to next point from there to there and so on. If one is interested in connecting smooth curves, then spline interpolation or spline curves are always useful and it has a different kind of splines also, style spline, equation driven curve where you can specify the equations also.

Then we can learn about Sketch Fillet, Sketch Chamfer. These are the things when we want to construct a smoothed surfaces we use this. For example, let us use Sketch Fillet. For this side, there is a sharp corner I would like to pick the first one here and the second one here and now you see something like a yellow colour where the radius is showing 10 mm kind of fillet.

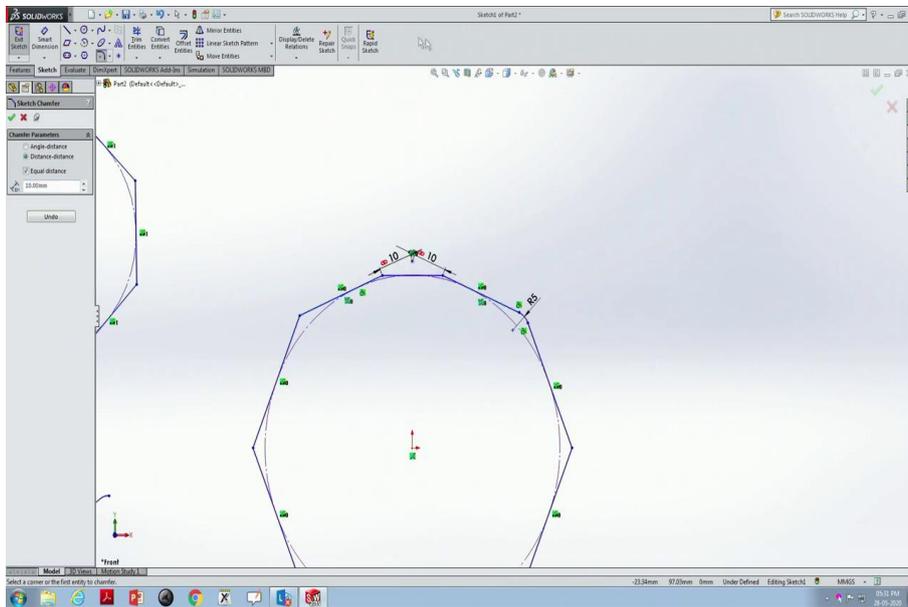
Instead of that, if I am going to specify 20 mm, it shows 20 mm radius; instead of that if I am showing 5, a smooth surface it will construct. Once it is done, you have to click Ok button.

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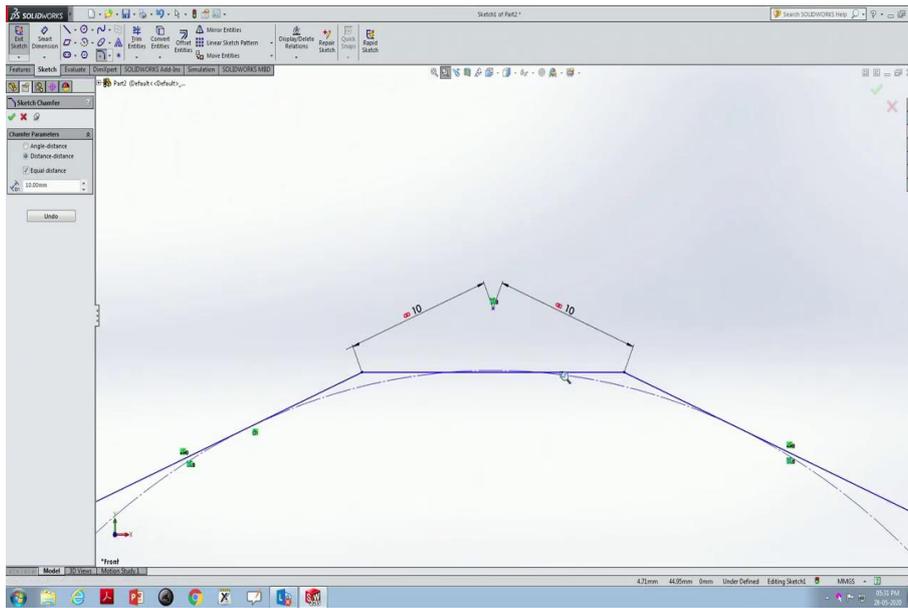


Then if we are zooming that portion it will not be any more a sharp corner. It shows the dimension also with 5 radii we have that fillet. Similarly, let us use the Chamfer button. Here we have a Chamfer. So, let us pick this one and this one.

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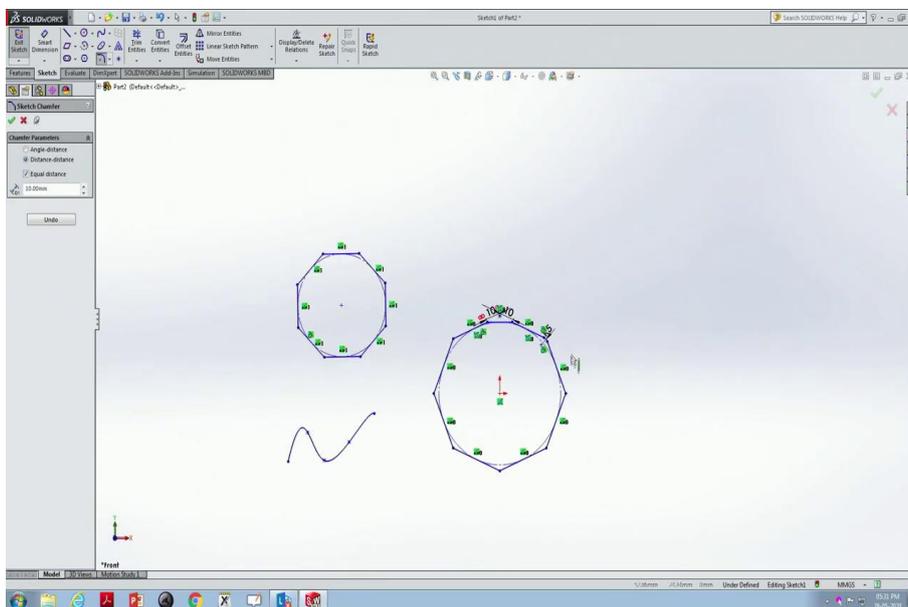


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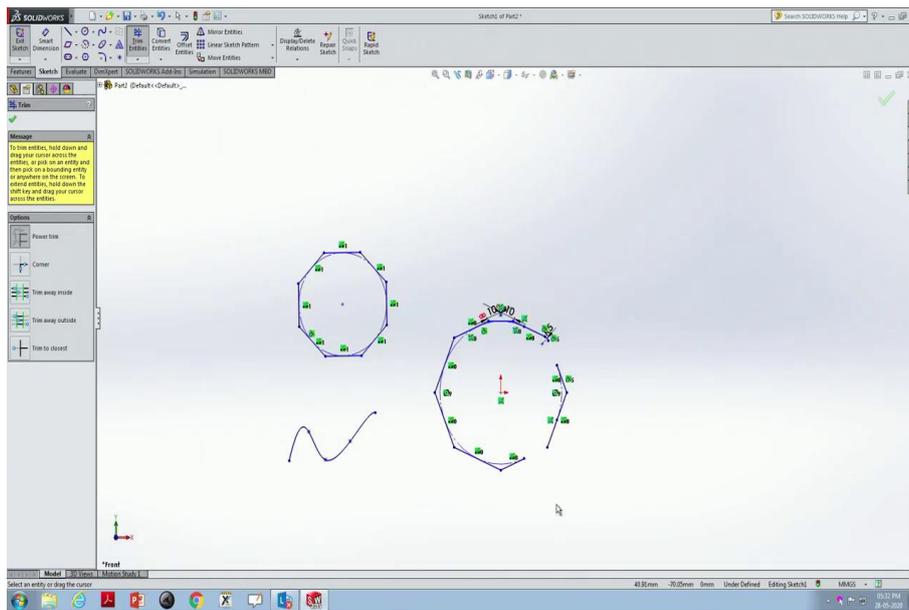
Now, if you are seeing this the sharp edges removed by a cut where that cut clearly shows that the distance between these points from where we have that chamfer is 10 mm and 10 mm. This is the way we use chamfering and fillet.

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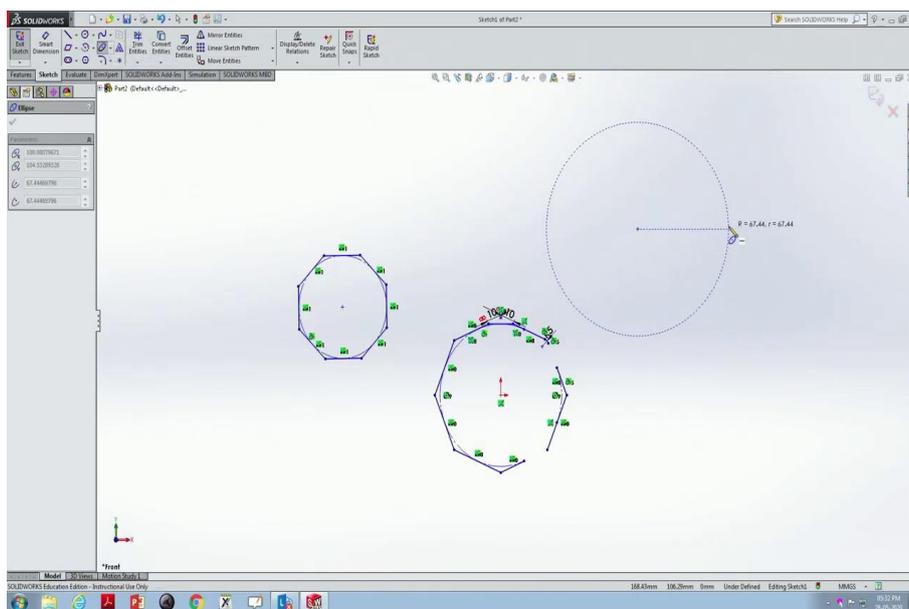
In the last class, we have learned about Power Trim. If I want to use Power Trim.

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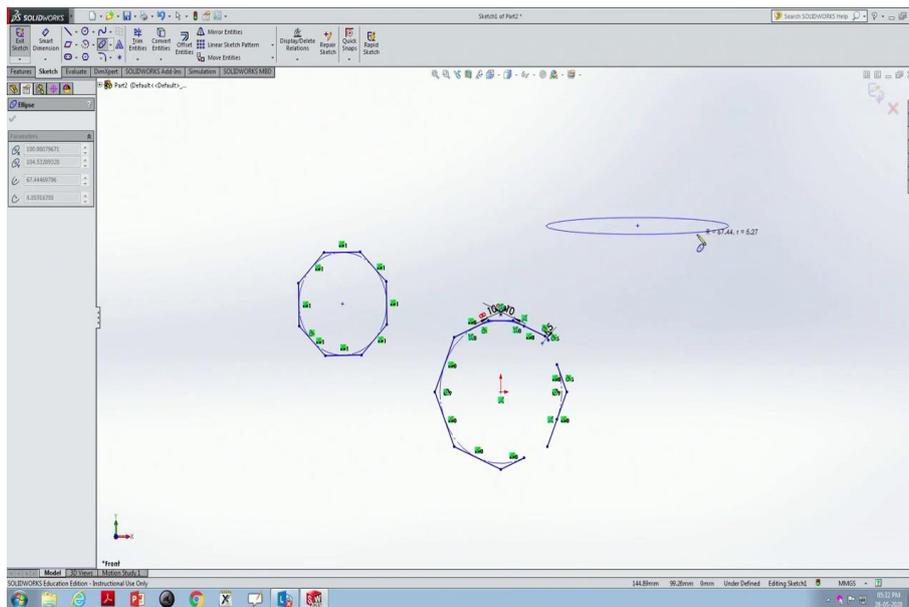


If I just do that it removes that object which is in between those two data points for example, here first data point second data point is there curved is there. So, if I use Power Trim it removes that object, but here Spline is a continuous curve though it is showing like points from where to where we are going to construct, but when you use this Power Trim it removes the entire object, whatever the entire object you have between the points that will be removed.

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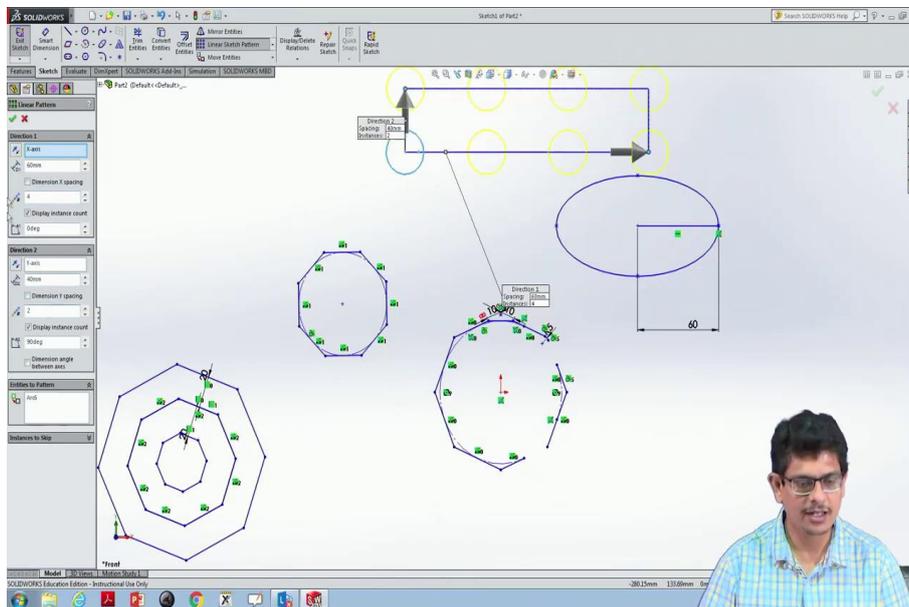


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Similarly, if one is interested in constructing an ellipse first one data point one has to pick, second data point, then if you are moving it around you will see the ellipse.

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Then, you want to adjust the major axis, minor axis these kinds of thing, then we can always use a Line. So, based on that Line dimension we can always either shrink this ellipse or enlarge the ellipse.

Now, there is something named Offset geometries; in the earlier classes, we have seen when surfaces we are constructing we may require offset kind of surfaces also, for that purpose we use these Offset Entities. To use that let us construct something like an object of this shape which is an octagon.

Now, I would like to construct offset for this. So, what I have to do is first pick that point uh pick that object then use Offset with 10 mm or perhaps 20 mm we are going to construct offset. Once we click that, we can click Ok. So, outside of that, it is going to construct that offset.

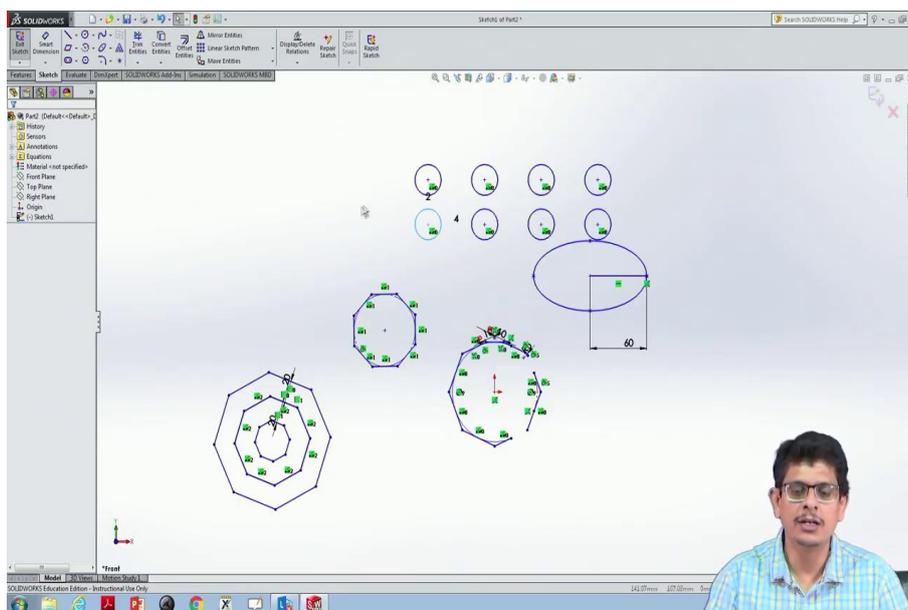
We want to change that to inside, what we have to do is use Offset now make it Reverse. So, inside also we can construct it. So, there always be different options and based on carefully picking these options we will be in a position to construct internal-external kind of objects.

There is one more powerful thing which we call this Linear Sketch Pattern. For example, I want to multiply or produce many objects in a row or column; something like a circle after circle after circle I would like to construct. For that, we use this Linear Sketch Pattern. Let us use that.

Something like a circle and this object we want to repeat it. For that purpose what we use is to click this Linear Sketch Pattern. Then it asks how much distance it has to be there. So, maybe let us say 20 mm, then that is the thing; maybe 60 mm we would like to specify. Such kind of objects we would like to have four in number in the X-direction, then you can see 1 2 3 4.

Similar way we would like to have two rows, first row and second row we would like to have. For that purpose in the Y-axis, we can use two rows with a distance gap of some 40 mm maybe in minus 40 mm.

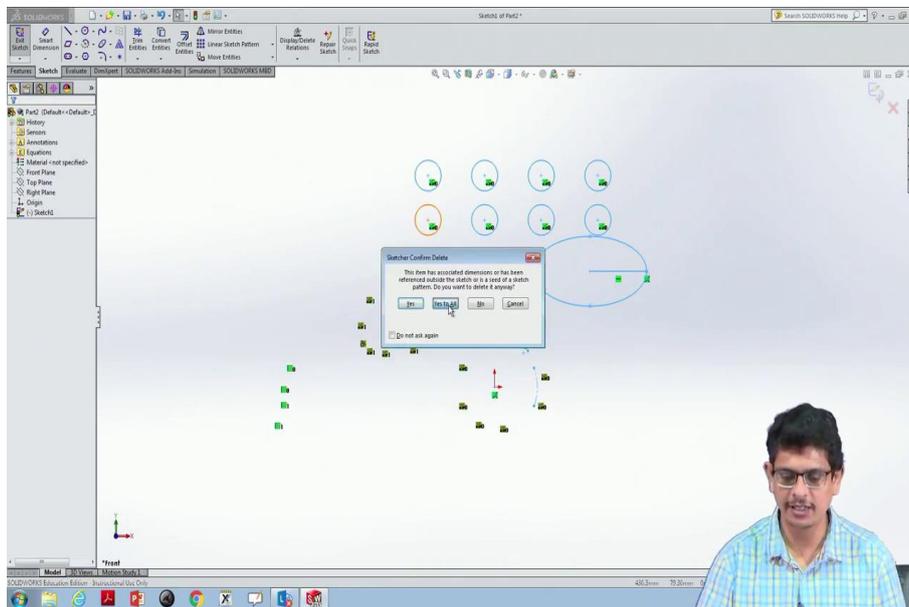
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When we construct that we have this object repeated kind of pattern. So, here it is not taking a negative number. So, it is always 0 to whatever that maximum size this solid works permits. Now, this is the way a rectangular grid or number of points one can construct it.

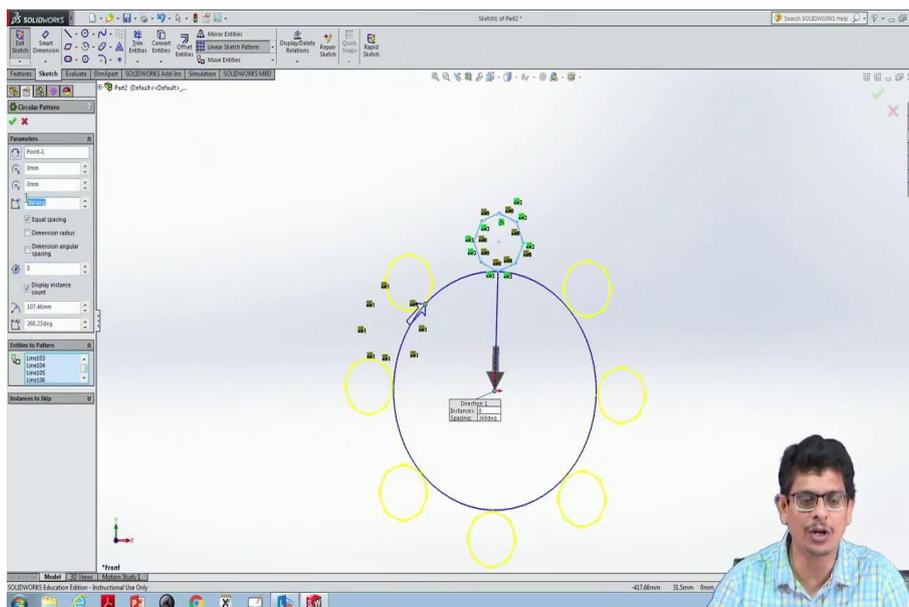
Now, let us look at a circular kind of pattern. I would like to erase all these points. So, first of all, I have selected you to use the left button, click that hold select everything, then leave the button then it will be highlighted.

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Then you can press Delete, Yes to All. Now, I would like to make one more pattern like maybe an octagon I would like to construct here a small one.

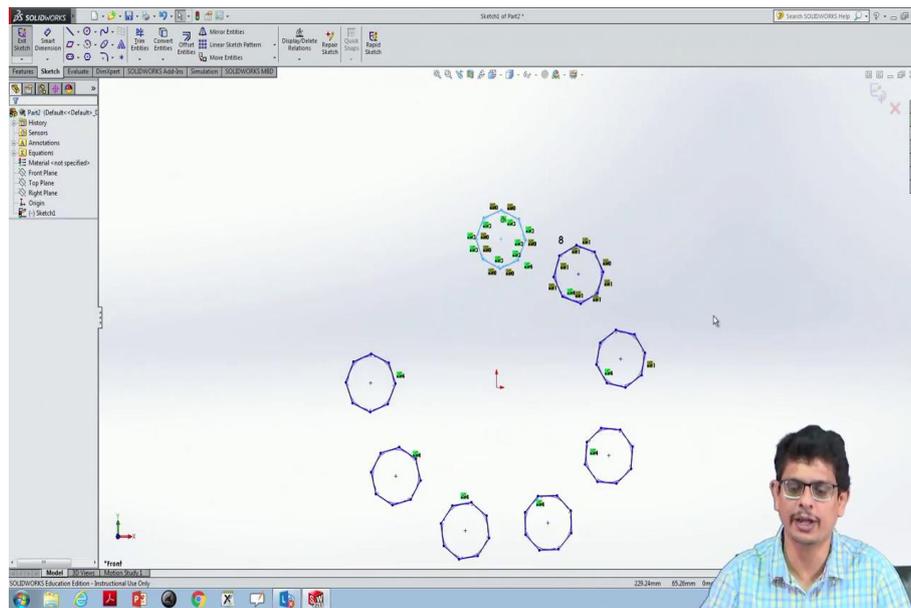
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This one I would like to repeat it in a circular pattern. Now, when I click the circular pattern around certain circumference all these octagons will be placed something like whether I would like to have 4 or 8 octagons.

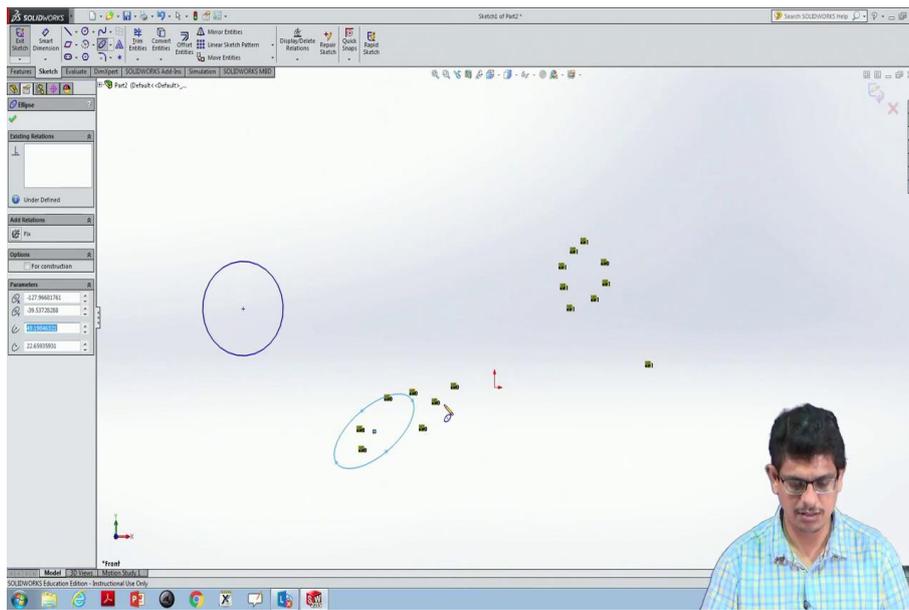
So, based on the number what I am going to specify uh I can always specify whether it should touch that surface or should away from that surface also whether I would like to have complete 360 degrees or only 270 degrees.

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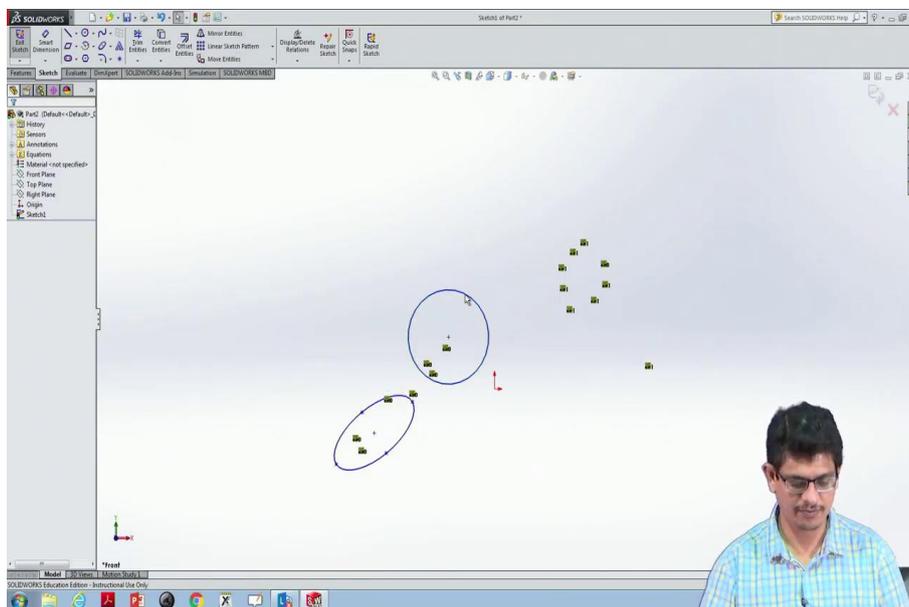
When I click 270 degrees in the clockwise direction, it showed only up to 270 degrees and click Ok. This is the way we circularly repeat the patterns.

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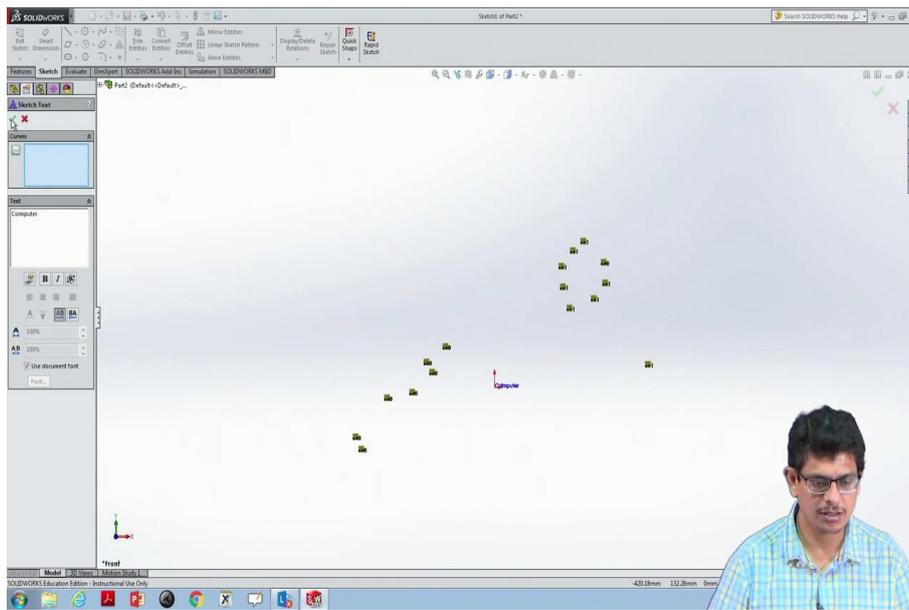
There are many other things also like move entities and many things. Let us look at that. For example, I have one circle here, I have another ellipse here and I would like to move this one. I would like to move it drag and place it here.

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If I precisely know where to locate your GUI permits you to move objects. What you have to do is first select that object, go to Move Entities again click that object, move to your required location drag and drop it. It does for one individual entity. If two-three individual entities, if they are not selected together, only one of that highlighted portion will be moved from one location to other location.

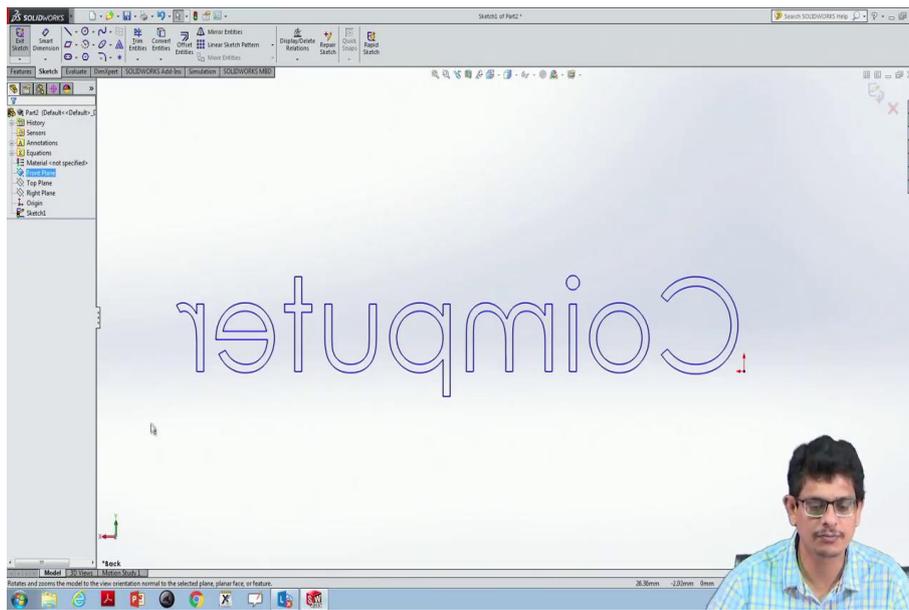
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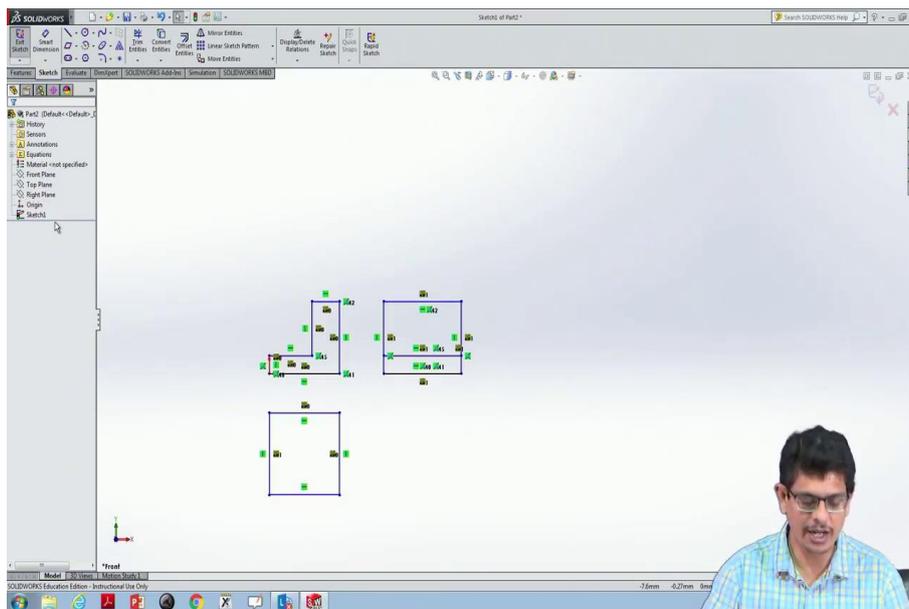
Similarly, you would like to write some text on your drawing sheet. We can always write something like. So, it showed something like a size like a computer. Based on the dimensions what we are going to pick how big is supposed to be based on that we will see this computer later. So, when you are typing it shows the numbers, based on that you can write it. There are many more options also internally where you can change that text to different kind of styles.

Now, we will learn about how to construct 3D objects, how to use extrude kind of commands filling the materials constructed, how to remove part of the materials and how to visualize different views like front view, top view, side view of that object and cut sections of that. One more thing if because of beginners if one is interested in constructing top view, side view, front view, the easiest way what they can prepare is straight away they can go to front view.

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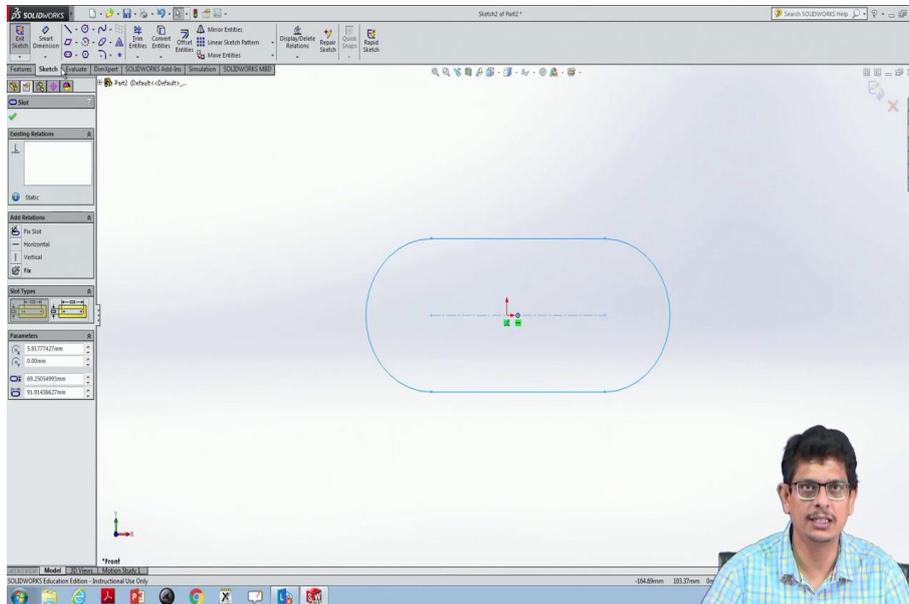


And, for example, I would like to construct something like for just 2-dimensional object if I would like to construct something like front view, top view, side view what I can always do is the top view, side view I can always move so that it aligns with that dimension in a perpendicular way I can go from there I can construct and from here also we have a line supposed to come from and go.

So, this is the way if I would like to construct uh first quadrant projections like something from left side view I would like to look at it how it looks like and so on. So, I do not have to jump on to the top plane, right plane and front plane. One plane is good enough if you want to just give a try in terms of

constructing 2D sketches. There is an automated procedure also to construct these things if one can construct straight away 3D object ok. First of all, we will learn how to construct a 3D object.

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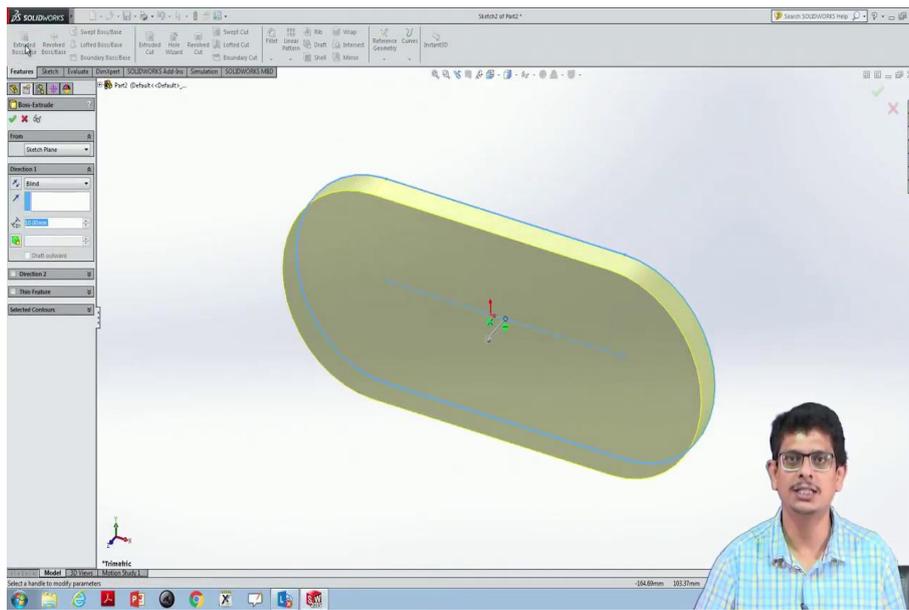


Now, let us begin with a Front Plane normal to front plane maybe pick a Straight Slot from here to there to that. This is a 2D thing. What I want to do is add material the similar kind of material like layer by layer in the other direction; that means, perpendicular to the computer normally to that computer monitor, I would like to fill many layers so that a thick kind of link I would like to see.

For that purpose what I have to do is the first always the first part is a 2D one. We would like to repeat that 2D one by several layers to construct the 3D one. First select that entire object select means to keep your finger on that left button hold it, then select an entire thing to leave it.

Now, next to Sketch there is something like Features button. This is the one. This is the Sketch mode where we are in; from there go to Features, click Features. Then it shows something like extruded Boss Base, Revolved Base and many things. Extruded means a manufacturing mechanical technology; extrude means you are going to fill more material in that direction.

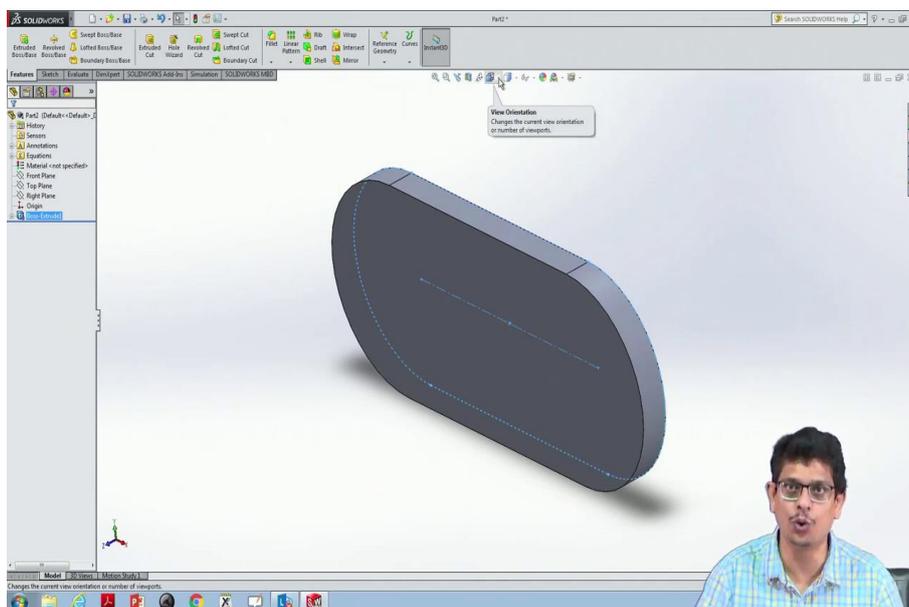
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So, pick that Extrude Boss. Then it shows you a 3-dimensional object. The same 2-dimensional configuration something like a link it shows. Now, here you have something like Directional sense, Direction of Extrusion whether you would like to go normal to that direction or away from that plane.

And, there is something like how far you would like to go from the plane of reference. When we are learning more about planes of reference constructing that we will learn about that, but from the 2D sketch whatever the plane the front plane we have chosen 10 mm depth or perhaps height we would like to go by filling this material.

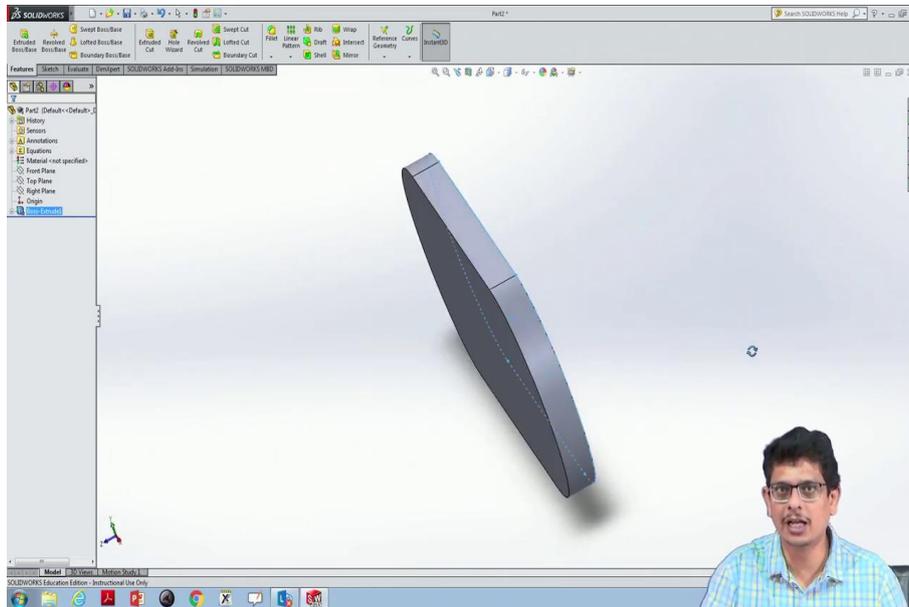
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then click this Ok button. Then it constructs a 3D object.

Now, you would like to visualize this 3D object in different ways. For that purpose, you click your scroll button, click and move the mouse in different directions ok.

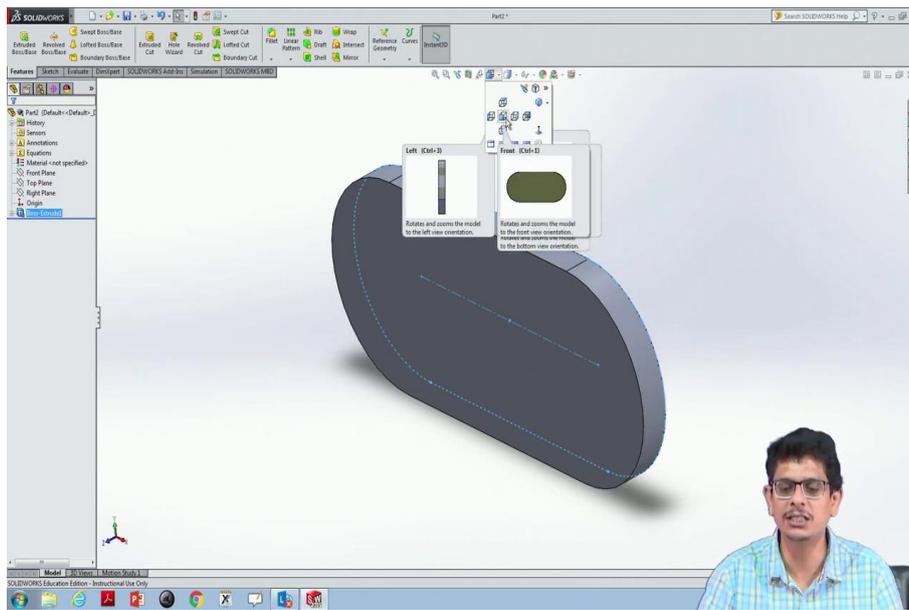
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So, what I am doing is click that scroll button hold it and move your mouse here and there, you will get the 3-dimensional appeal.

Now, I would like to visualize this entire 3D object as one of the orthographic views; that means, I would like to visualize in this direction, in this z-direction. For that purpose, there is a button at the top on, if you see that there is something like View Orientation. Next to your Zoom buttons, magnifying lens, cut and other things there is something like View Orientation, click that.

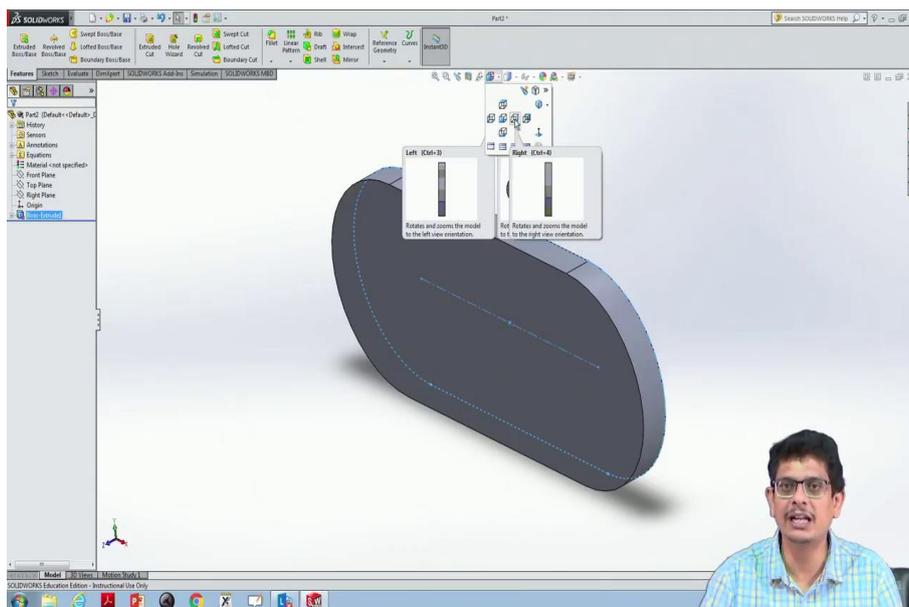
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There are different views uh do not click anything, but just move your mouse onto that. This tells you a kind of view in the direction of that blue surface. There there is a block the cuboid is there, the blue colour is the portion where it is highlighted you are going to see that if you click it.

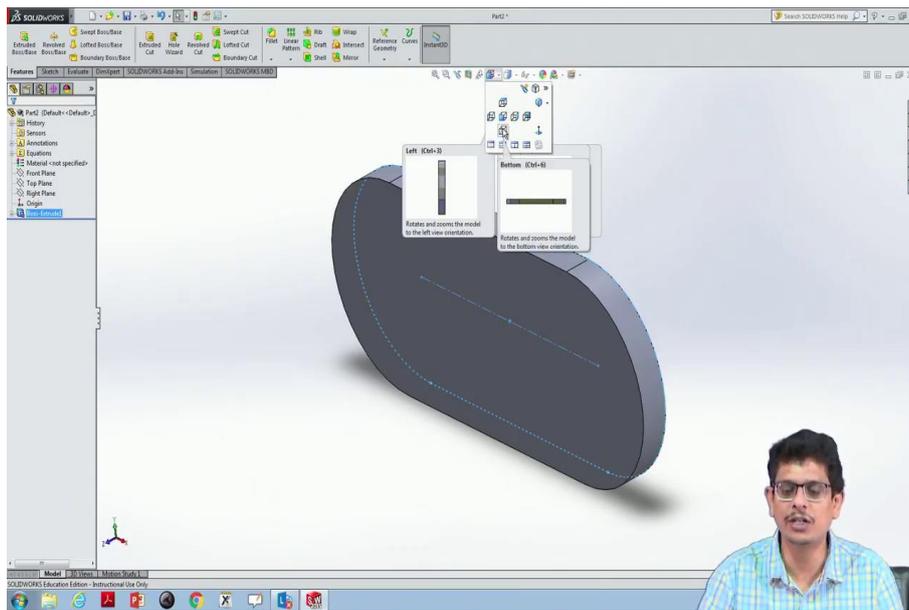
The same thing for the same cuboid, there is the blue surface on the left-hand side. So, if you are going to click that you are going to see that view.

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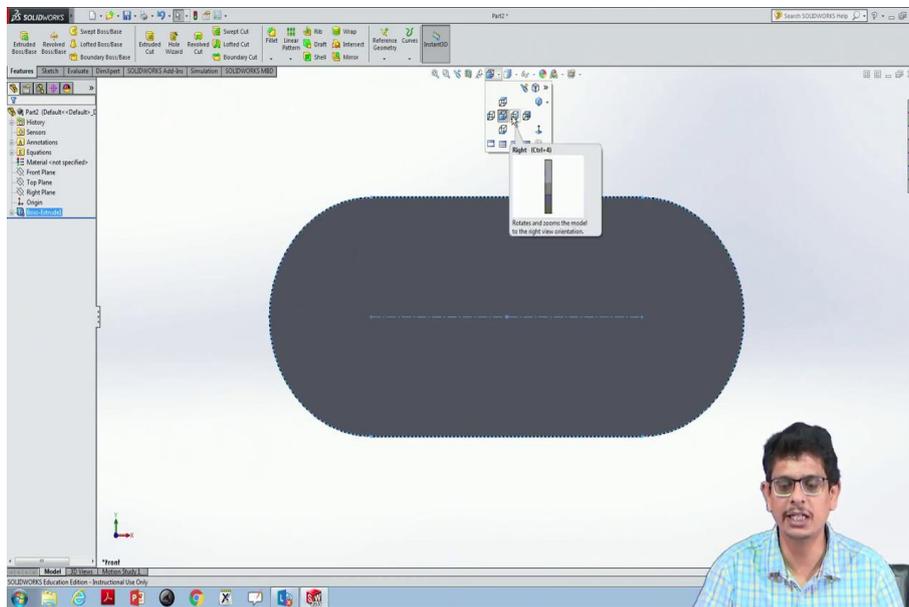
Similarly, right side view.

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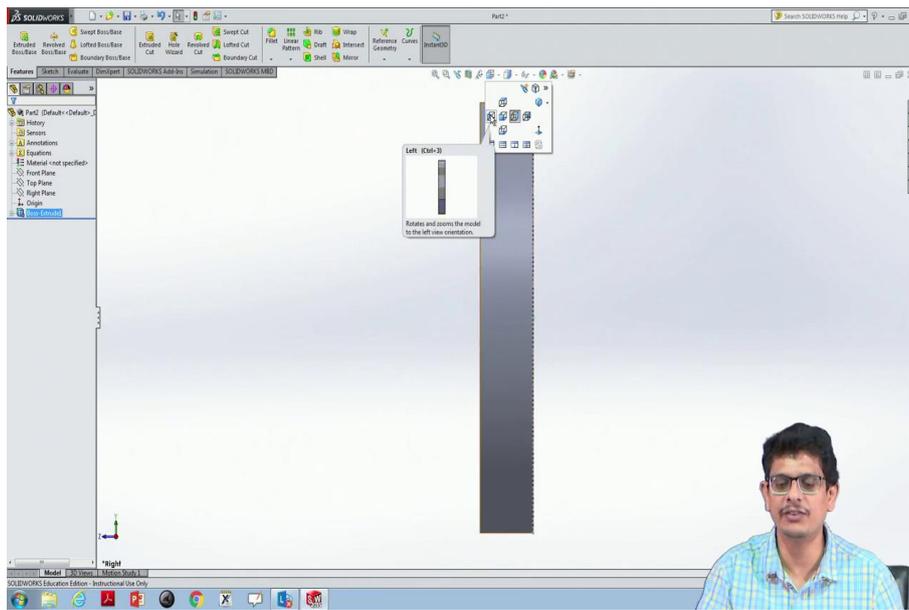
From the bottom view you are going to see something; top view you are going to see something. So, first click this middle one, front view.

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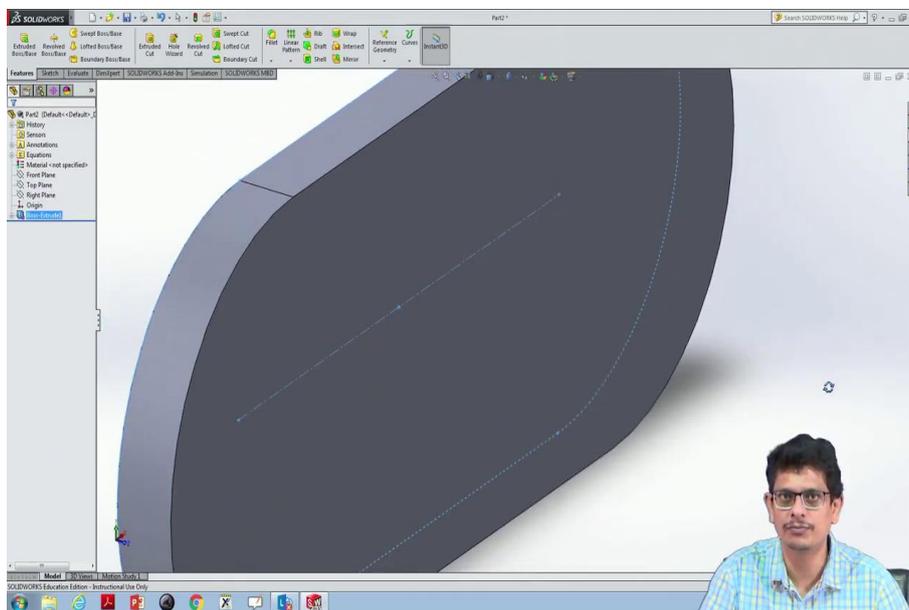
So, your 3D object tilts in that direction, so that you will see only this view. Now, I do not want that, but I would like to see one of this particular view.

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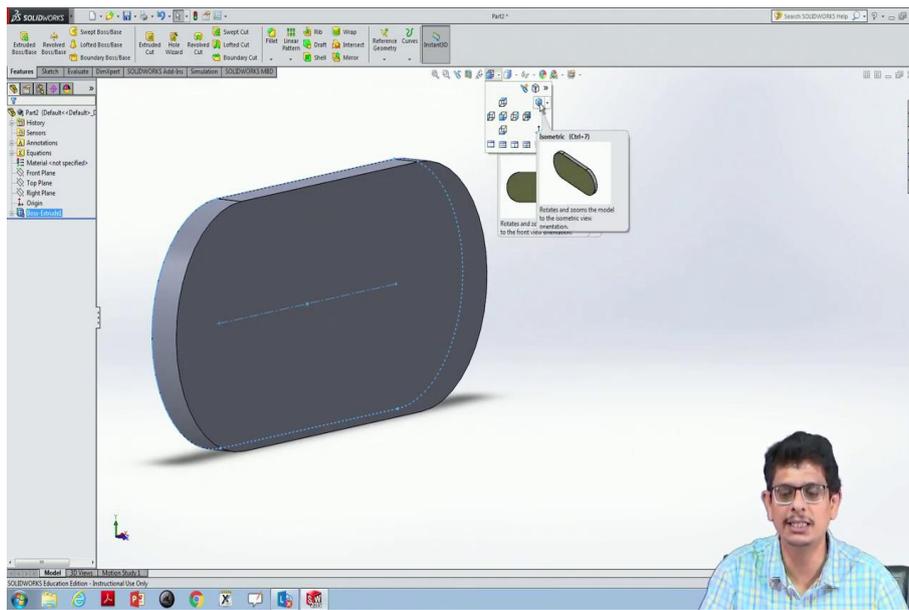
Now, see the orientation. So, this entire object rotated in that rightward direction that is the face what it is shown. Similarly, click the left side face. Now, that entire object is flipped in that direction, so that you will see that left one.

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Now, still, you can use your scroll button to rotate the object also.

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If you scroll it, it magnifies - zoom in, zoom out kind of things happens. Now, you would like to have something like an isometric view. For the same thing click that, you see ah. There is something like a blue button, not the views orthographic views, but there is something like isometric with control plus 7.

So, if you are going to click that it aligns in such a way that you start seeing or uh isometric view where 120 degrees on the principal axis you will see; that means, if I am going to draw something like axis here, one of the thing axes what it does is 120 degrees with respect to other things.

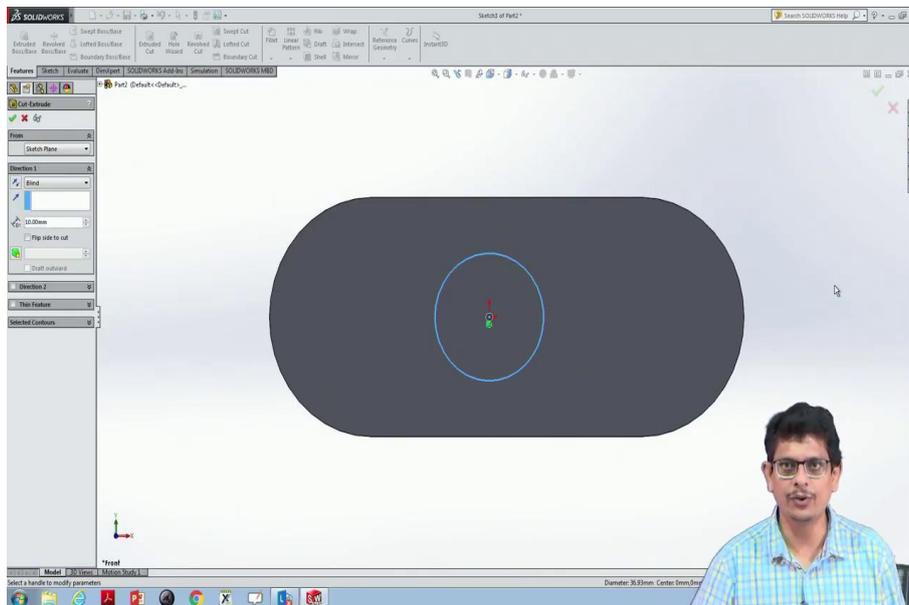
Now, in the same orthographic Isometric click this down one. There is one more button-like Dimetric views. In the earlier classes at the manual drawing, we have learned something about Isometric Dimetric Trimetric. So, let us click Diametric. The typical US system where the lathe machines and other things what we have seen in the earlier classes that view you will be having.

Now, click the Trimetric view. So, now, it is slightly tilted. Now, for the Trimetric view. I would like to see the front view. There will not be any variation in that direction because these are the orthographic views what we are trying to look at. At Isometric, Dimetric the view what we are seeing might change, but when you are going to look at orthographic views this information hardly changes.

Now, I would like to see something like normal to that surface, then it rotates in that way. So, one of the normal is this front face. So, let us try with some other 3D object or perhaps I would like to make holes through these centres. At one end I would like to make a circular hole at the other end I would like to make something like a polygonal hole.

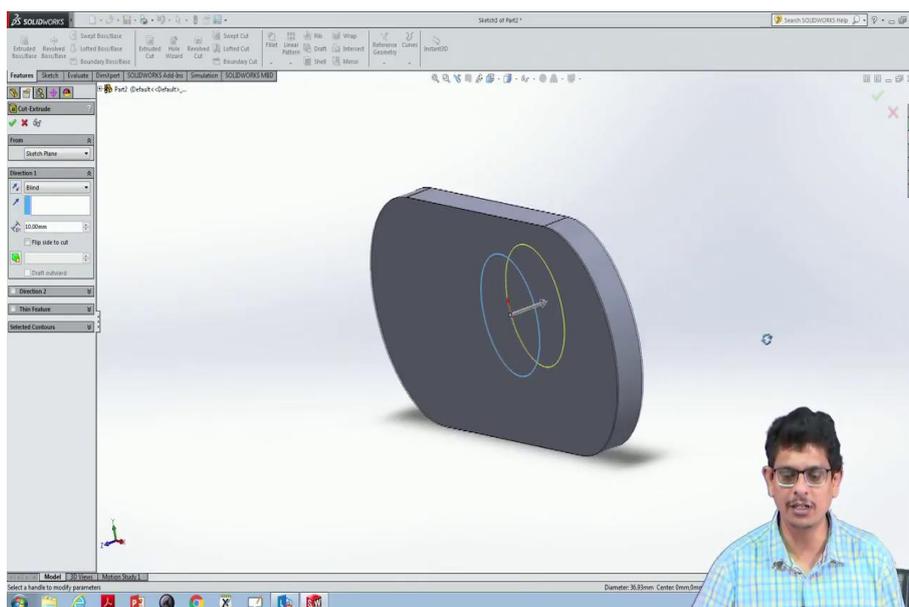
So, let us first arrange it to Isometric view. So, I would like to have something like a circle, something like a polygon. For that purpose what I have to do? Pick the front plane because I would like to make a hole; that means, first I have to make something like a 2-dimensional sketch after that drill a hole through that.

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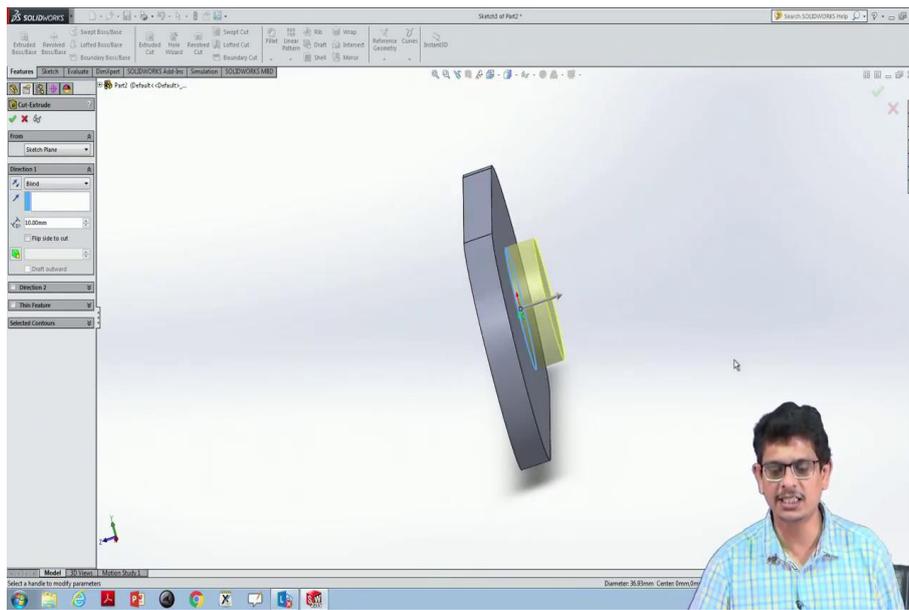


So, for that purpose we will go to normal to the plane and somewhere here what I am going to do is use a Circle.

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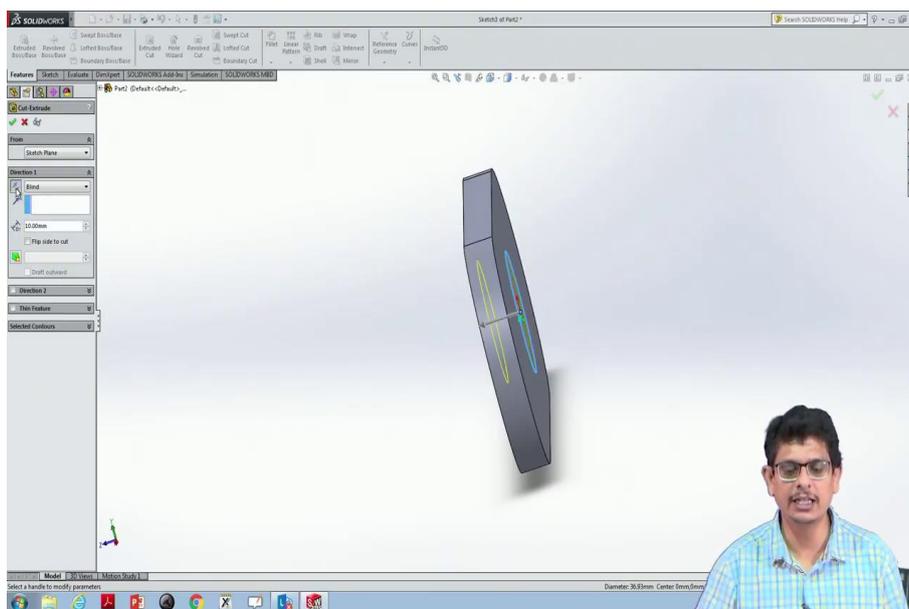


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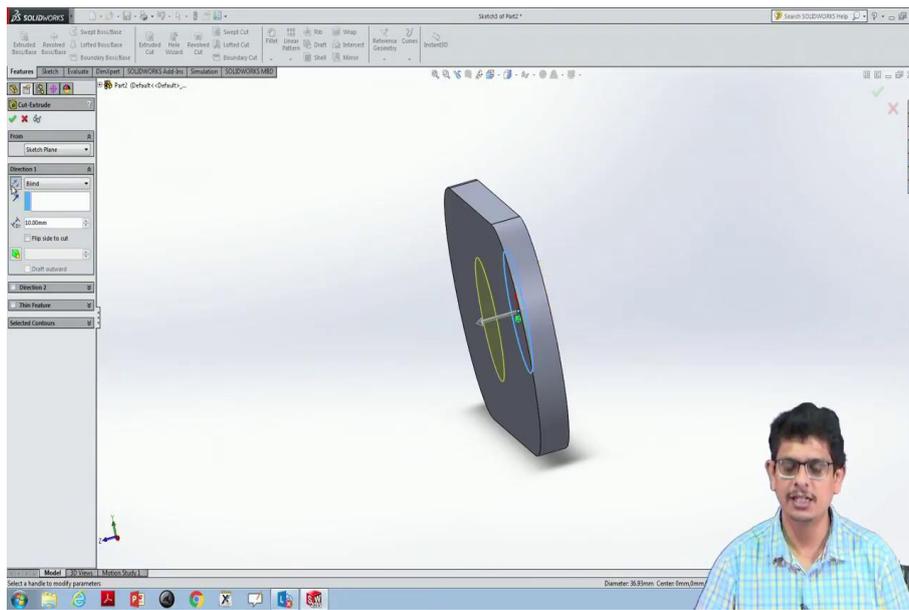


Now, on the circle, I will go use Extrude Cut. So, I clicked Extrude Cut, now click your scroll button, move it in that direction. It says that in the circle direction there is something like protrusion happen, that is, the direction of cut what we are going to look at, but because this circle is drawn on that face if I am going away from that there is nothing to remove. So, I have to reverse the direction of the cut by clicking this position. You see there is something like Direction.

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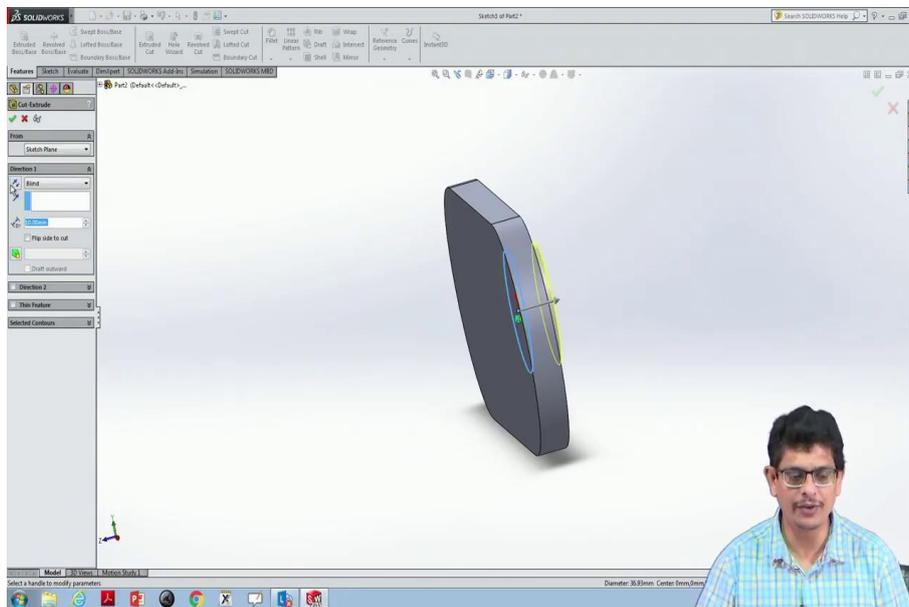


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So, if I click that this is the direction of cut what I am going to have.

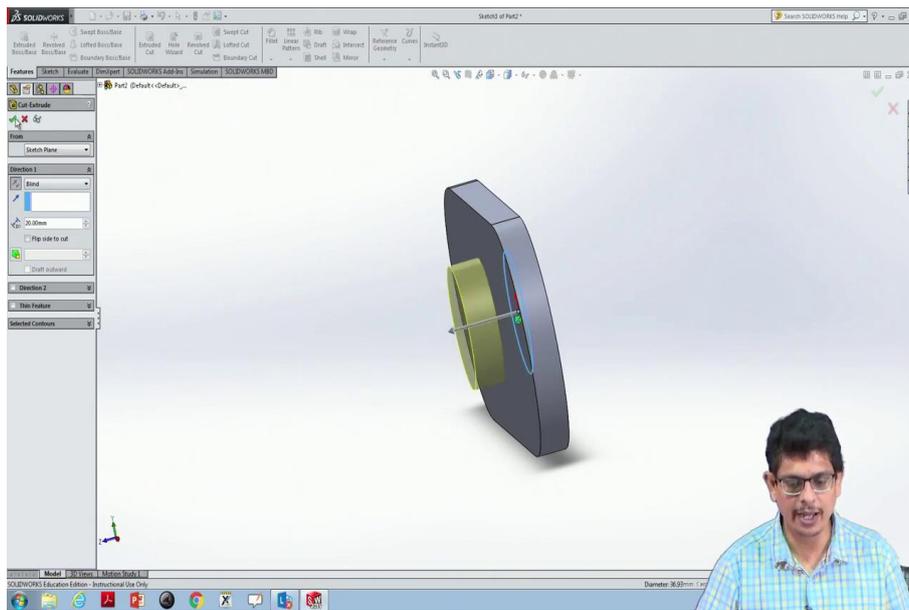
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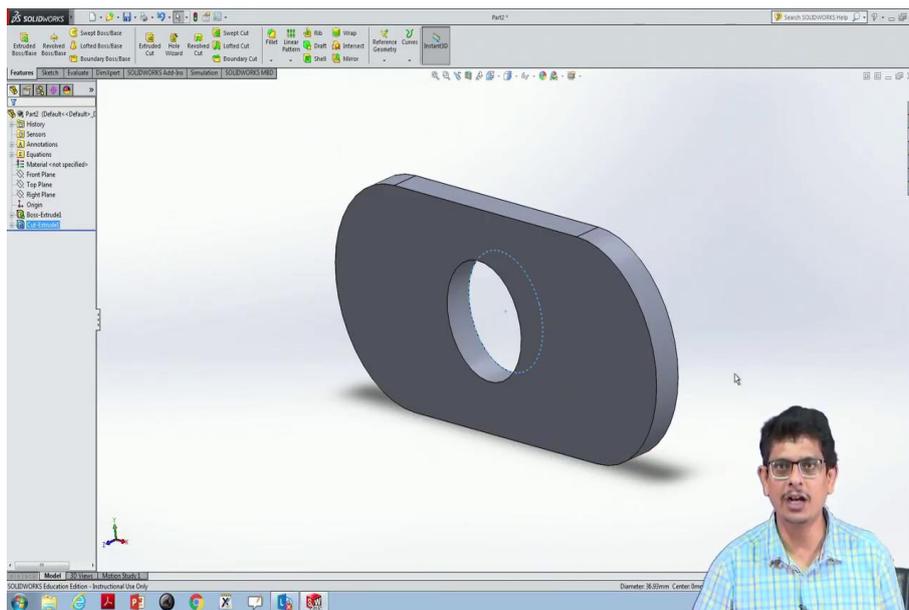
For this 3-dimensional object let us do it once again for that circle. Once I have picked I went inside of that to Features; not extrude bars because I do not want to fill the material. I want to remove the material.

Then go to extrude cut; the cut direction shows that away from the object nothing to remove. So, I went ahead, reversed the direction may be the depth of cut I would like to make it something like 20 units and then click ok.

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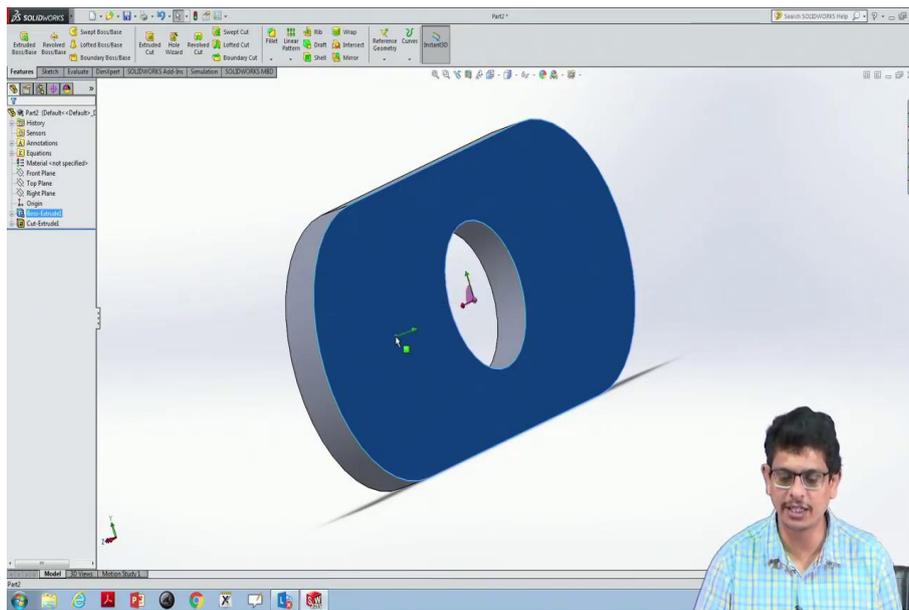


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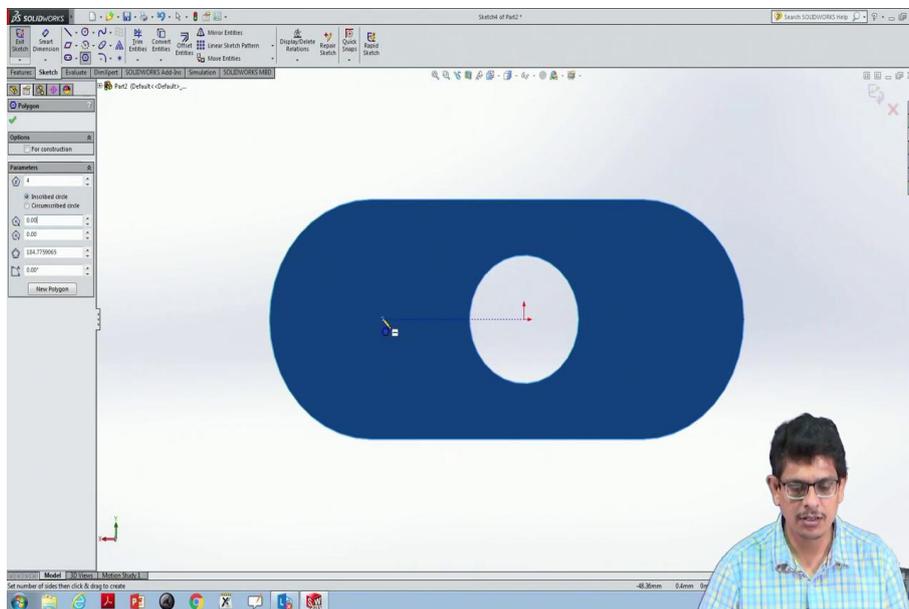
Now, if you are seeing it makes a hole ok. Now, I would like to make or perhaps add a material.

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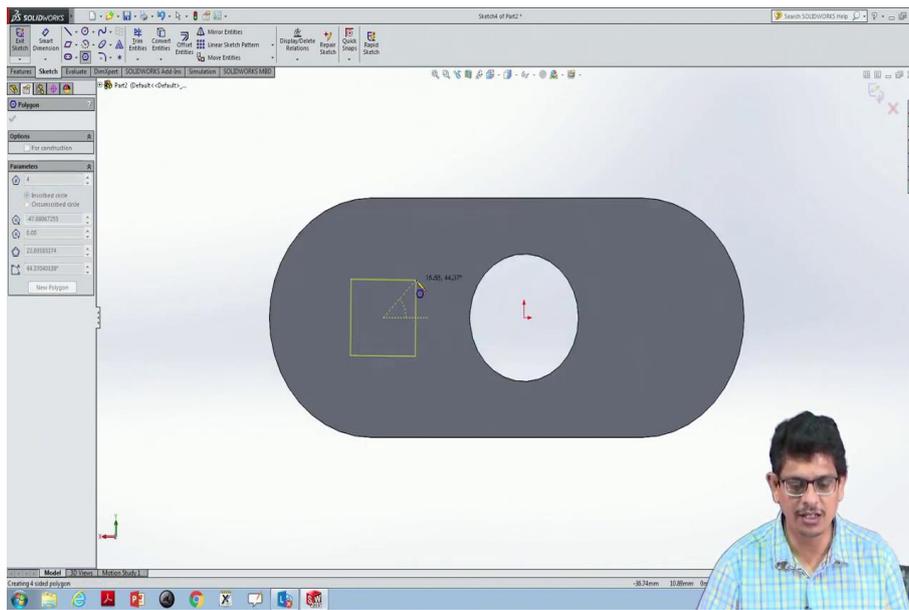
Add a material here maybe something like a polygon uh prism coming out of that link that is the thing what I am interested in.

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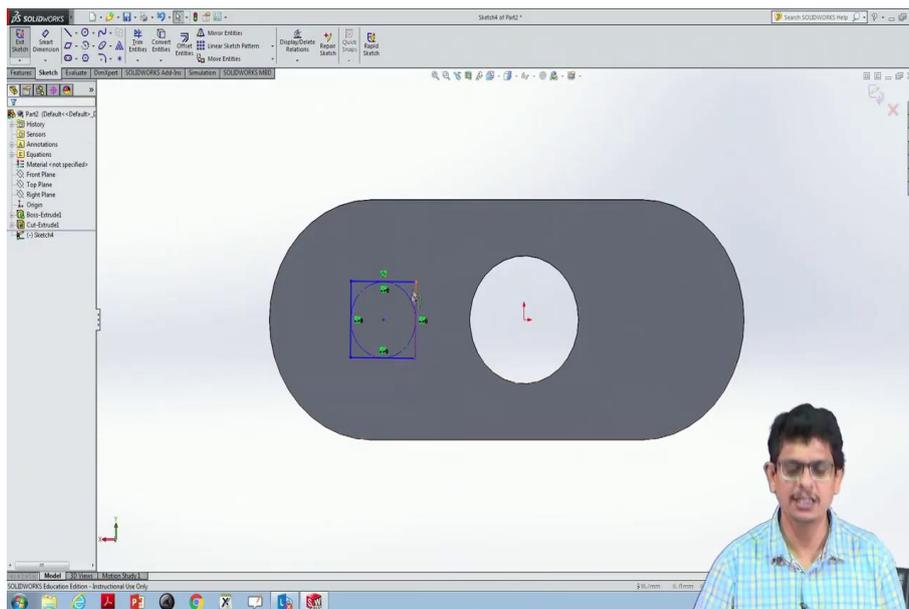


So, first, construct a normal to that at this location go to Sketch, maybe this is the Polygon; a polygon of 4 units I would like four sides I would like to have square.

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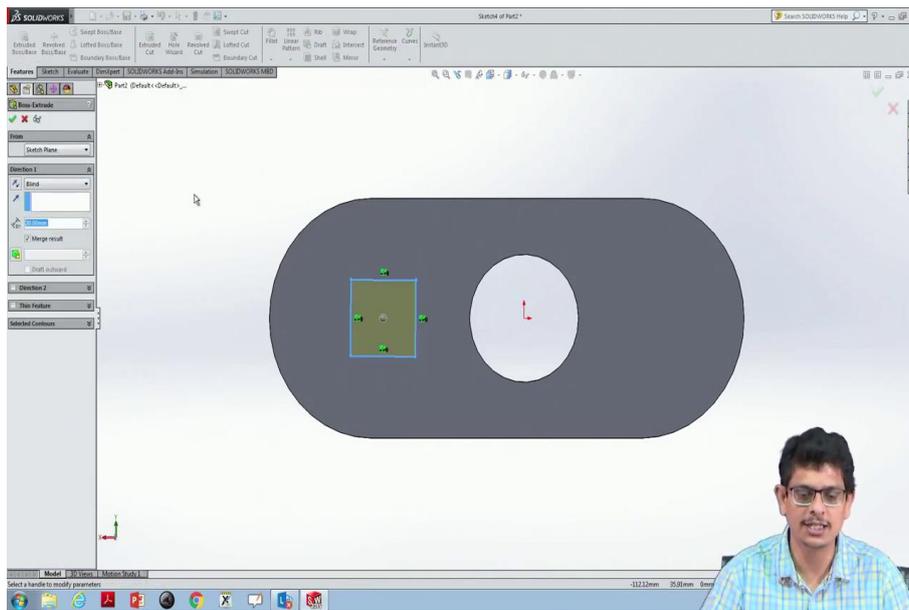


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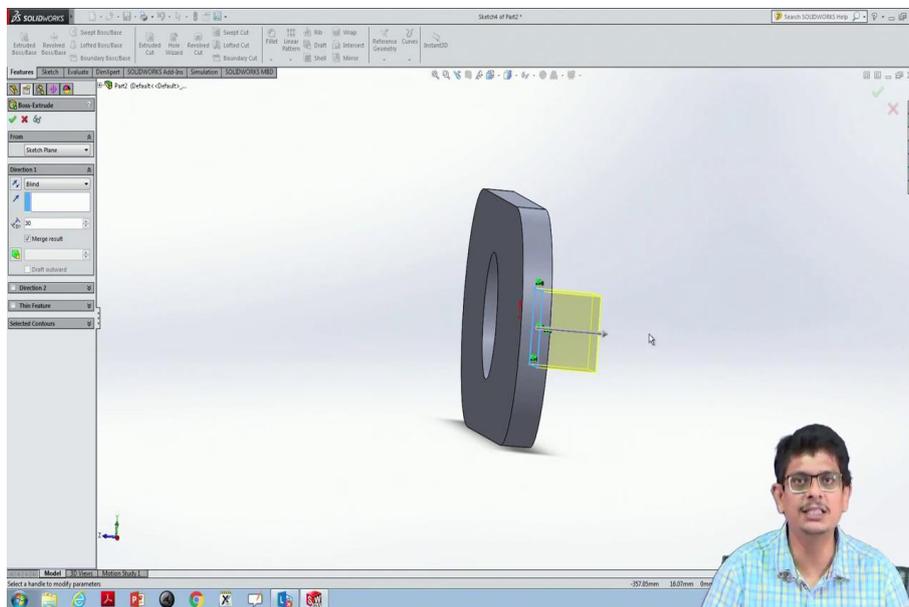
From there centred one I am going to use some arbitrary square. Now, I do not want this circle. So, I remove that circle.

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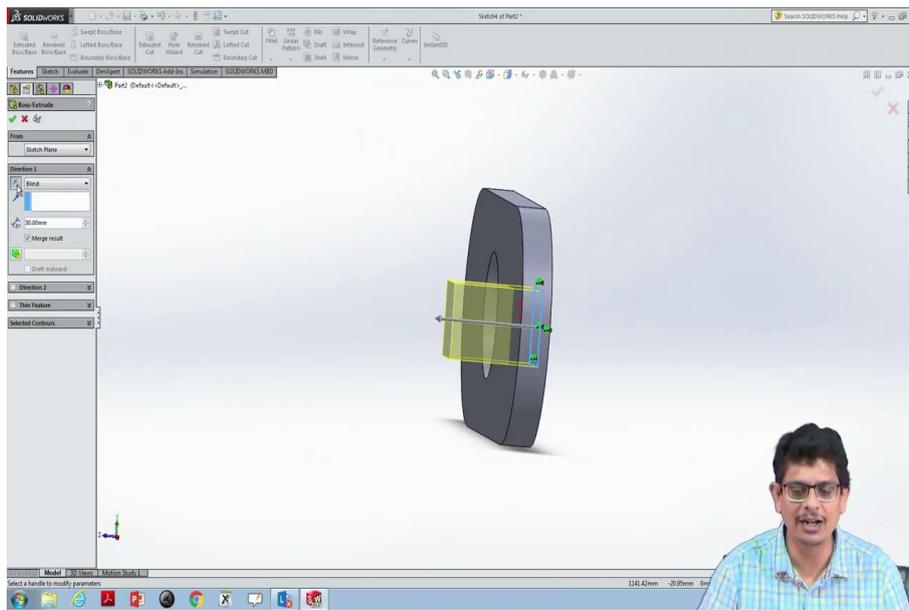
Now, this is the square which I want to extrude. So, first of all, I have to highlight; highlight means click the left button, go over that hold and leave it. So, everything is highlighted. Now, go to Features; what I want to do? Fill the material. So, that a prism can come out of that object.

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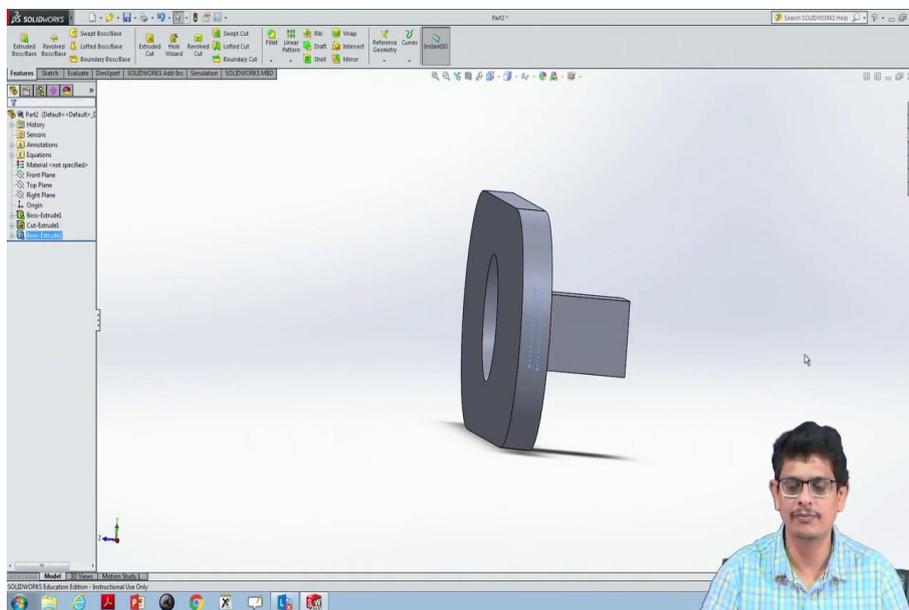
So, Extrude Boss. Now, how far I would like to know? So, whether this much portion or perhaps longer one, 30 units. I go there. Is that direction I would like to prefer to fill it.

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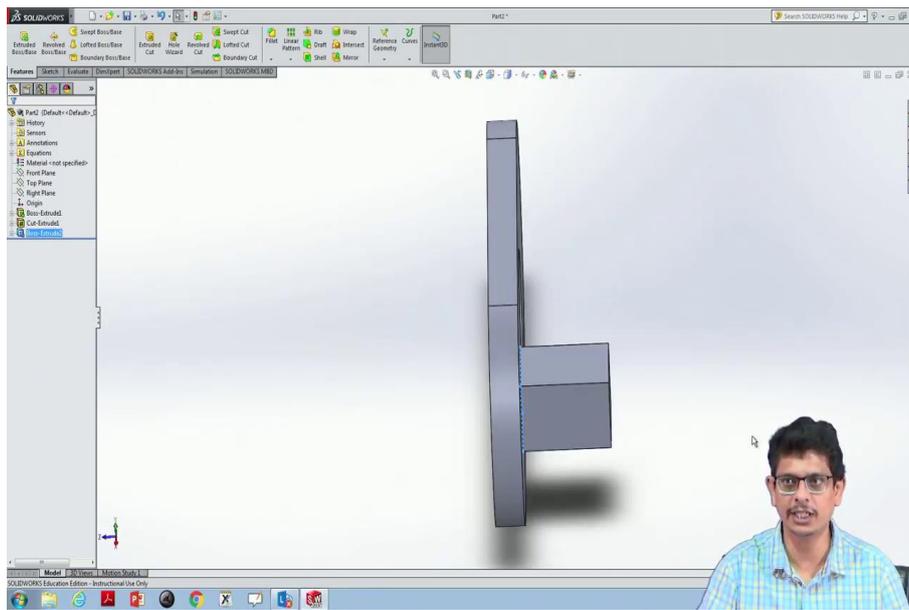
If that is not the case I will reverse it in that direction it is up to me which direction I would like to go. Now, for the present case, I would like to add material away from that link. So, once I am done click Ok. It creates that kind of 3D object.

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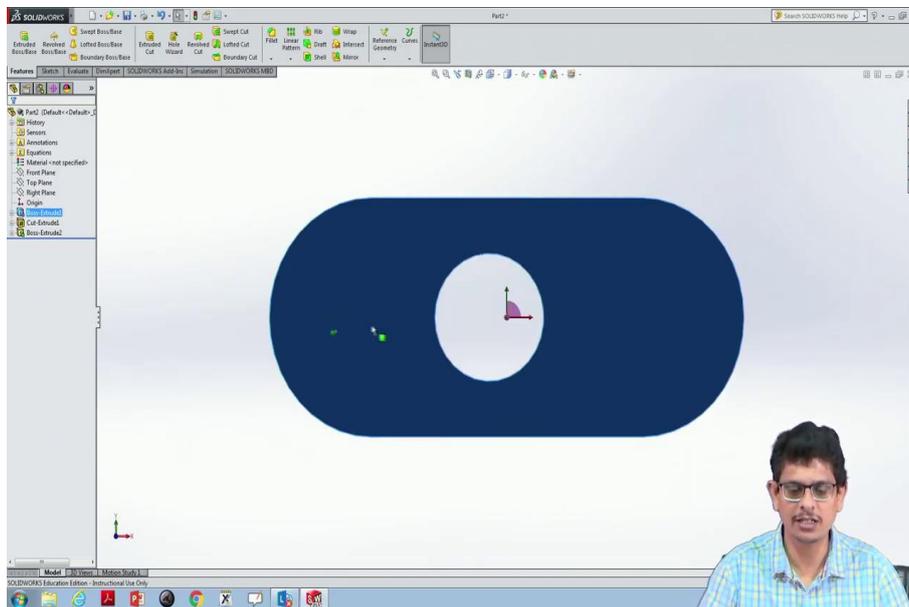
So, let us look at that link ok.

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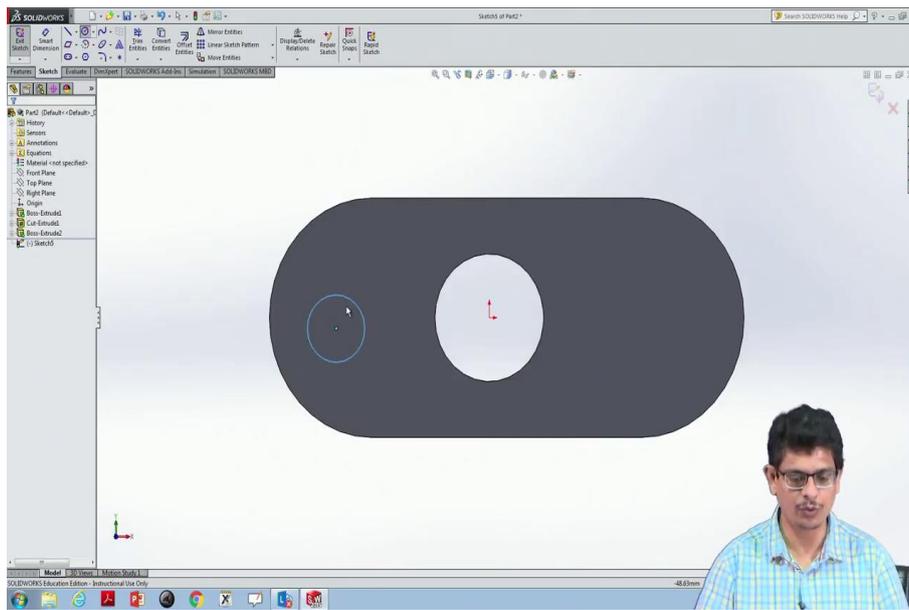
Now, I do not want the square kind of link, but something like trapezoidal kind of prism coming out of it more like a pyramid. For that purpose, I would like to make use of this side.

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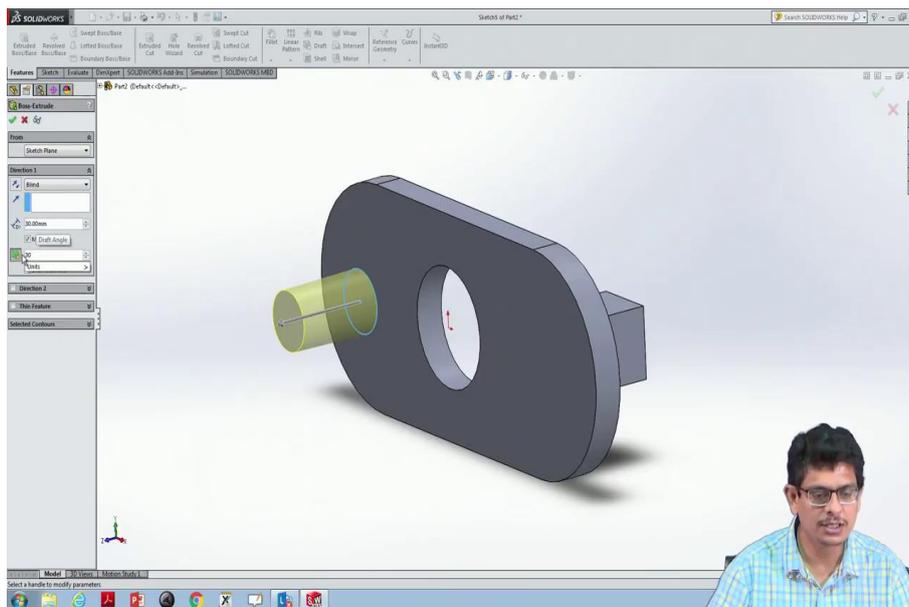


So, first normal to that. Here I would like to construct another maybe is try a circular one I would like to construct; so, Circle. This is the circle what I would like to have and I would like to fill the material.

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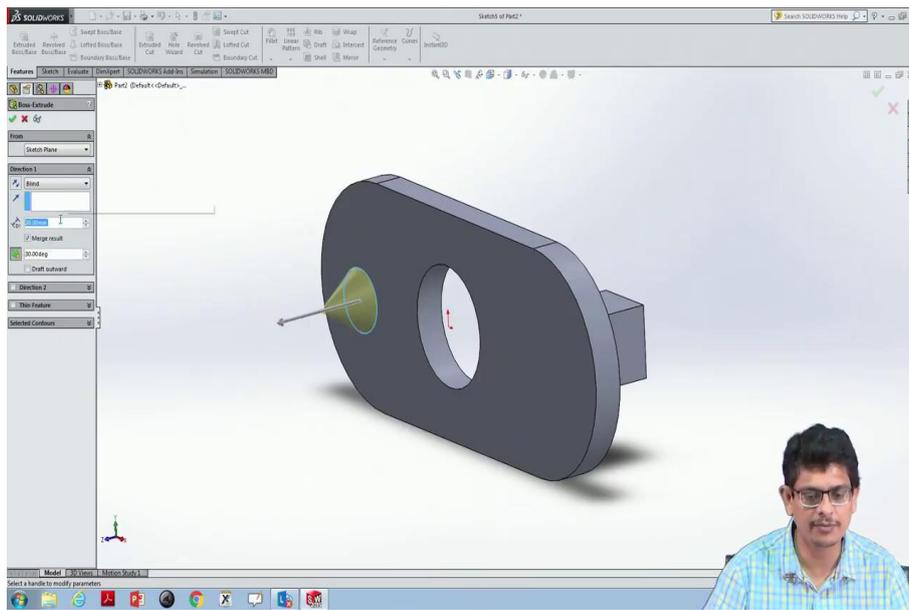


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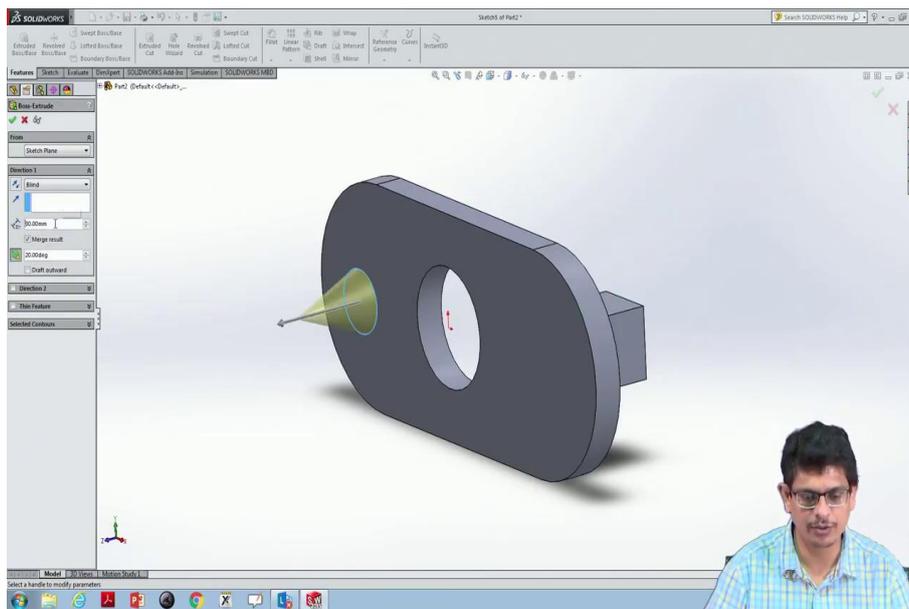


So, first I have selected that. Then go to Features; rotate the object first, then extrude boss it shows something like cylinder can be made, but I would like to give something like taper maybe 1 degree, 10 degrees, 20 degrees. So, I am going to give some 30 degrees taper, maybe some 20 degrees taper I would like to give.

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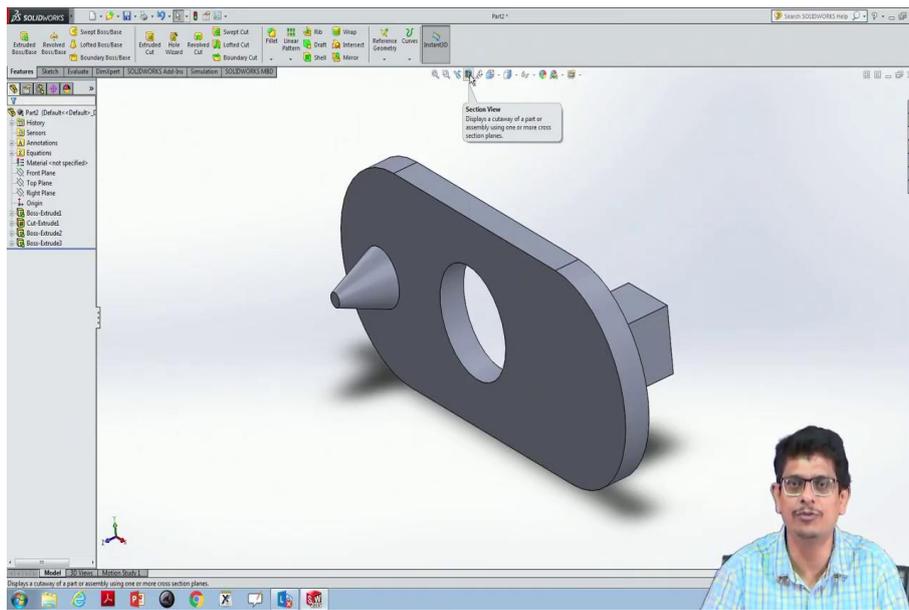


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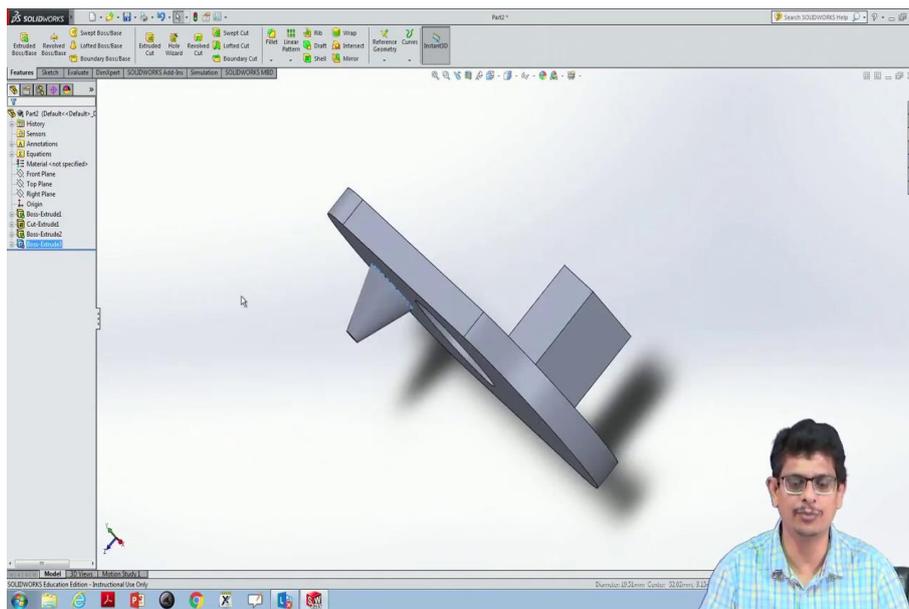


Then length I do not want to give 30 mm, but something like 20 mm I would like to give. So, that a tapered cylinder I can see.

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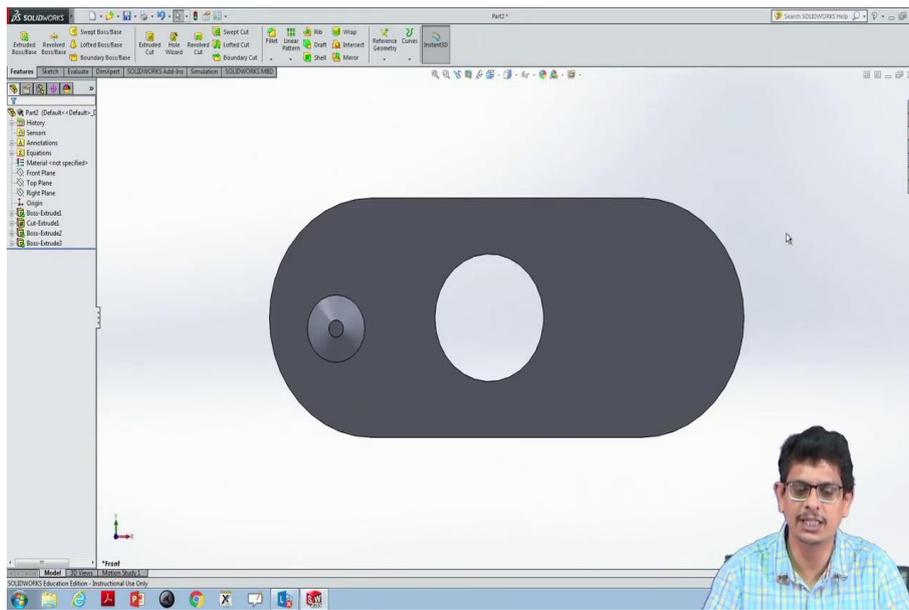


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You see this is the way we construct this 3D object. Now, let us look at different views for this, the Isometric. This is the way the Isometric thing looks like. What is the front view, can you guess it? If I flip this entire object I will see something like a link, there will be a circular hole and there is what do you see? Concentric circles I am supposed to see.

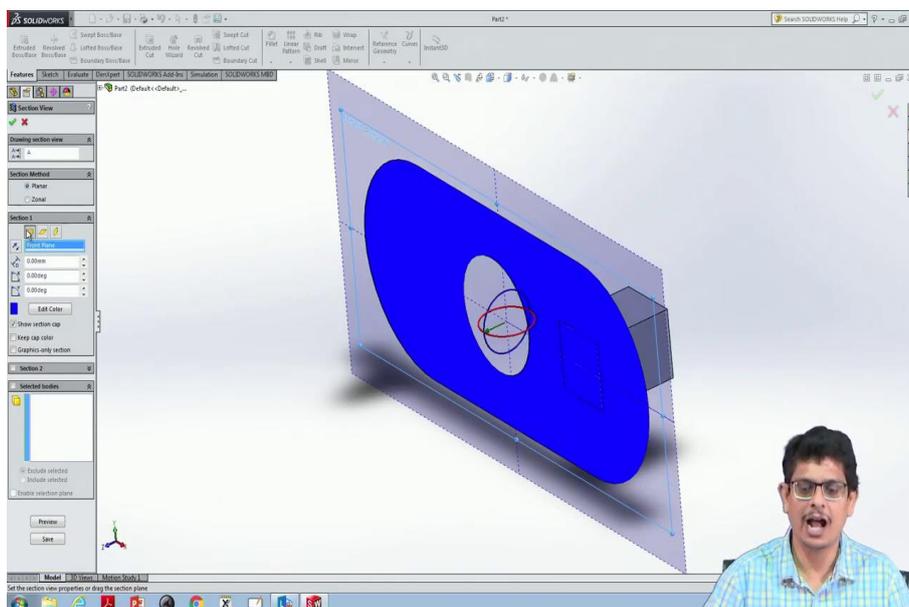
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So, let us look at that you see a 3-dimensional there is a circle and there is a concentric circle and because of lighting, the entire power of solid works comes at this level by carefully giving light on that object.

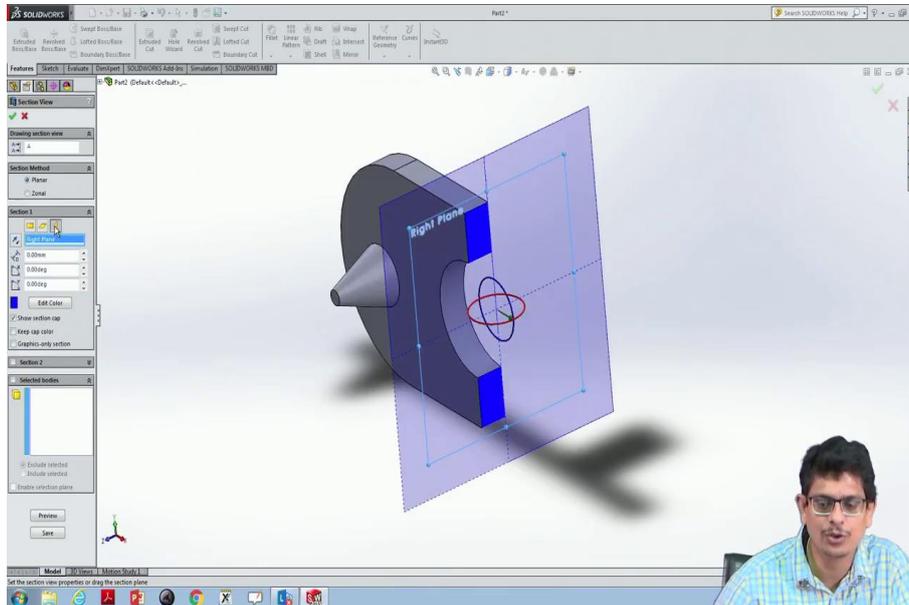
You still start feeling like there is something like a 3-dimensional thing. It helps us to visualize that object. So, let us look at this. Now, I would like to have a cut section maybe a cut section passing through this and I would like to remove the frontal portion. So, for that purpose what I will do? There is something like section view. See there is a link which shows that hashed kind of portion, click that.

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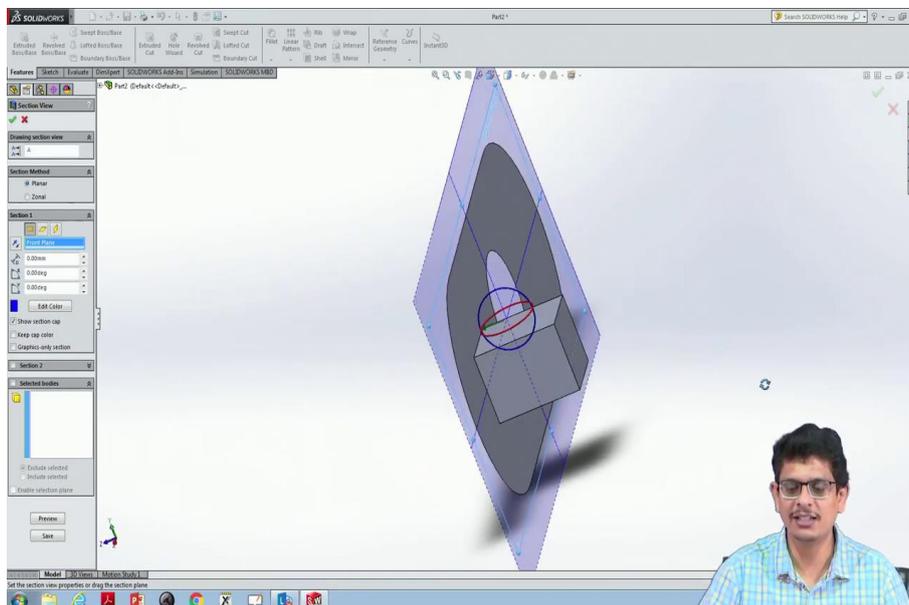
Now, is that the slice what I would like to have.

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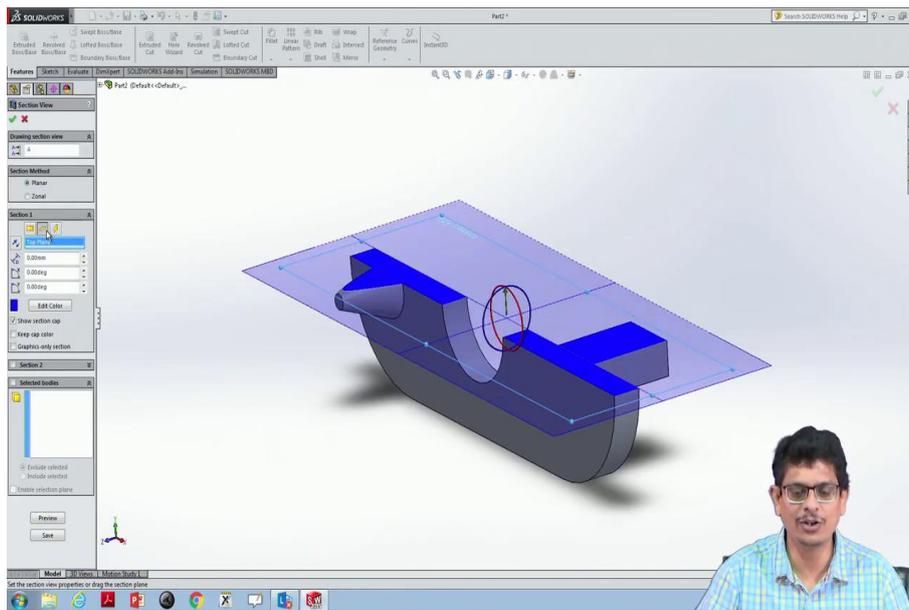
Or do I have to change the angle something like I would like to have this section.

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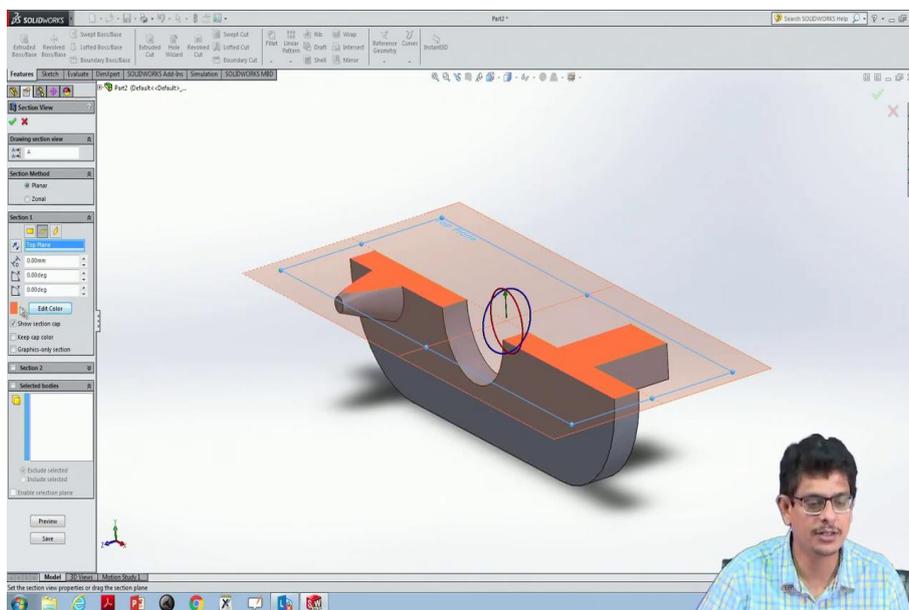
So, there are different planes I would like to have that section, still, the backside one not removed you see. When you are removing the frontal portion, that is the way sectional views works.

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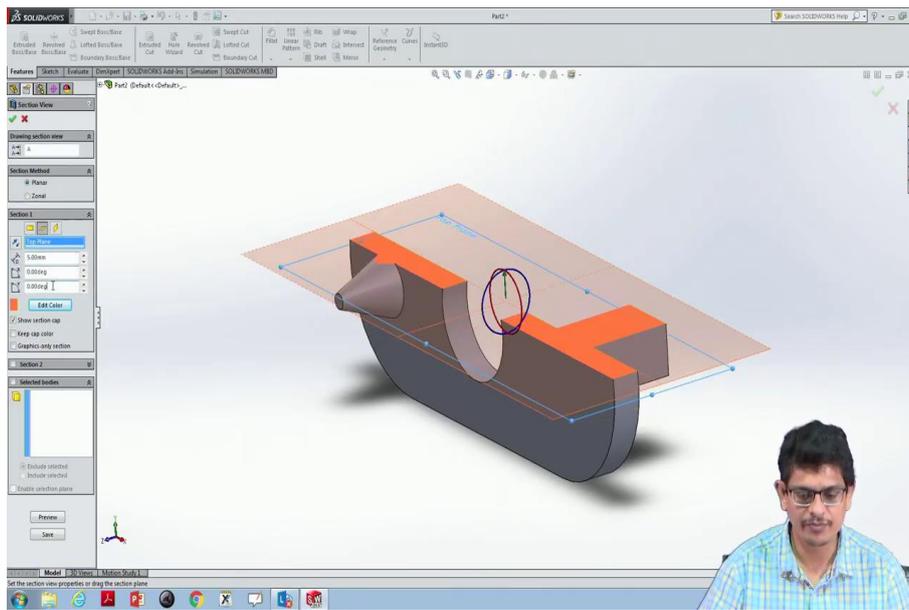
I would like to have that section something like a horizontal slice passing through that object so, whatever the top portion that has been removed. I do not want to give a green colour a blue colour. So, I can always give some other kind of hashed kind of colours, for example, I would like to give saffron. So, that is the way I can construct it.

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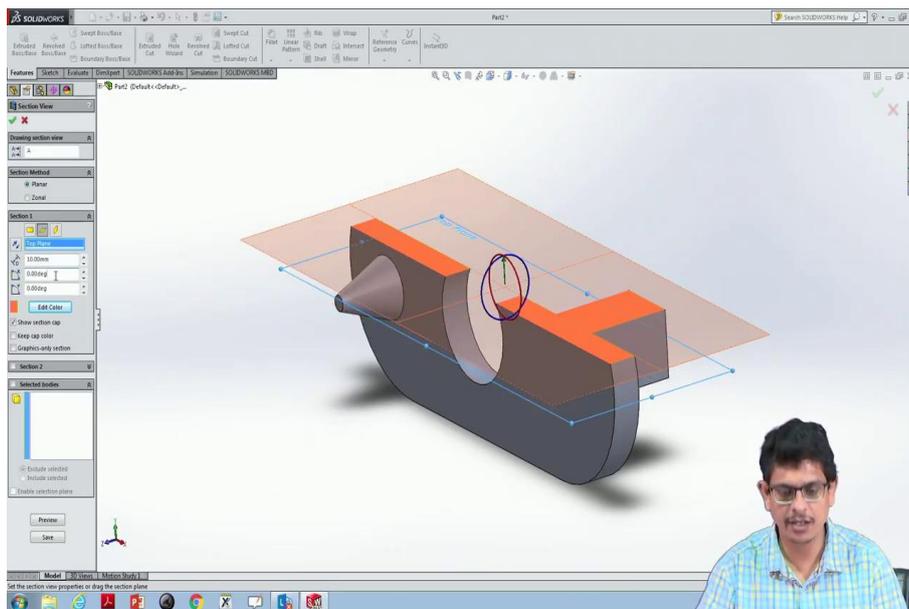


Let us click. If I click Ok it settles at this section, perhaps I would like to make this section up and down. For that purpose what I have to do? Instead of 0, let us give 5 mm.

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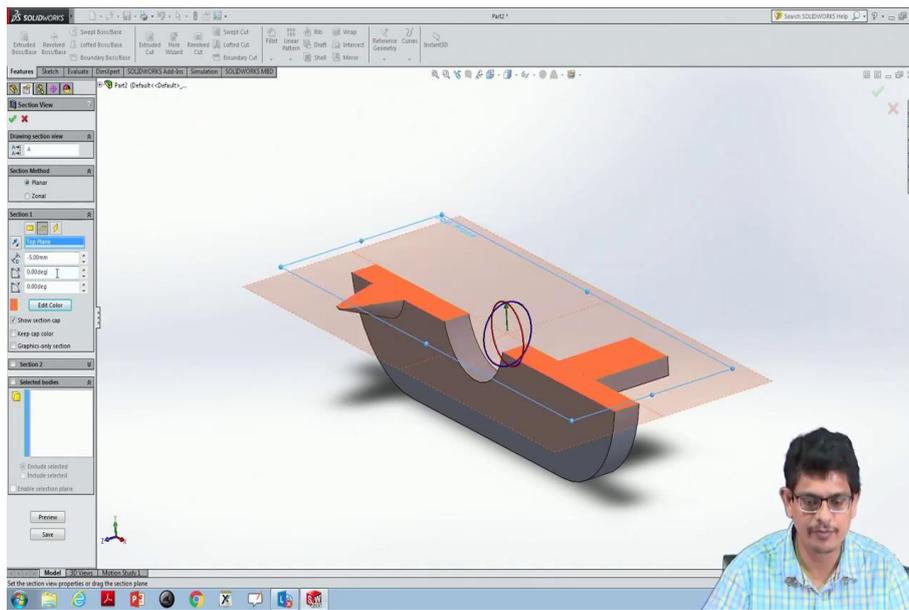


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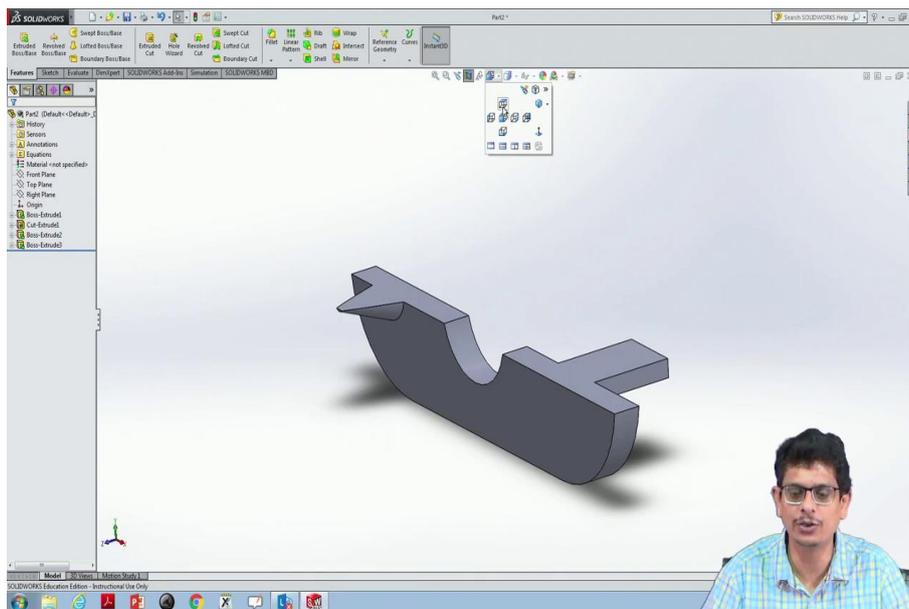


So, the slice has been moved up now let us give 10 mm. So, that is the way we see the sectional views. Now, let us give something like minus 5 mm. So, it went down; now, click Ok.

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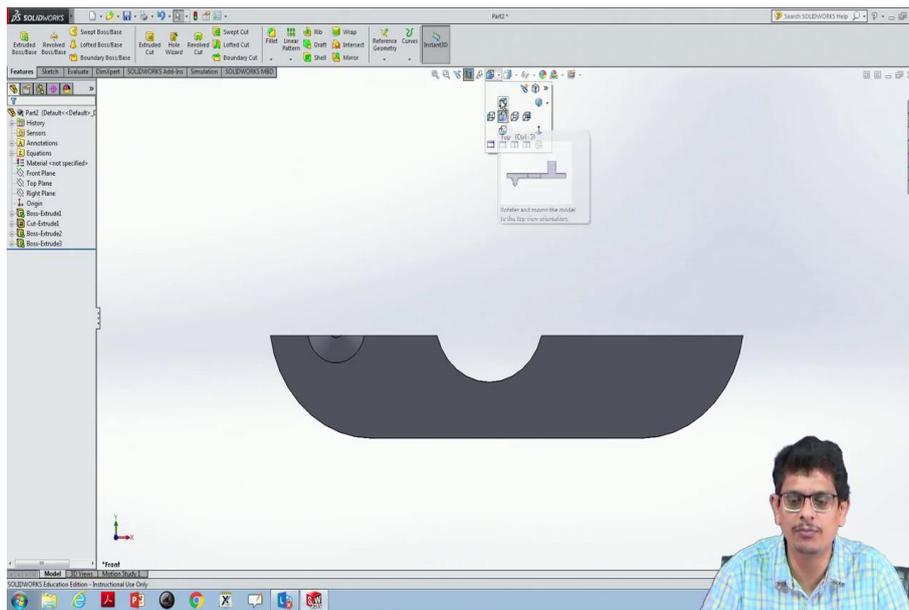


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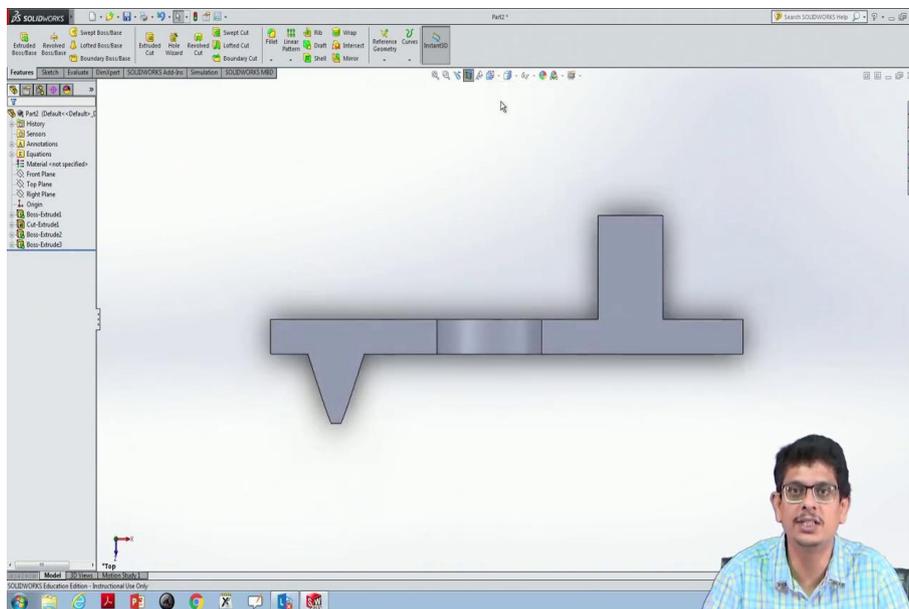
The sectional view with the isometric angle we Isometric view we are seeing.

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Now, I would like to see something like only front view; the backside version would not be visible. So, at sections when we are drawing the things we do not show these hidden kinds of lines.

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Now, I would like to see it from the top, this is the way it looks like. The 2D sketches what we have drawn the same representation you will have at computer level also because earlier days something like some 50 - 60 years back people communicate their skill set in terms of drawing, production drawings everything through 2D drawings, but nowadays this 3D software help us to visualize the object to design it.

Because some of the designs like for example, whether this tapering happens or not, how much tolerance has to be given all these things at the computer level you can construct many things. You construct one part, your friend will construct some other part, then you will assemble the joint, then you will pass it as drawings.

These kinds of things can be possible only through computers. And, you can repeat the drawing you can save it multiple copies you can make it within a fraction of seconds and so on, ok. In the next class, we will learn more about these 3-dimensional drawings.

Thank you very much.