Physical Modelling for Electronics Enclosures Using Rapid Prototyping

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Lecture – 30
Multi Direction Features

Hello. So let me demonstrate one more time what I just started and (()) (00:22) it will break.

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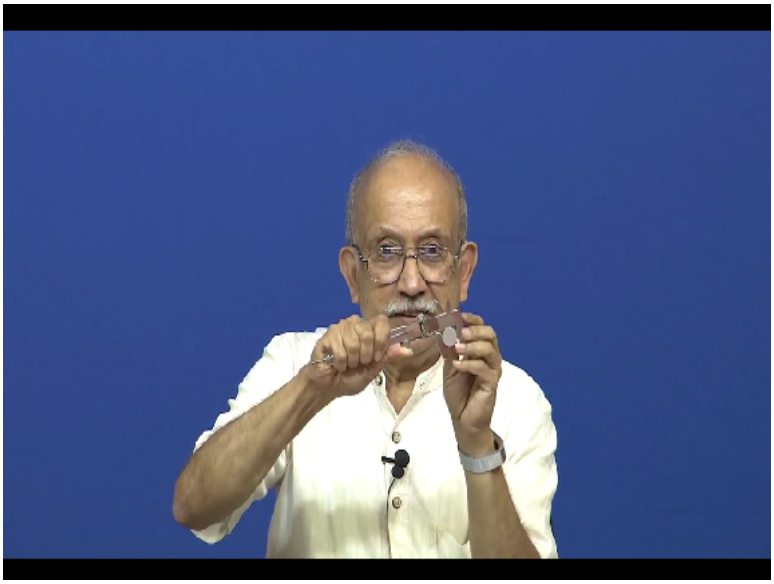

You see here the starting point of any of our design is reality. So if somebody tells you, no, no, there is an equation or there is an open source file, you can download, that open source file was created by somebody using a Vernier callipers and reality. So I will just start with how to create a clamp. If you remember I went around trying to show you and lot of samples also I had shown. Obviously, the very very first starting point is starting with reality.

So this is a very cheap Vernier and maybe you can get it for around 3 US dollars or in India it costs you around, costs us around 200 rupees. Not the best but serves the purpose. For reference purposes, this serves well.

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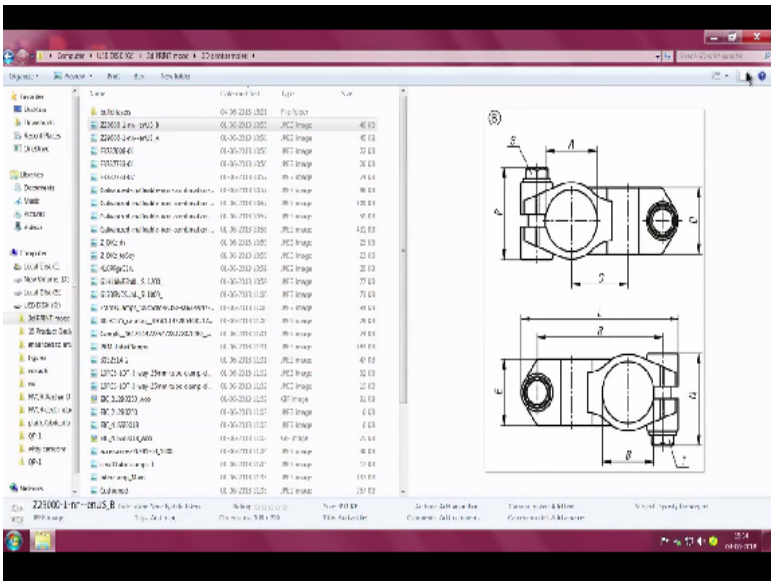

Now, if you look at my monitor here, I had started with these clamps in the morning. You remember, they were very very simple clamps and lot of designs and all, I will come back to that, I will show you one of them which I had started trying to make out of it. So this is about one of the simplest ones you can imagine.

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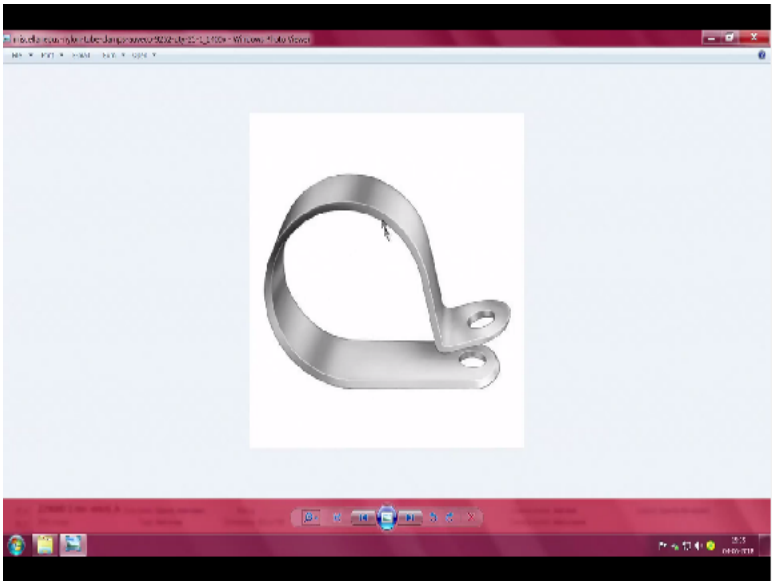

It is a sheet metal clamp. Somebody has wrapped it around and made this, small this thing here, so that to the extent that if you now put something, say a fastener here or a button, you can carry anything. And generally things which are characteristic like this, are probably used for cable harnesses and cable forms. So you may find this in your car. So you have bunches of wires which are stuck everywhere and these wires have to be put near a; what do you call a convenient place?

Especially when you are inside in an equipment, invariably you have these clamps. 2 or 3 things are; they are not much load bearing and they are usually made out of plastic.

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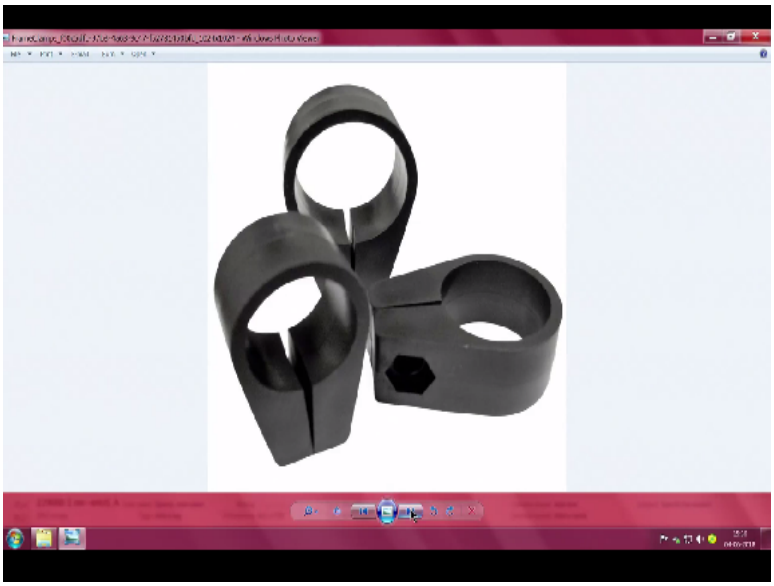

In contrast, these are all load bearing members. See here, I told you. Then this is something which is cushioned and I already showed you this which is part of the, your bike for the seat cover. Then more advanced things. As you see here, slowly things have; it has compensated one for the other. This looks like as (()) (03:00) that is a glass filled nylon and this external thing, I mean what do you call, opening here is for supporting something there and in the end, it will help you make things.

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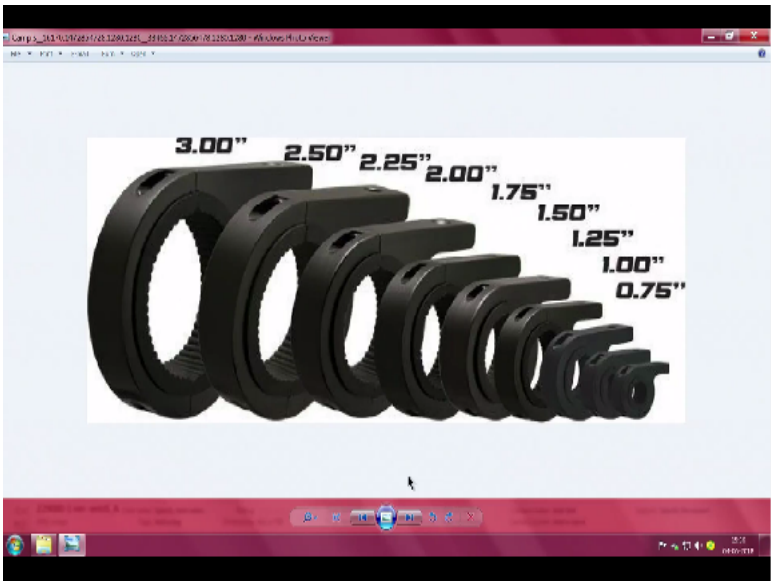

And you see here, this again another clamp which I was explaining to in the morning and this is where making solid models helps. If you recollect, I had mentioned that some of the, what do you call, pipe fittings and all that, have this thing about being, I mean, mentioning inside diameter because the fluid has to pass through that. However, in the case of construction, like your curtain rods and all the outside dimension is critical.

Now you see, the range of these things is. Somebody makes one proper 3D solid model for it, it is a matter of extending all the other things and you can make any item you want here. So I just to want to tell, this, what do you call, this is 19 mm which will come to 20, a 3/4 inch, 1 inch is 25 and this will come to 31 mm and so on. It keeps going on like this.

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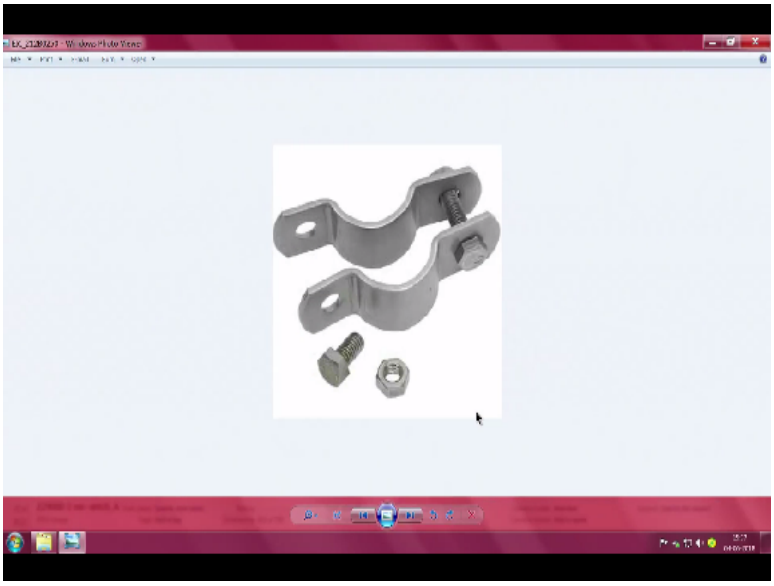

So if I keep, these are a little high strength alloys. If you remember, this one comes from both sides. Of course, it will never be fitting like this. It is only a matter of convenience they have shown it here. It will be turned to the other side. But in the case of supply, usually you supply it like this. Now let us say this is a good starting point.

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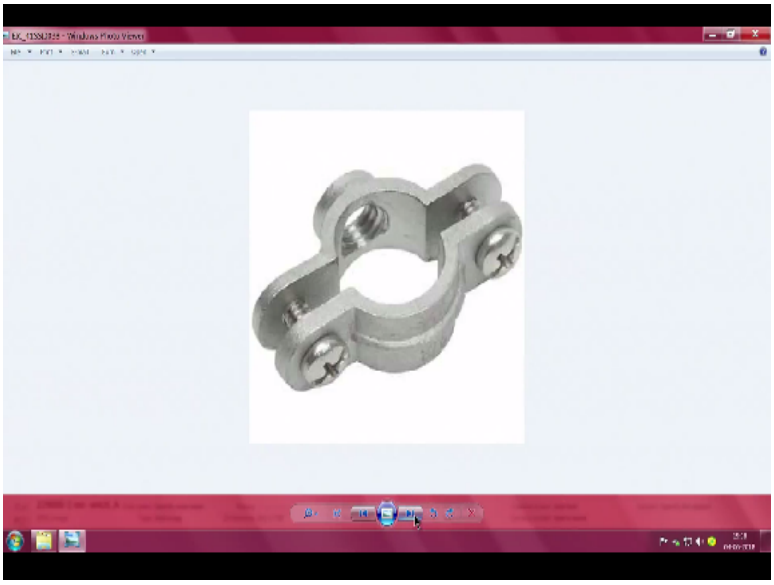

Seen this? Depending on your strength requirement, we can always play on these things and make them stronger or weaker.

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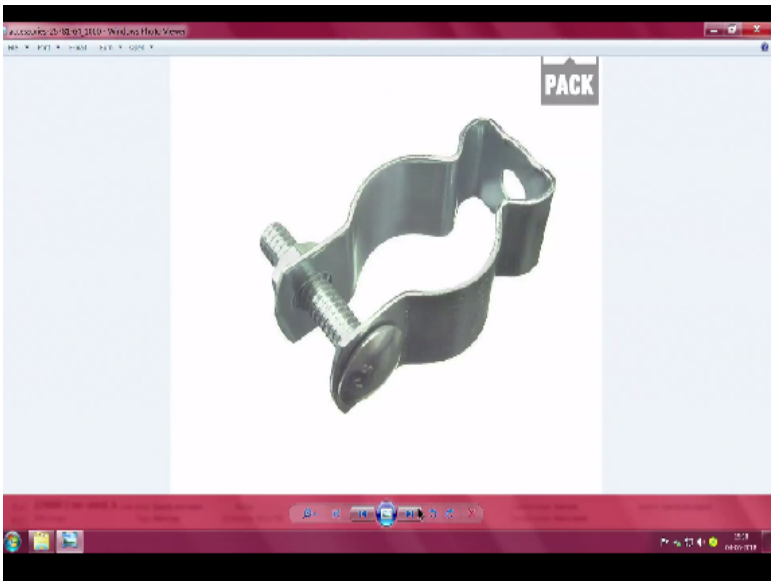

This is something very interesting here. Whenever you find a thing like this, most likely is a flat cap dome nut probably sits here and after that this thing is used for mounting it.

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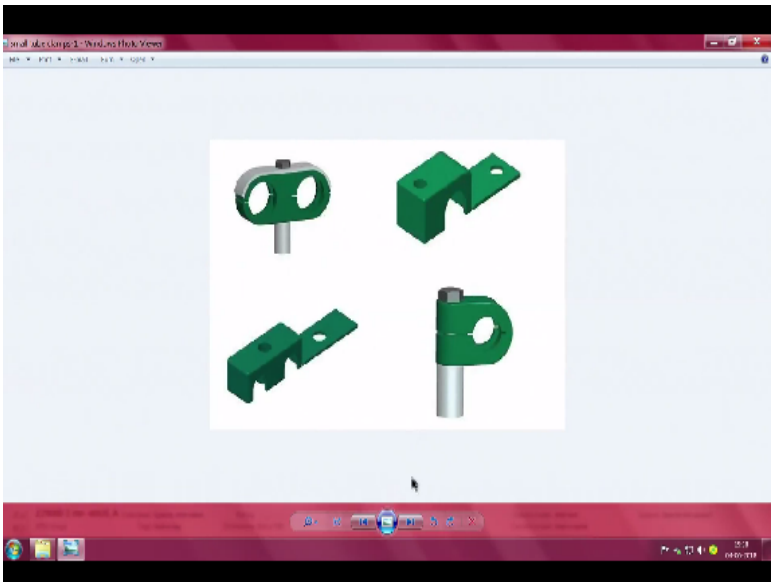

And this also I had shown you earlier saying variants on the same theme.

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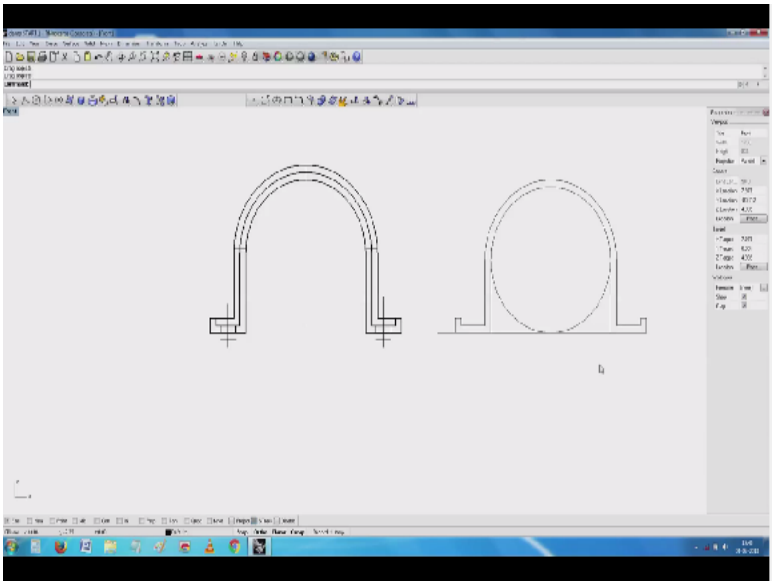

Now I will see what best I can show you and how to improve on these things. So let me now get back to; sir, can you please show me the other monitor. So you see here how I have built this. Obviously the starting point is a circle and things built around the circle. This whole thing has been developed from the basic circle.

So if you see if I draw a circle now, it fits or does it? Yes. As you notice, some small error here, yes. In fact, indeed it is an error. So this will not, what do you call, sit comfortably unless I am looking for that packing which I have shown you. Advantage of making these things is now very easy for me. All I have to do is, now if I want this, this line to sit here, I need to select this and make it that much shorter. See my design is perfect.

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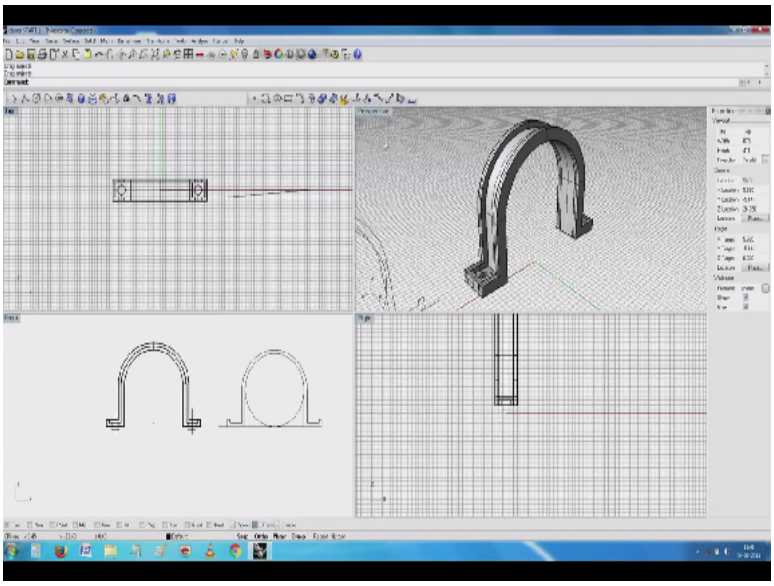

We start with these small errors. Now you will notice if you remember in the earlier session I was talking to you making, how to make this flanges, how to make it, I mean, various other things. It looks fine. Absolutely there is no problem. I have this beautiful clamp that is produced here. Now comes to what are all these openings and then is it strong enough? You will notice that at this point, it is possible that it may develop a matter of stress concentration and may give way.

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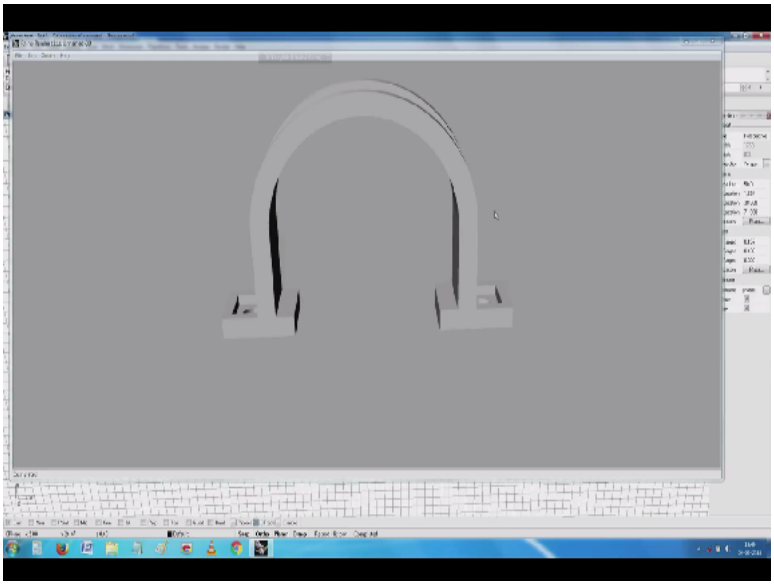

To prevent it, a small fortification has been done here. Can you see here? What has been done is, a small addition has been made here so that, looks a little stronger and probably it is a little stronger. Seen this? Now you will notice 2 or 3 other things saying even if there were little pulling here or anything, if I put a proper screw here, proper I mean fastener here, it will clamp

it. It will sit comfortably. So this is one of the options.

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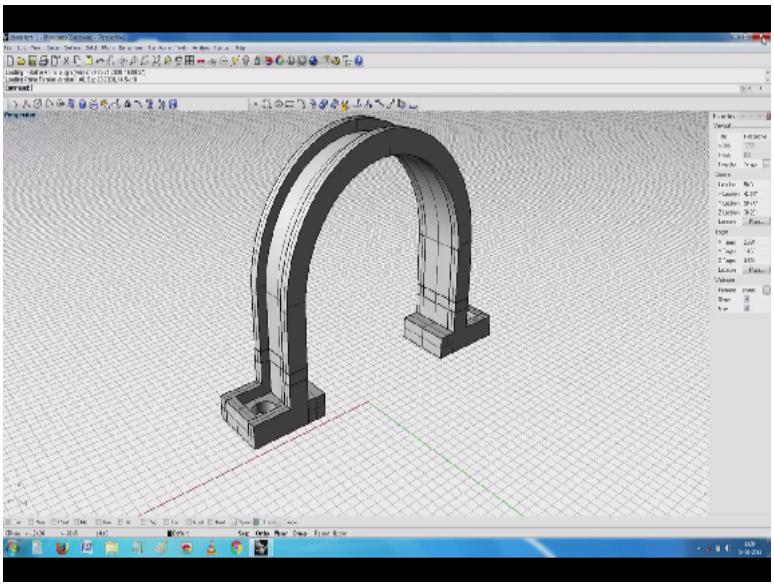

This is the same, except it is made vertical. Got the point? Now I need to check how well this builds, how does this unit build itself? Meaning when the layers are cut or built, so one way is run it through the machine, there is no issue at all. We can easily run it through the machine.

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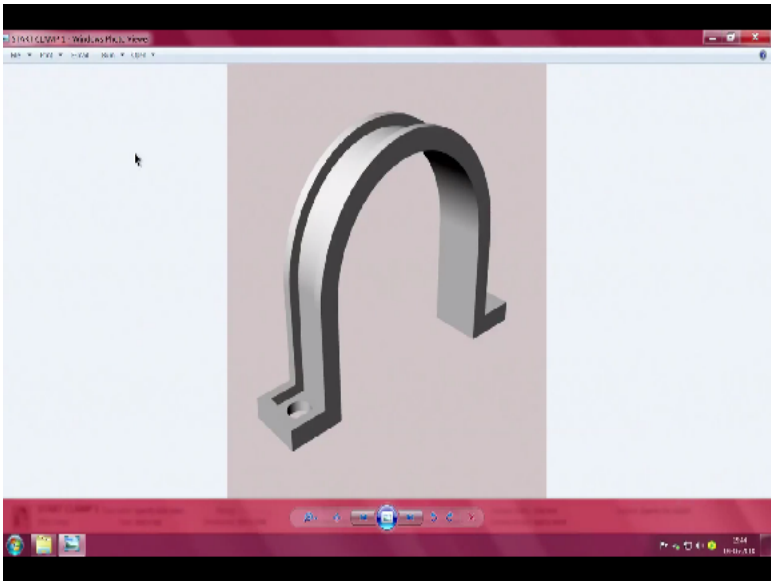

But however, now that with the new this thing, with the new economy, you can just upload the file and you can watch what is happening. Instead of our having to depend on, to see if there are errors, any building experience and all that, one of the simple way of doing it is, we ourself can cut these at various layers and see how it builds. So seen here. This is the same thing. There it is

actually it is working here.

This monitor is slightly better. Can you see the small detailing here? At this point, observe carefully, I will, I will make it a little bigger for you. It looks a little dull and the way the rendering engine works, you cannot get the rendering properly unless you have these highlights which are caught there. Now when you do the filleting, object looks slightly better. Now I have taken it one step, rather I will not say, I will not say, observe these things. That was the picture you have seen.

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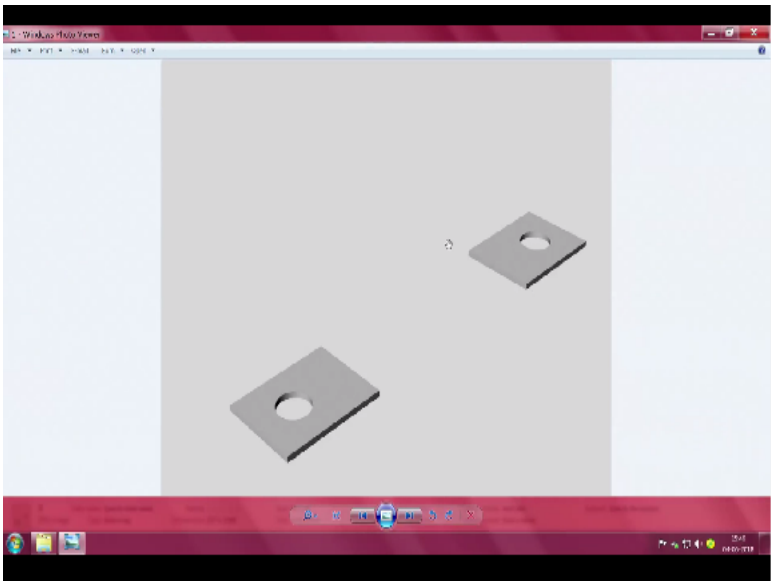

Now if you see here, what, after building the whole object, what I have done is, using a little, how to tell, tips and tricks, I have cut it into various, various sections I have cut and the solids have been, you know, stacked one over the other and if you follow a particular sequence, it looks as if almost an animated way of the build layers can come. So if you look at it, this is the very very first thing at the base. The base has been cut and that machine will start building things like this.

So when I get, I could not access the machine. So when I get the machine, I can show you. Typically, probably that, you know, first of all this criss-cross, one base is built all around and after that depending on the thickness and depending on the commands we give, material, you know, either is built like that or material now goes around being built like this and so on and

including the circular holes, can easily be built.

So this is the probably, of course, I have taken first a 0.5 mm slice. Probably every 0.2 mm, there will be a slice.

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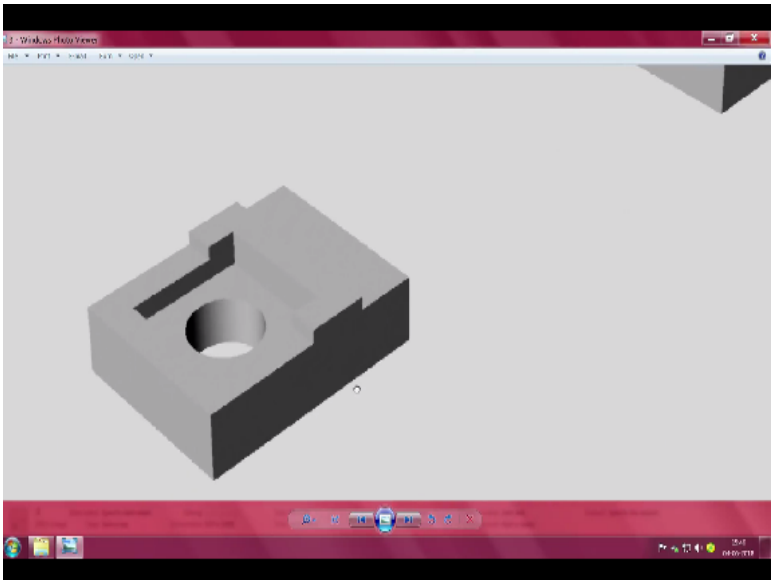

Next slice, see here already I had jumped by around 15 layers. What has happened here is, starting here slowly layer on layer that layer has been built and after that this next section, this section is being built. One thing you will notice is all are erect here. As such, there is no problem. The machine continues to build, very conveniently.

It will, say the top layer, it will come here like that depending on the (()) (12:40) sometimes it builds these layers, sometimes it builds layers; otherwise, you know, layer by layer, the whole thing is build. This is the next, may be around 20th layer.

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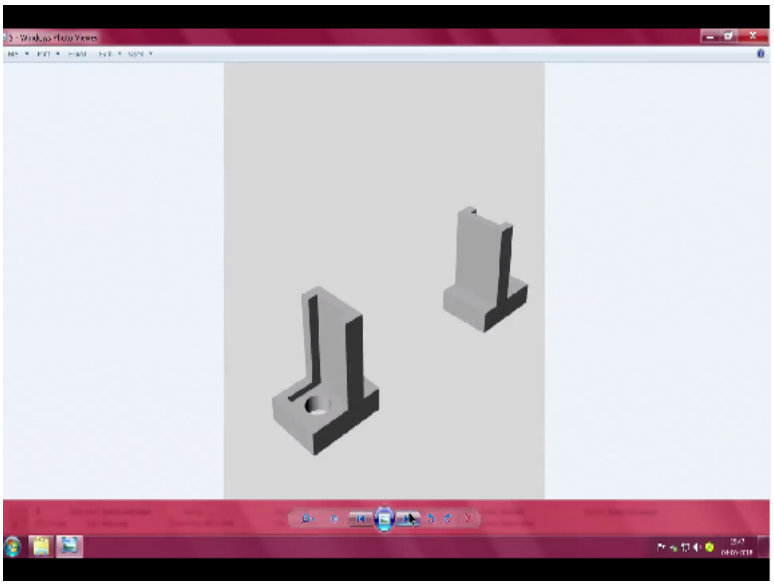

After that, can you see slowly the vertical column part of it is being erected up and up. Can you see? I have skip several layers because there is no change in the section. So in this top layer if you see, probably it is very easy, either the printing takes place like this or depending on the type of machine, usually to make it level, the printing takes like this. So far it seems to be very very convenient. There is no issue about it at all.

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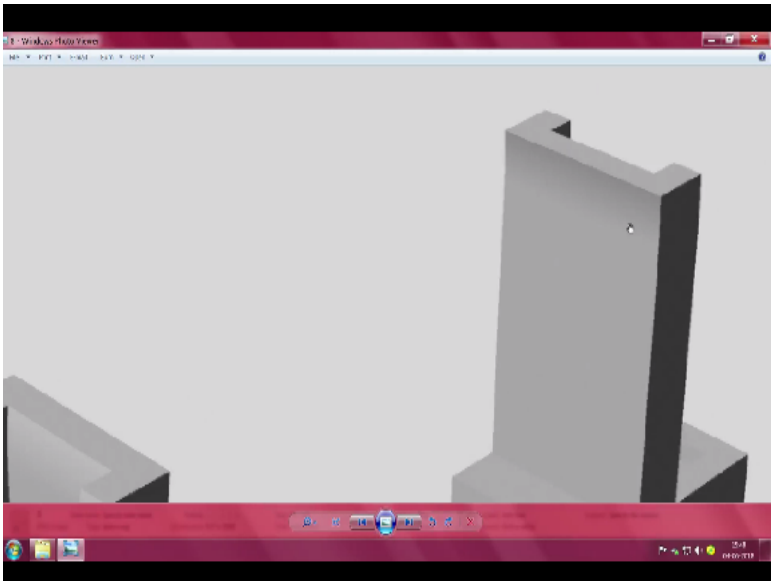

Now if you go a little further, next layer, can you see something which is happening here, slowly a small offset is getting formed. You will not see it that much here. I will try to enlarge it and show you. Can you see here? The first tilting is taking place here, first tilting. So while the cross section is same, slowly the, see here, this one is slowly coming up here. That is next layer is

slowly being made to shrink inside.

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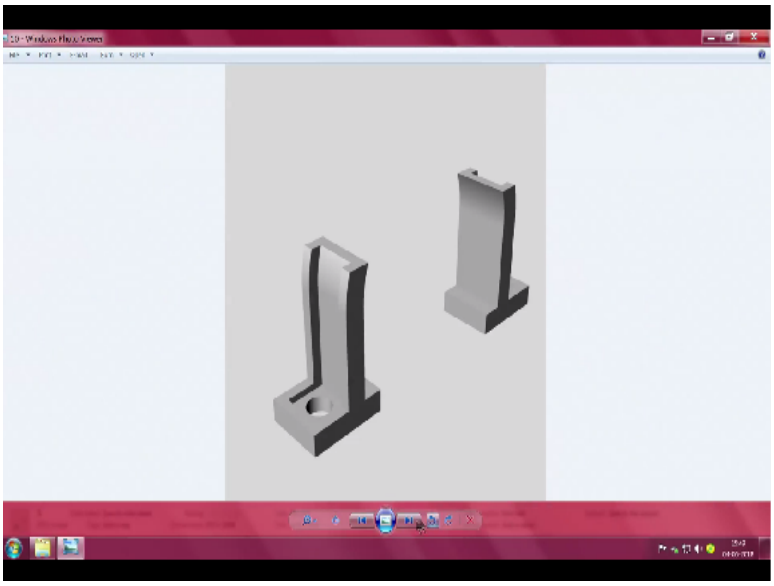

Now can you see here? Already very conveniently this whole thing is coming up. At this point, this is where a lot depends on the machine capabilities, a lot depends on your particular job saying if this inclination more than about 15 degrees and depending on the height, this support structure has to be given. Where machines have 2 materials, support material is different from build material.

You will notice that machine because of the previous whatever we have indicated and because of this small step here, it is possible that the build material stacking will start here.

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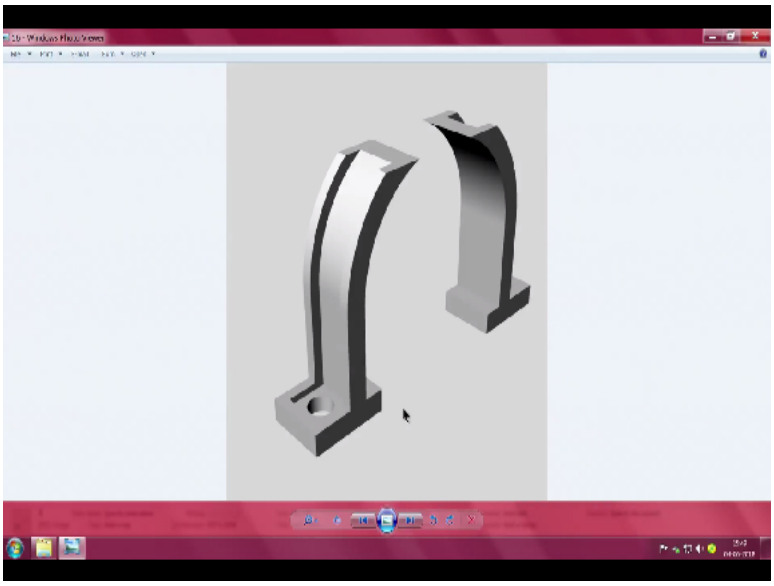

See here, what is happening? Now comes the other thing. After it crosses around 30 degrees, that overhang cannot be supported which is not possible to support the overhang. So lot of build material starting about here and up to here, up to here, up to here, same here, up to here, all this material gets wasted. But in some objects, we have no choice.

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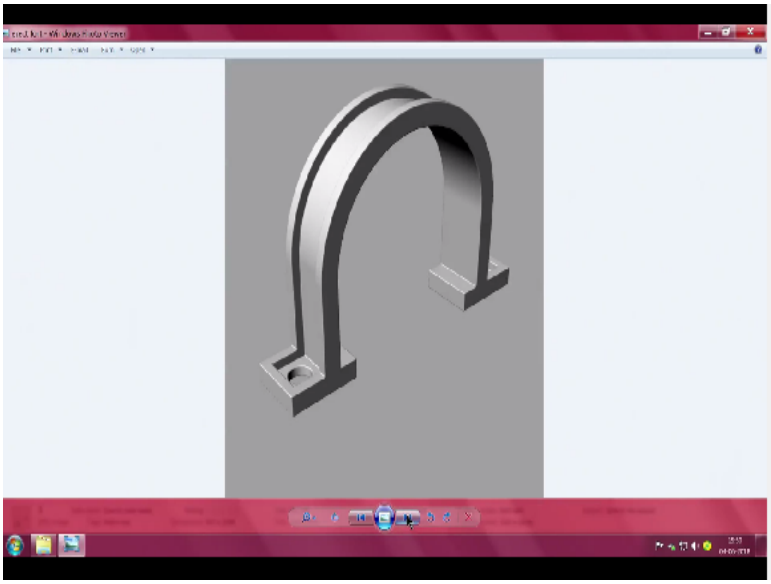

When that such a thing happens, we really do not choice. You see here, after this, next layer is that bridging is taking place. Finally, it has come up to here and the job is practically complete. While in principle, it looks a nice, this all empty cavity is a big problem for us to build. It does not, you know, happen as easily as we would like to have it. And this you remember, I have give this radiuses, it is only meant for us to understand how the operation takes place.

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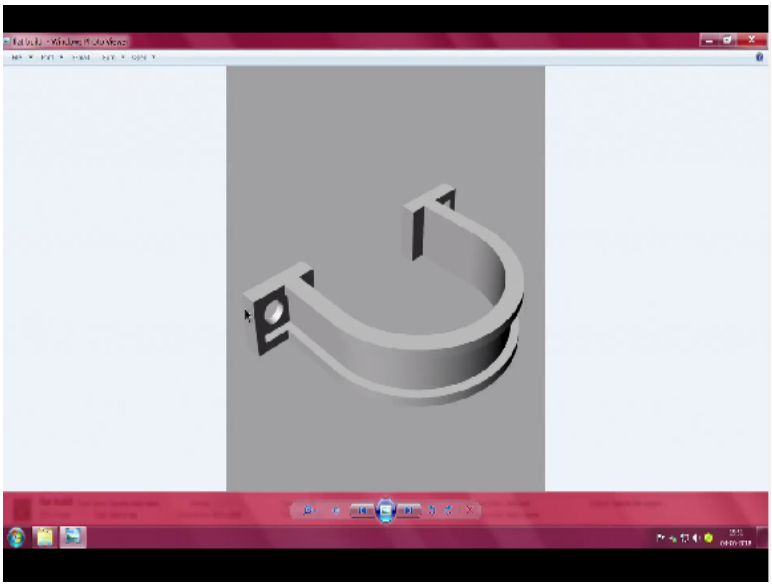

Now I will go up. Imagine instead of trying to build it in the vertical direction. We try to build it by making it lie flat. Advantage of making it lying flat is that round, it is easy to, no support is required but only thing is this holes may have a detail problem. Because the holes are coming from the other side. So invariably support material comes here depending on what is important. In this case, this large this thing.

It is obvious but in other case, I will show you another example where these are orthogonal, what to do about it is, see here, now building it like this is not at all difficult.

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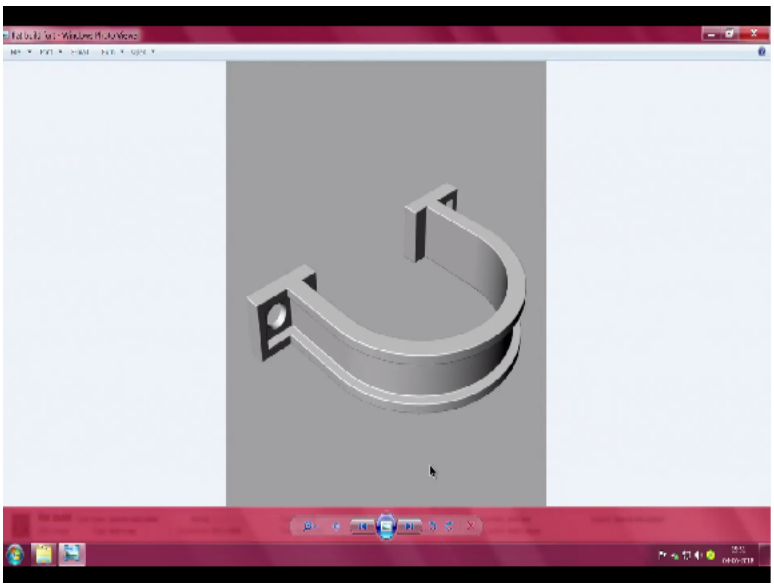

The next picture will show you same thing but I have added this fillet so that you can understand how the object looks like.

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Yes. I thought this is obvious. First layer will be flat. Next layer because of this step, it comes here and movement, this small coverage comes, now usually depending on the software and the amount of intervention, these, for these openings, some horizontal, what do you call, support is given usually. From this direction, support is given. At this point, it is very much possible for us instead of making a circular hole, why not just give a square opening.

Say in our case, things do not matter much. Because you can always keep a washer which will support the fastener and anyway when both are, you know, kept under compression, life is very very comfortable. However, if it is circular like this and the moment it reaches this 45 degrees, there is a little chance or some amount of confusion may happen.

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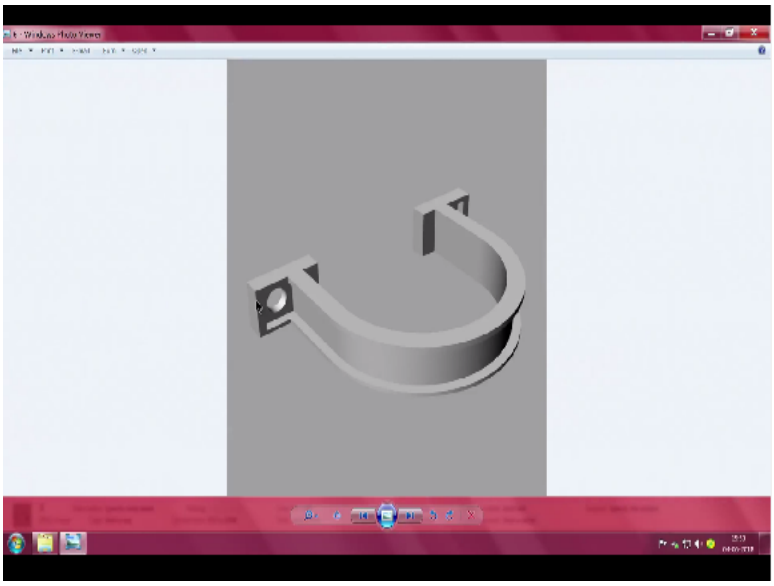

Finally, it is almost getting ready. You see here, the same cross section is maintained here and it has come here. So one of things you will notice here is, first of all, number of layers is small, compared to the other direction.

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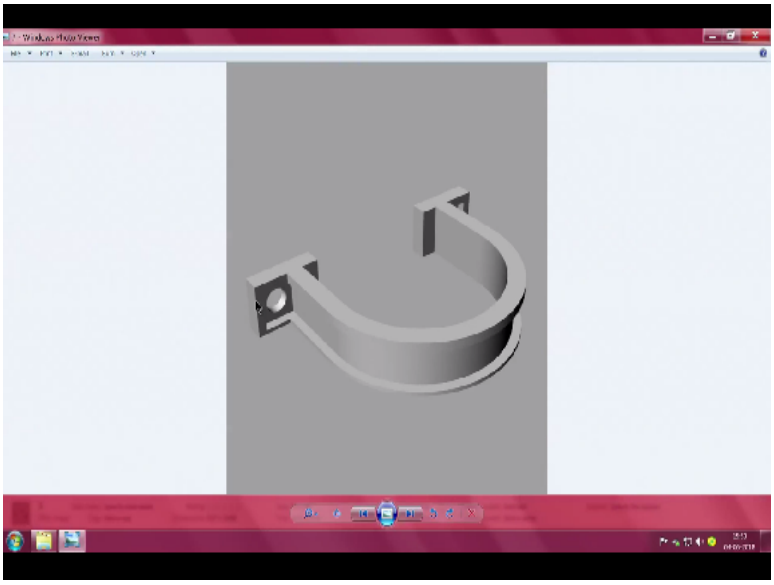

Here because it is flat, it is easy for us to build and multiple objects and see here finally, this is the last layer. This is the completed job.

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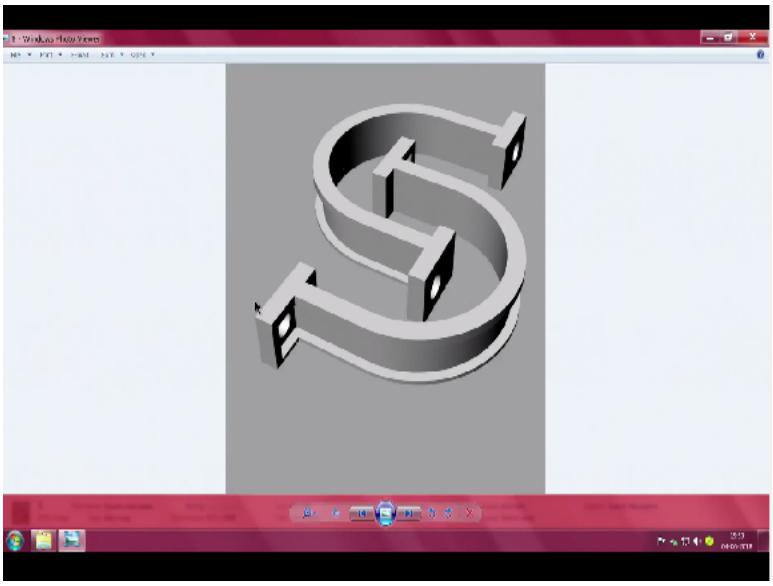

And we can may be place things here like this so that building it, it will be relatively easy. Actually, it is extremely easy to make these things. Now comes the other thing. Generally, very rarely we will using a single piece. Usually it will be pairs or multiples. So in the case of our rapid prototyping, after you have finished one satisfactory piece and you have modified the 3D file, sometimes you are on file here or sometimes it is possible to edit the mesh.

After you have finished the mesh and gross everything, you can print multiple things. So what you will save there is the set of time of that machine and all of them will be having uniform conditions. In case, there is a mild warp, it will reflect on anything and in case the material difference is there including the, this thing, all of them will come perfectly alright when you make this here.

So this is a very interesting way we can make these things. Now let me see what else I have here.

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Imagine, this needs to be replaced using your 3M, I am sorry, not 3M, using your 3D printing object, now we have ended up with definitely a small issue. If you want to keep it flat like this and build with this way, this will require a lot of support and if you want to put it the other way, we still have a problem. This is where you need to take a proper decision. In spite of this, because of this long this thing and all that, I would rather build this in this direction.

Because the small amount of material that needs to be built here and all that is not a big deal at all. In contrast, if you have to now erect it and try to build here, this will end up with the problem. It will lose part of the strength. And secondly, because it is metal. They have tried to compromise. This one is some very very high strength material and a very special type of welding has been done here.

All this you can easily overcome in the case of a 3D printed object. Once the 3D printed object is ready, now you can probably pass it on to the manufacturer and ask him using that file, they can recreate and make these objects. So as a prototype device, it makes very good sense.

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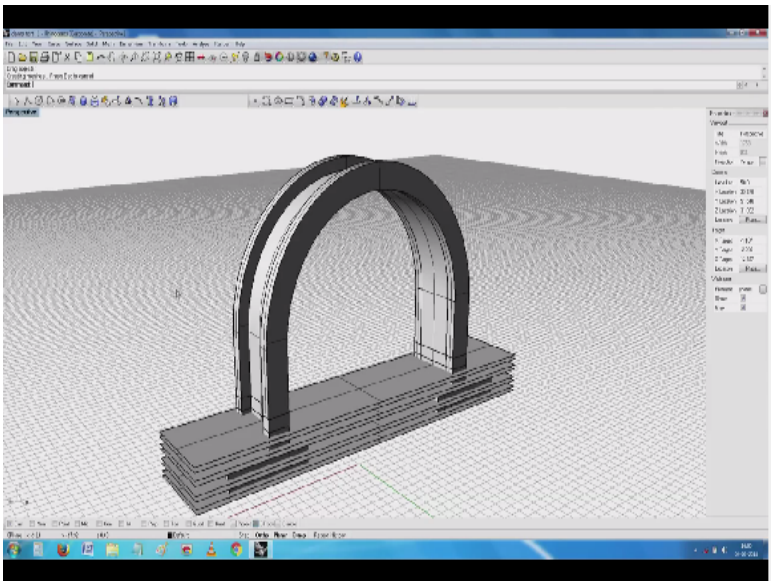

Now if you can kindly see the other monitor, I will just try here whether I can create another type of a job here. Okay, let me, I mean, let me play with this itself. See, how to show those layers. The whole topic was, I was trying to build those layers and show you how to make it. After having created this job, it is very much possible depending on the software we have here, several of this software give you an option to cut them into the slices. In this particular item, I have here, there is something called the, a cutting plane.

See that is the cutting plane. Because of various technicalities, it is a little boring but kindly just be patient with me. See I got this is specific to this particular solid modeller. I have several of these cutting planes which will slice this object into these shapes. Now do you need it? Yes, sometimes when the object is complicated and you want to know how the support takes place and already it is a closed object, like you have a gear train or your clock mechanism or you have often those (()) (23:06) which you see on YouTube where interlock thing is there.

Typically, if you want to build the differential which is there inside. Now it is possible using this 3D technique, you can build all the parts one after the other and then assemble it and fire the whole job at the same time. So typically a differential, you will find, you know, is a box like thing, 2 projections here and inside, you have 2 wheels, okay. And the wheels are supported to be, wheels are supported by another 3 or 4 other bevel gears and these bevel gears have a ring around it.

On top of the ring, you have the one more bevel drive which is connected to the propeller shaft in the case of a rear wheel drive vehicle. In the case of front wheel vehicles, the top is now connected to in there, what do you call, something from the crank shaft which is again part of the gearbox. Now using this 3D printing technique, we can build the whole thing without having to make all the parts and put it together. But at least for a working model, this is very good.

If you have to talk about a hypoid, usually when the real wheel drive is, we used to have a hypoid. So hypoid drive and all that is very very easy to build here. So later on I will get it.

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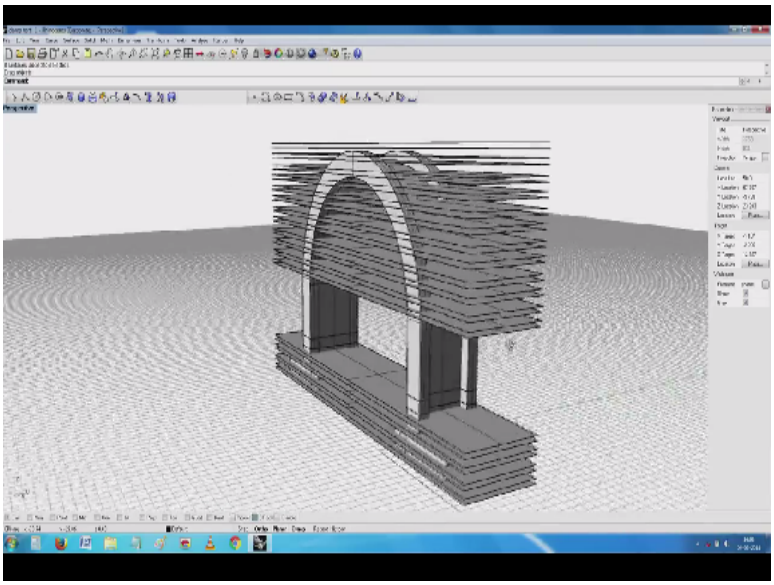

Now let me show you this just for the purposes of… See I have got so many slices here which is again because this particular trial version what we have or a student version what we have, does not have genuine 3D capabilities. I will just show you how these things work actually.

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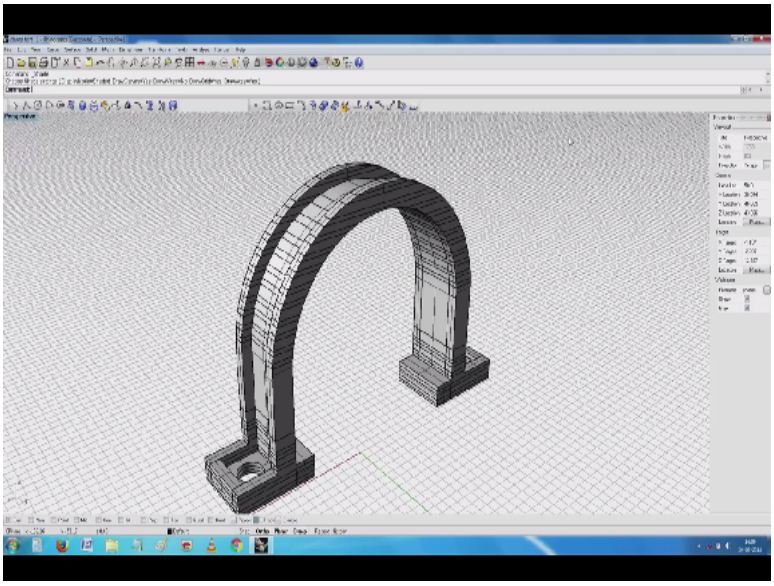

So easiest things here we can do is, here we need to, what do you call, split these objects. So it is a select object to be split. This is the object to be split and select cutting objects and I call these planes, it is taking time. See this. Large number of splitting has happened. Finished object looks like this except there are slices now. And further we have this again peculiarity for this particular software, I need to; Yes. What is happened is?

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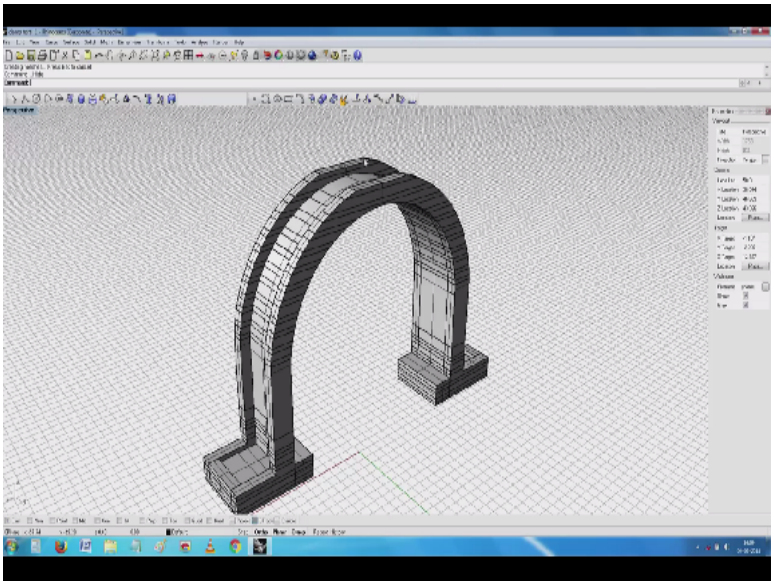

Now if I want to see how the slice is build. See.

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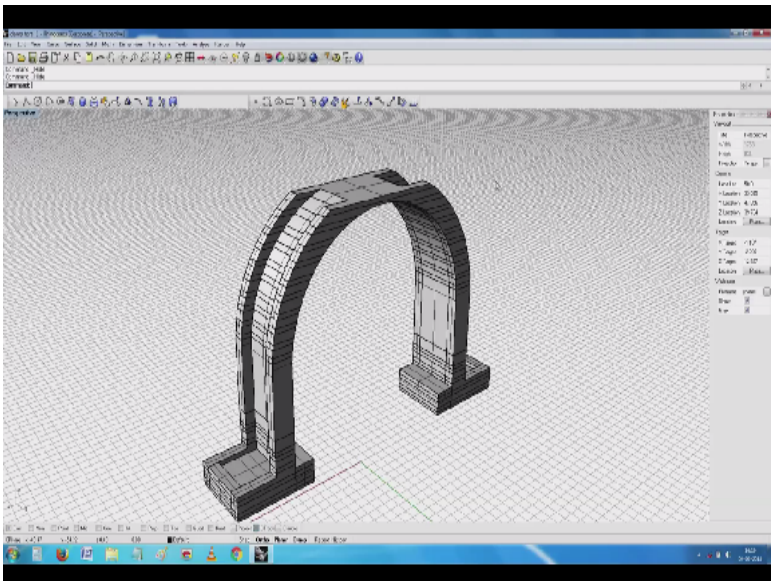

This is the last but one slice. Next slice and so on. So nonstop, this builds up.

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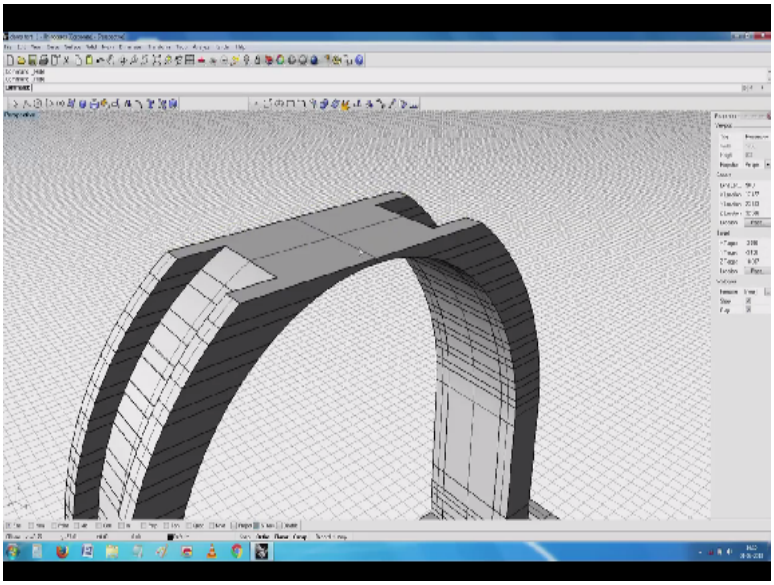

Now comes the main issue here. I will, probably I need to pause it here.

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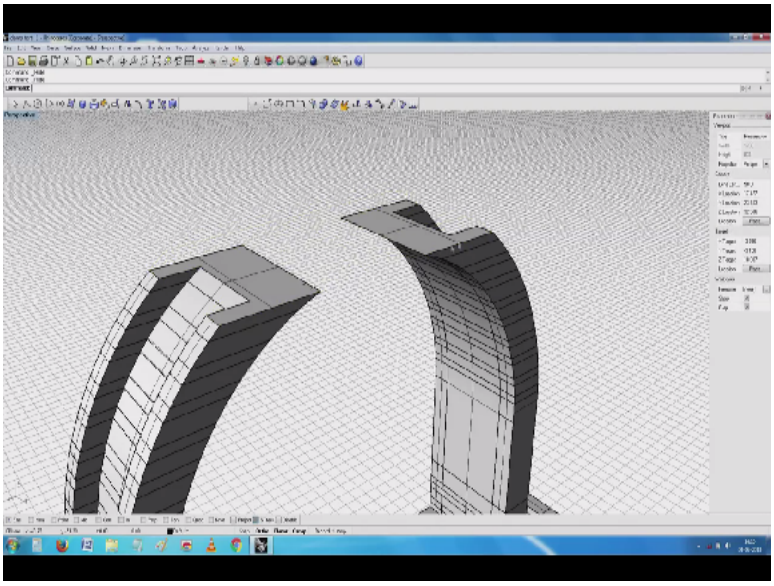

After this, I need to pause it here. Can you see here? So far, it is unsupported. So as it is unsupported, we end up with various problems.

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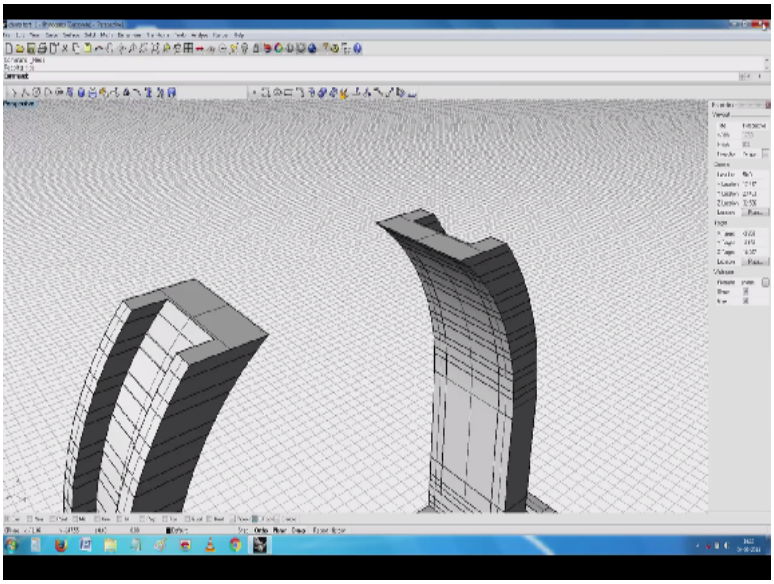

So if I now hide this, this layer also, see what will happen? Probably if it comes up to that 45 degree rule which I have told you earlier, probably things build, absolutely no issue at all. But beyond that, some additional support structure is required from the bottom. So it is obvious. Intentionally I have taken this.

Now if I, you see here, how after the slicing and how this. While this is not animation or such, we need to have control on this here. See here. I have a beautiful object ready. This thing in

contrast the other way, it comes up to here. While this is obvious, now I will try to go to the other one.

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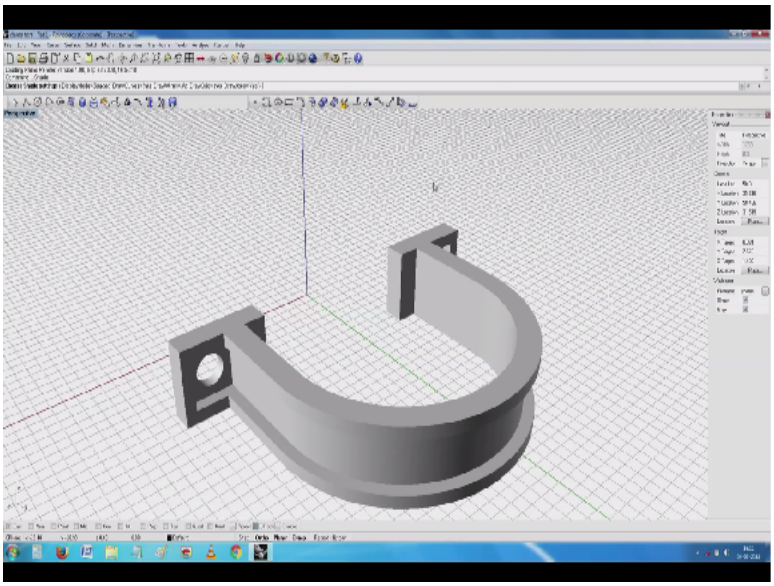

You see here, this one is made to lie flat. If it is flat, you would have noticed already that the support from the top layer is not needed anymore. This is okay. It is obvious and, what do you call, it is like stating the obvious and then if you remember here, this is the one that I have added here to make sure that things sit comfortably here.

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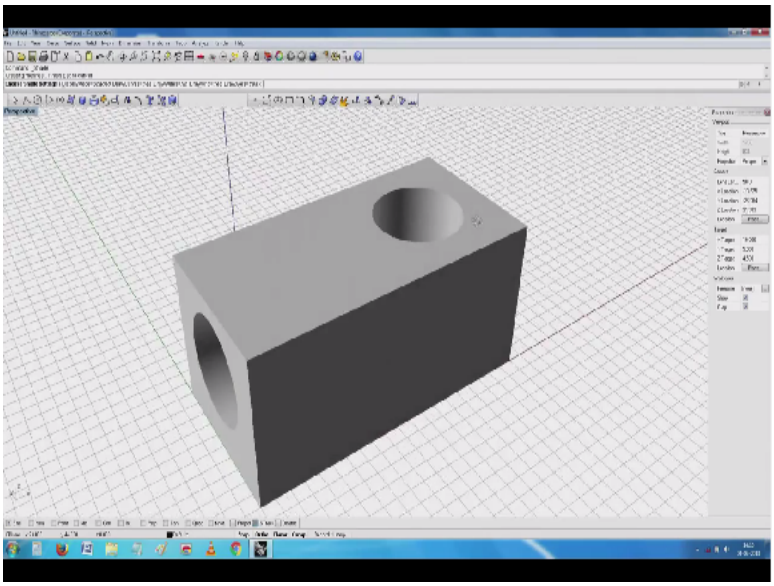

Now I will see if I can create a new object, same again, mm, interesting, what do you call, a small device here and I will get to it and tell you what it is. So we have here, let us say, this one I

have just, what do you call, made a very… Imagine, it has a through hole here and on the other side, a blind hole and, got it. You get an object which has a through hole here and a blind hole here. Now whichever direction I build, I end up with a small problem.

So is there something which I can do to make it easy to build and lay it in such that a circular portion, the build up is in the direction of the axis of every circular object. Because first of all, granularity, because usually the layer thickness is coarser than the xy build thickness in the table. In the xy plane, the resolution is very good but in the, what do you call, layer thing, resolution is slightly 1/4, what do you call, 1/4th of the other thing.

So an object like this whichever way you try to build, we still end up with either this will be here or like this.

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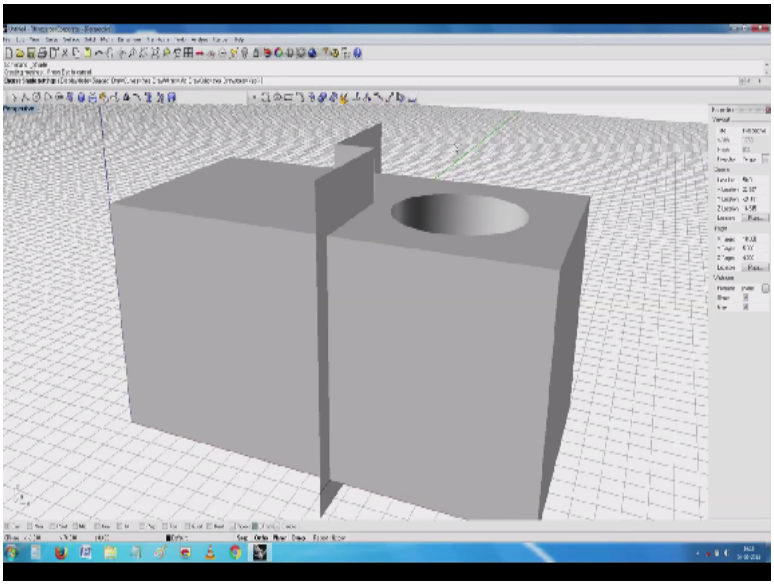

So what one of my colleagues has built, built is, has instead suggested why do not to split it and then try to attach 2 things to each other which may be, in the long run, a very sensible and simple way of making it. So what has been done is this particular object was split like this. Where did my beautiful line disappeared? I have a cutting line there. You have seen this? Just like I have done earlier, I will now try to split this object.

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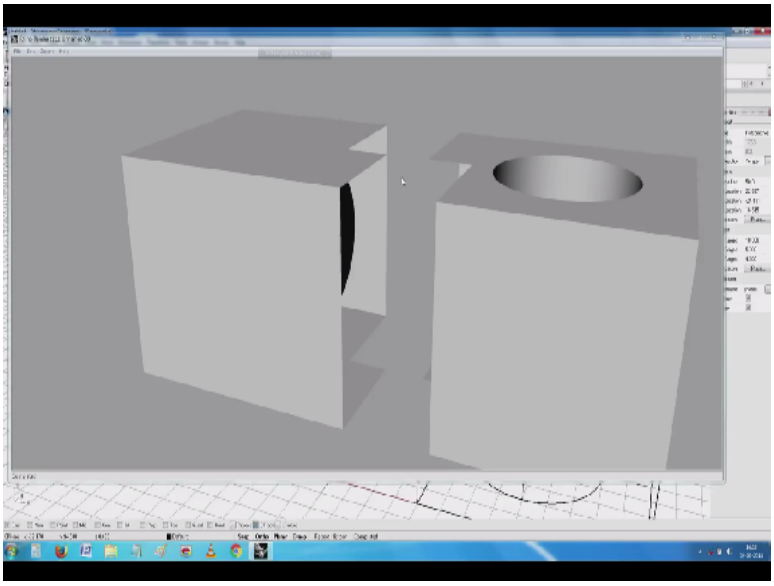

Select object to split, select cutting object, it has been split. This I hide and now I have 2, as I told you this is not a genuine, this is not a full-fledged solid modelling objective thing. So I need to now manually try to close these things which I have here. I will try my best, kindly, please bear with me.

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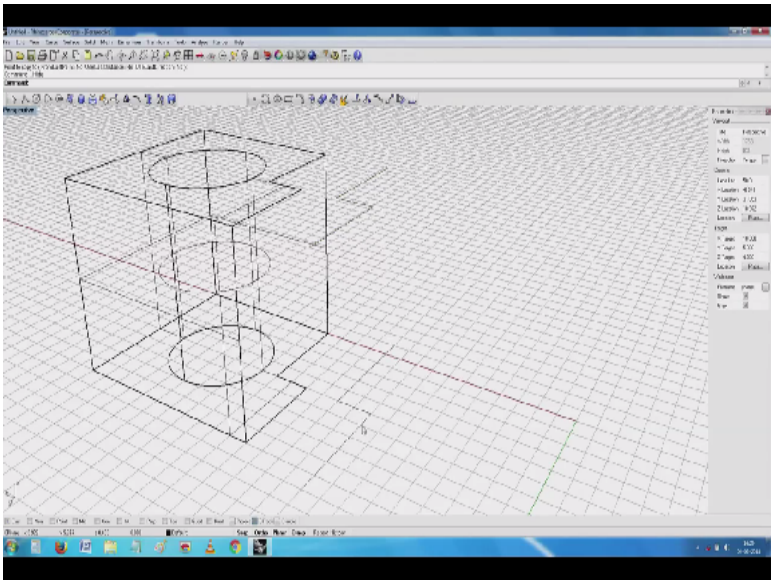

So easiest way is I will create another surface using the edge curves here. I have curve here, curve here. Temporarily, let me hide this so that it will not come in the way. You have seen here? I have got 1 object here. I have got 1 more object here.