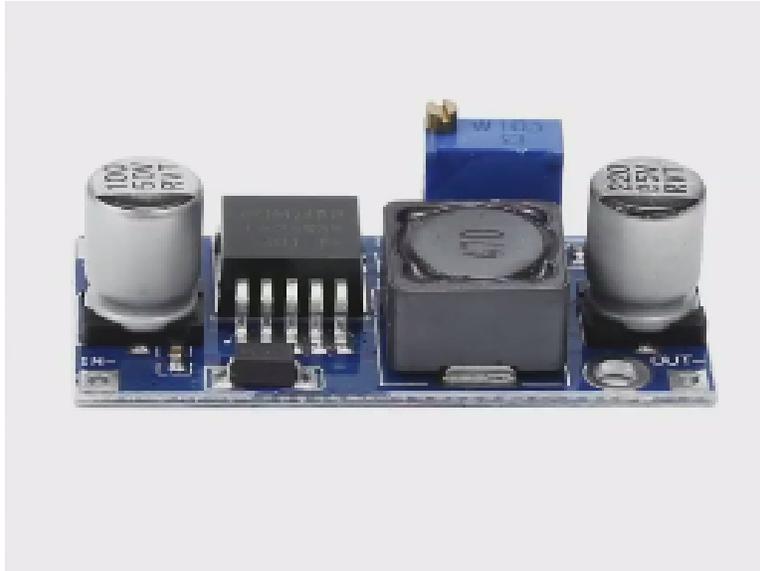


Physical Modelling for Electronics Enclosures Using Rapid Prototyping
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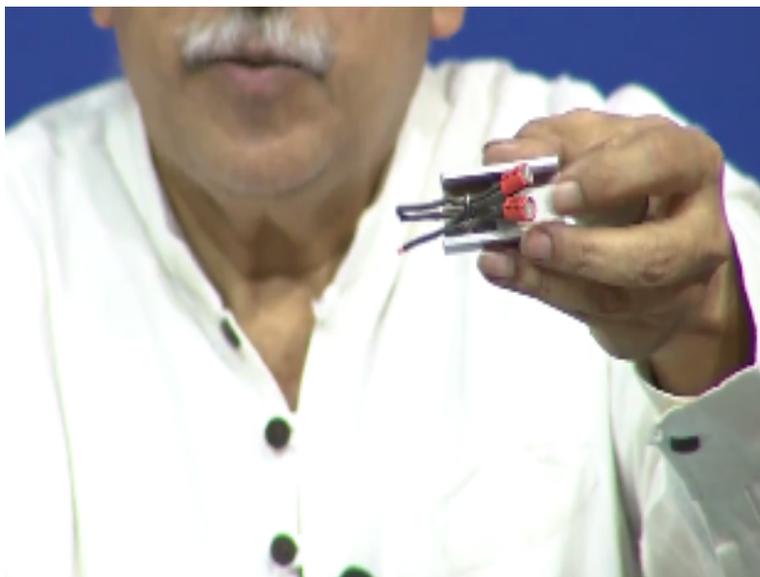
Lecture – 15
Heat Spreader to 3D Print

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Hello, so though this lecture is a little to do with 3D printing, we still have a starting point where we need to start. I just thought I will remind you from where I left off here.

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You see here this is the original 3 pin series pass regulator, you will notice here in this case, wiring and whole thing repairs; I mean, sorry, is relatively easy, all I have is, I need to make a little bit of installation here, I have heat shrink sleeves, then there is a reverse protection diode and all thing has been nicely enclosed in a aluminium box, you see here and I have an advantage here, the moment it is made of a conductive material in this case aluminium, its whole thing is very cheap.

Probably, this cost maybe, to fabricate and all that know very little and then in the shop may be it can be sold for 1 rupee because it is not any special what you call, specially designed extrusion, it is just a long aluminium C channel that is cut and then a hole has been drilled and then only thing is in this case for our safety, we have made a special what you call, one clamp like thing and we have pasted it and that to has been made to ensure that there would not be any shorting.

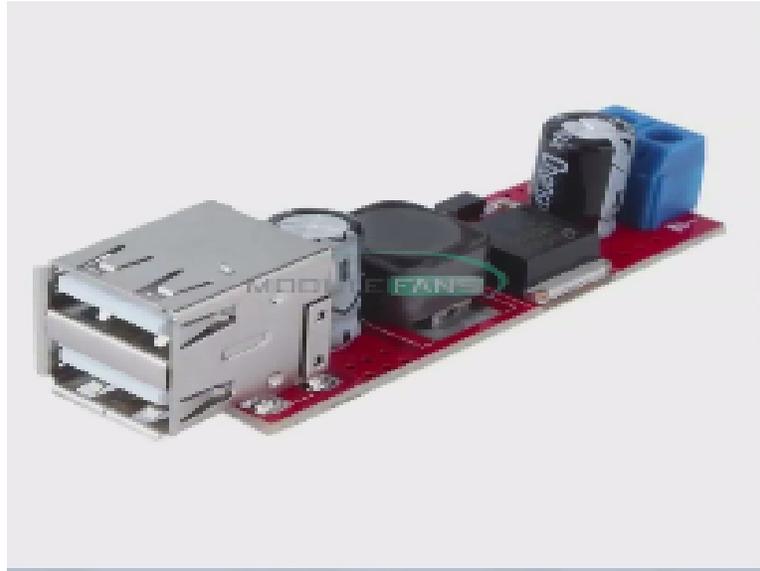
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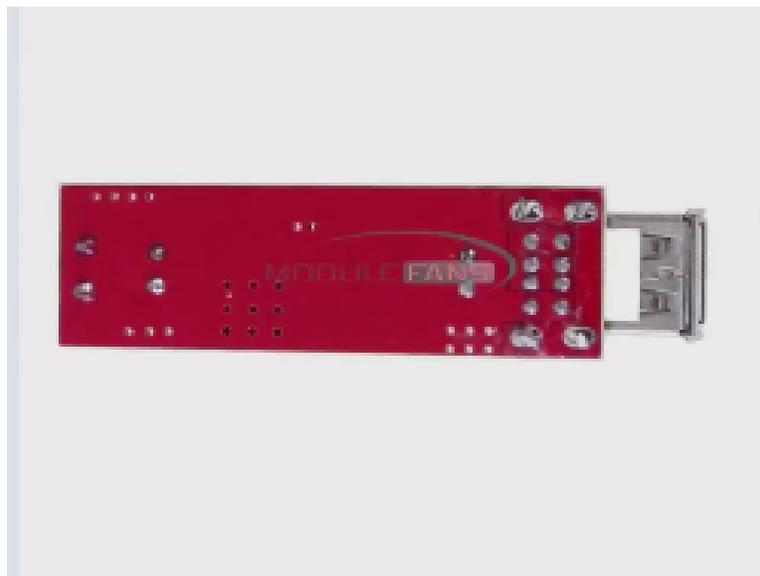
So, in this case overall a linear regulator is very, very cheap, there is no problem and the main heat dissipating components can form the box also however, when we switch over to any of these elements like these two elements, these are all switching regulators, you have seen this know, it is about the same size as this, there is no problem that is a reason know, why I in fact I picked up, the switching regulator also is about the same size except that is full of electronics.

And full of places where it likely to get short circuited, so first obvious choice will be for us to have a nonconductive enclosure, so the most common way of making a nonconductive enclosure is probably make a C then I put one more C on top of it and now comes the slightly what you call involved topic about it.

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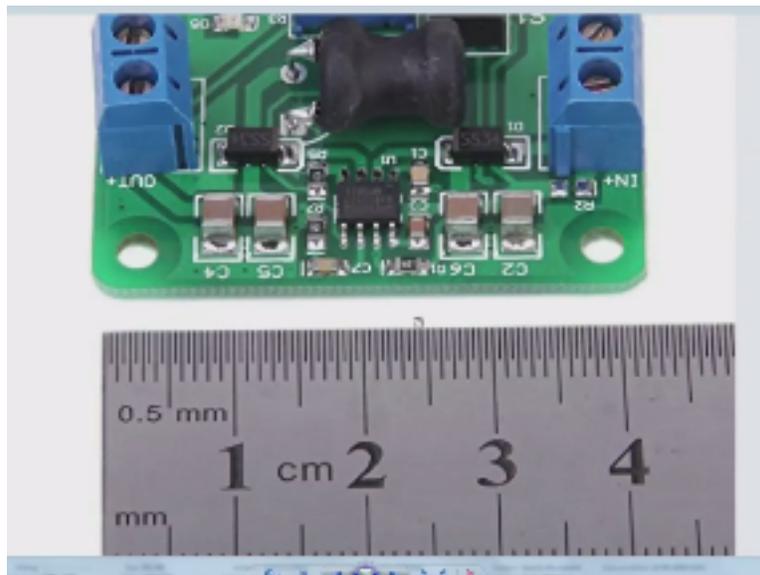
Now, if you kindly see the channels here, I will just check you to seen something here, the same thing, the same circuit except that it already comes with that know, mounting holes, there is only a small provision for a heat sink here, otherwise it comes all the thing with its own output jacks,

this particular thing know, is an output and then we have an input jack here, so the previous picture shows you, this is the input and this is the output.

So, in this case, it is probably relatively easy for us to just fabricate a cover and there is no electrical connections involved and in fact, we can make a tube like structure perhaps take a tube in which we can push this through and on one side, we put an insulator and overall we are in good company making a enclosure with our rapid prototyping for this this is relatively simple, all we need to do is; take the dimensions of the box outside, okay, this is dual USB thing.

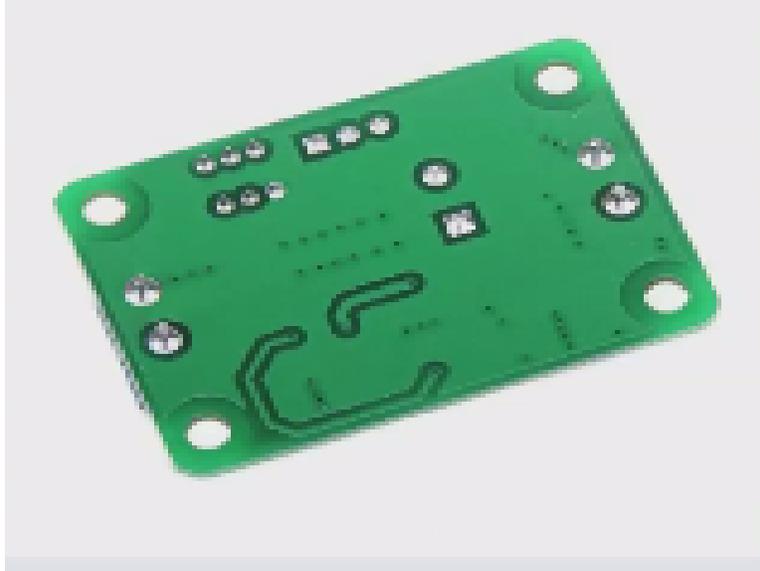
And then miraculously, they were made all the dimensions such that everything is within that height, so a tubular structure is easy and then the tube can probably stop here with the first step if you want otherwise you make an opening, make a barrier and then you have in and out like this that absolutely no issue about it at all.

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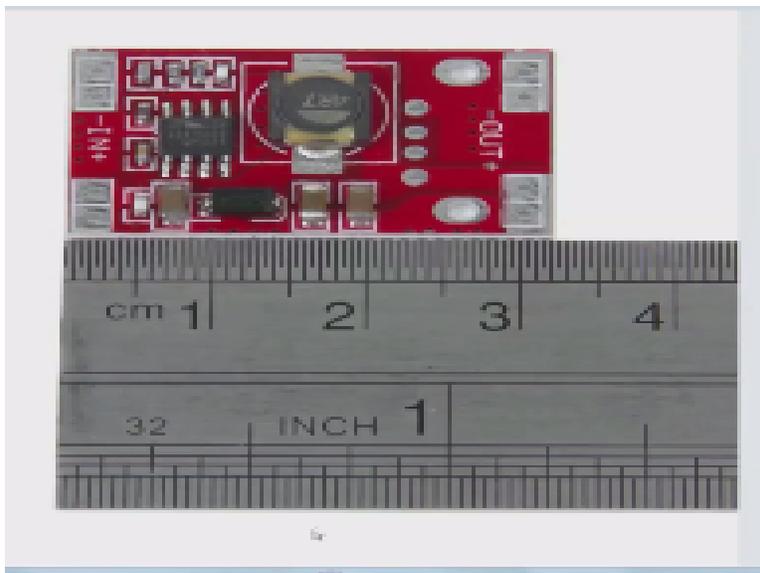
Now, you see, this is a slightly different thing similar concept except that both in and out have this screw on connectors. Advantage of screw on connectors is; no more wiring is required, no more soldering is required, so if I make an enclosure for it, I can ensure that the enclosure nicely sits here and again, for our, sorry I hope I have not deleted it, for our convenience and to avoid engineering drawings, I will tell you why the engineering drawing here show is.

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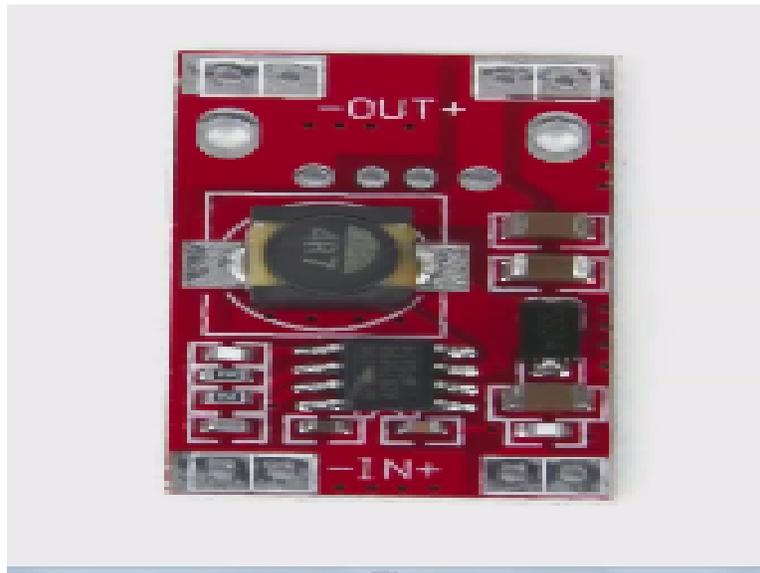
In fact, they have put a workshop scale and photographed it saying what you see is what you are likely to get, so it easy for me to see that if I see this right edge know, it is going to be around 42 and half millimetres and then it is easy for me, absolutely easy and then same thing with the other dimension also, then all the drawings things are given here.

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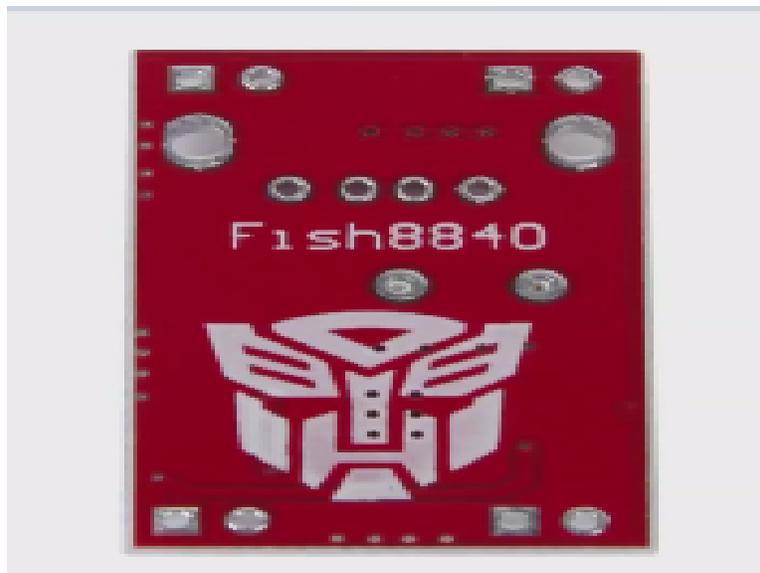
And you see here, this is 32mm by something else, same PCB without the components except that here you need to solder things either you need to solder or you need to use a special connector and so on. Usually, this is a very good starting point of our projects, so here both the mounting also are on the same side which is different from the earlier one, if you see here know, a mounting holes are all the 4 corners, then we come here we have only 2 mounting holes.

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Same thing here, the other dimension it is given, so if you check carefully inwards, it is 20mm/ some 32mm, within that 22mm, we know at least what is the area that is required. Why they give these is; these are generally used for printing into some other circuits.

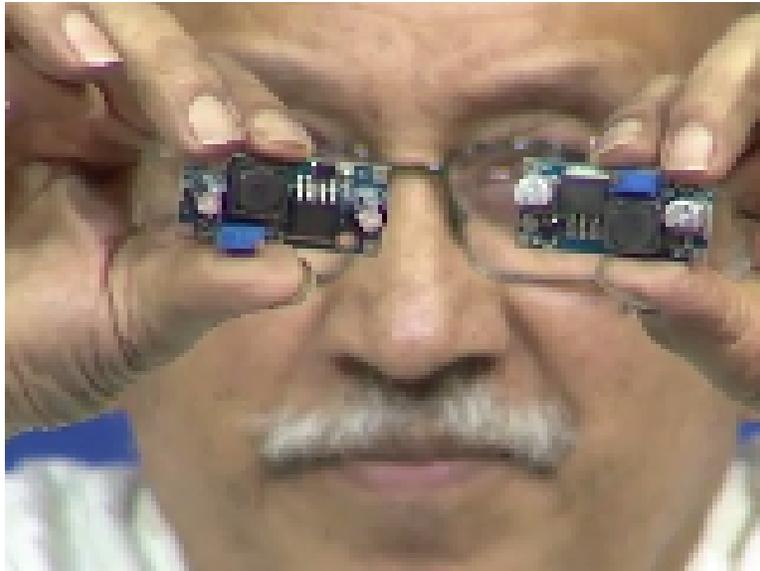
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Now, you see at the back, we have again the same, 2 mounting holes and there is a provision here for probably a heat sink probably, I would not say it is a heat sink or if you go back, you will probably check whether some other thing is; I am sorry, something else is included in that you see here. Yes, it is for a heat sink only, so we see here there is actually, the actual chip is here, okay.

This is a toroid or what you call a transformer to increase the thing, so after you look at it and all that know, these 4 holes may be for via holes and then you see carefully everywhere, this red thing represents the copper, so this copper has been made such that things are very nicely done. Now, let me what you call, stop here, show you these 2 things.

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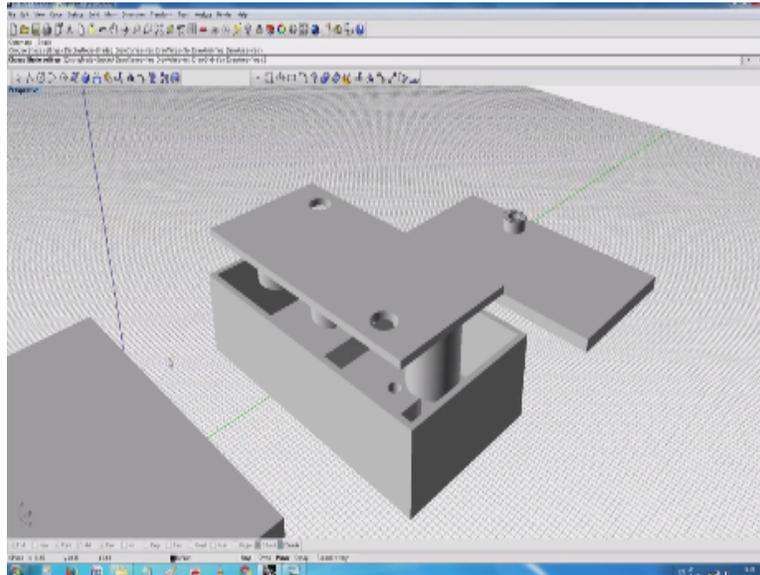
Have a look at these 2 things, sir, can you get us a closer look, their look about the same, is it not, if I now twist it, the look about the same except that when I turn it over, you will notice, that the mounting holes are opposite, it is not about twisting it, if we twist it here, you see here still they come onto the opposite directions. So, this is the case where making a, what you call, a general purpose enclosure know, is a little problem where our thing will help.

Can you see here, we have the mounting holes here, one hole is here and one hole here, top left, bottom right. In this case, top right, bottom left, so if you follow the particular type of sequence which I have shown you there including you made an outer enclosure and all that know, then you have a look at these components here also, you will not notice that these capacitors are taller okay, they are projecting beyond the surface that is projecting beyond the surface.

While this capacitors, they are about the same size, they are about the same size slightly in fact bigger and then they do not project beyond this, so if we take a dimension from this and if you

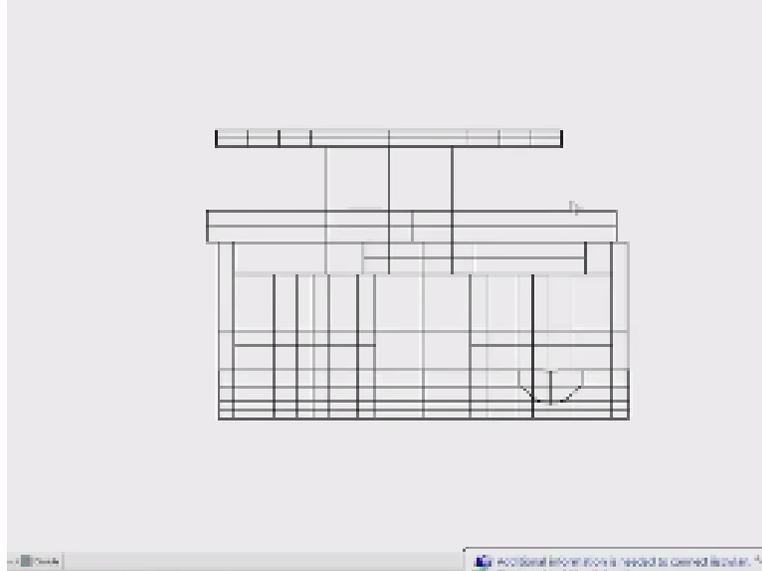
take a dimension from this and miraculously, you see when the position know is slightly shifted, it is not as easy as we think and overall, the dimension of the circuit itself know, is very different, one is bigger and one is smaller, this is where it helps for you to modularise your design, have an outside box, have the mounting studs and all separately.

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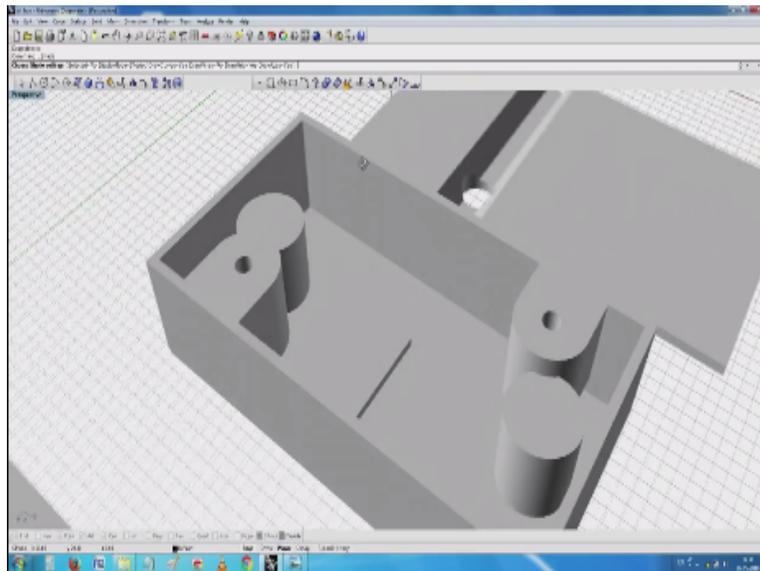
And have a heat sink position, which is separately and so on, now let me what you call, allow me to go back to the drying stage. I brought you and probably, left you here yesterday, so I have a printed circuit board which has 2 openings here, then I have a small aluminium plate just loosely I have shown you, what you call as you something is attached, it is not attached actually, if you go and push it here, it is very convenient just because on top of it.

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Seen this, it goes and sits on top of that printed circuit board, okay and makes a contact, so maybe if I put it in this mode and then put it in the 3D shaded mode, it will probably make more sense.

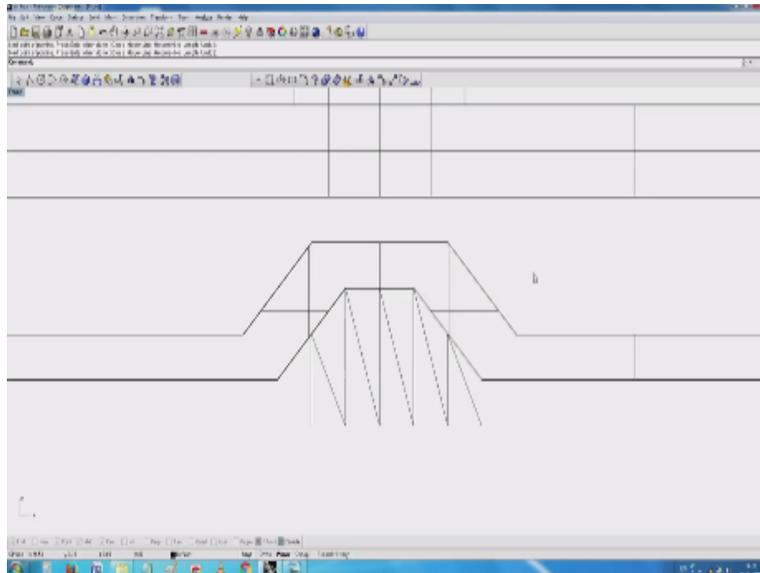
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So, in the shaded picture, you can see there, all if you are convenience, I have push the printed circuit board up, now I will push it down for you and one thing which was quite okay, now I will just show you why it is not, okay is this very fancy opening I have given here, thinking it will make it look good and maybe people will want to buy the product and so on.

Seen this here, I had a tuning thing and then this is kept here, saying it will help, now we come into the little bit of problems with construction of anything which involves this thing, I will now hide this to make sure that you know it will not interfere with our arguments. Now, you see why I have kept this boxes separately, this boxes are kept separate such that depending on the batch of the printed circuit board I have, I can move them to align with the product that we have got.

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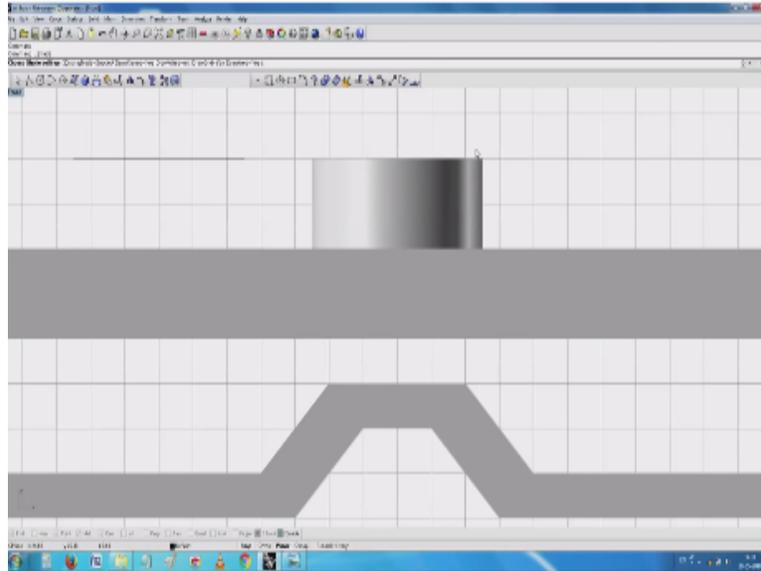
Because it is likely to be different anyway right now, I will hide them right now, I will hide the printed circuit board also and just for this thing, I will hide this also now, here we get into a very interesting, I want; I do know whether you should call it a problem or issue which you need to be solved. See, if I were to build, a taper twist like this and which is again in reverse you see, it is a part of the box, building up will start now.

This is the bottommost layer, in the bottommost layer the build-up will start, now we have a very peculiar, you see here an angle surface which needs the support from the bottom, so the algorithm there will try to build you know a lot of support material here, just for to make things easier, I will just try to draw a polyline and you see, if this were the base, the support material will start being built like this, which is instantly a big waste of effort.

And further, you will not get a smooth edge as we have shown here, it is fine because algorithm itself know takes layers and then in layers, layers will you know the thickness of the layer will

represent these z direction granularity and x and y resolution will depend on granularity in the other direction, so we may or may not be able to support, this is just a waste of; just a waste of material.

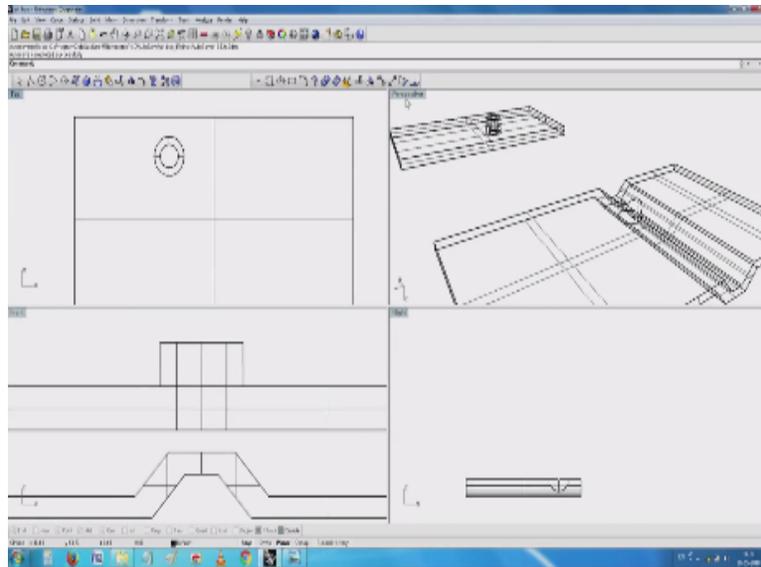
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So, is there a way of getting over this problem, so probably the easiest way of getting over the problem is first of all find out whether this is really necessary. Do we need to build you know, very complicated structure like this, reality is no, while in injection moulding once upon a time and then with the what you call little bit of aesthetics in industrial design well, it made sense similar function can easily be achieved instead if you just make a cylindrical structure here like this.

But then, one thing you notice there is no fillet here and then right now, for convenience sake we just made it straight, advantage being the layup will start at the bottom and then slowly after this thickness is built up, next layers will start building here and it does not matter even if in the plan with circular, it is not such a big deal for us.

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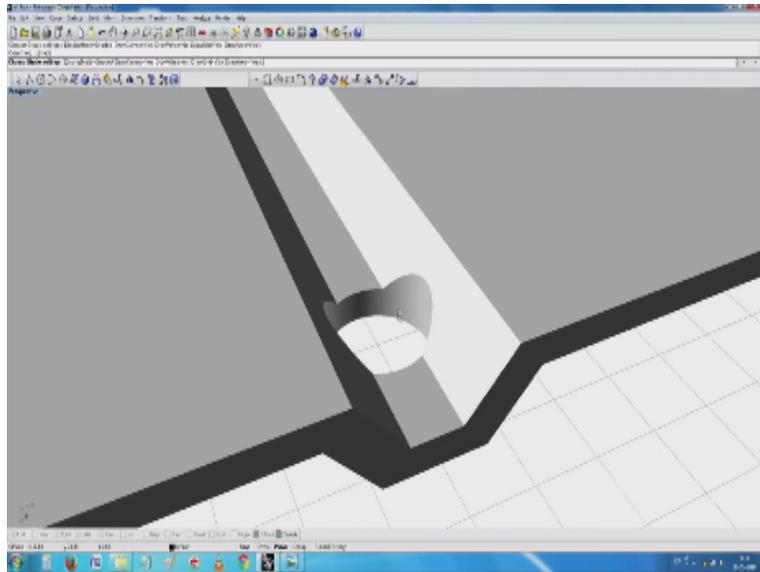


See, even in this view, if it is circular, it is not a big deal rather it is not a big problem for us. So the, what you call the fused filament device that head will start building up all these things, once again depending on how energetic are filling and so on probably, making it a square also may make sense just make it a square, same way here just for convenience, I have made it a circle, nothing prevents us for making a simple prismatic object into a square because building up is easy.

Right now, otherwise every time it goes and comes back and all that know, little bit of jaggedness will come here, is there any other way, yes, it is for you, make an octagon, make a square or make something which is there because of what we are interested in is the centre hole here, now you see building an object like this is relatively very, very simple in the amount of support material and the amount of time required that will reduce tremendously.

I hope you got my point, my point being that if you make all that fancy things which are required for may be in mass production in this case, we can optimise very well to do this let us say, you still liked that the concept of a groove and it looked fine, instead of sticking to this you know, vertical incline thing maybe some other way we can make, why not convert it into a vertical channel, maybe you can convert into vertical channel, make it like this, make it like this and then make the hole appropriately correct size.

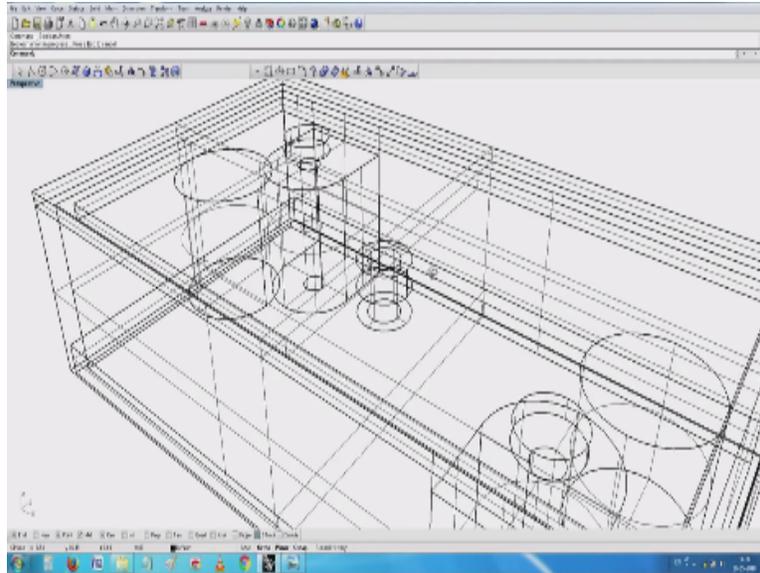
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And then you make a this thing, further you will notice, when you try to make a hole, the solid modelling package has made a very you know, what looks very cute, you have seen this know, a very, very beautiful, a really cute looking nothing has been made which at one level while it looks good, we do not know how well it actually builds up, see, nice know, it looks nice as a nice thing and all this here, probably misplaced.

Meaning, come in, you do not need that type of thing, all you require is a nice groove, in contrast the groove the other circular feature also is equally good, now I will presently what I will do know I will unhide all this hole lot and then see what is sitting where and then put it together and see what best we can do.

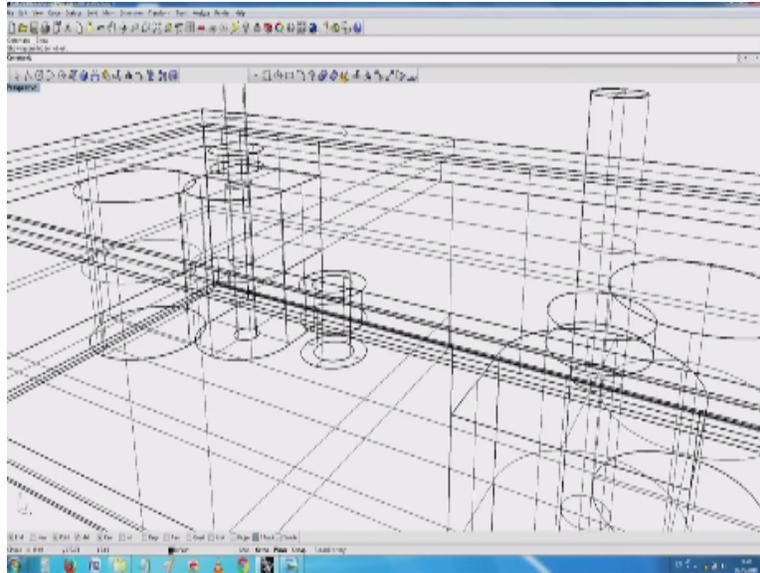
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So, this one know, I will just delete it right now, I do not want it, okay this stuff I have still. Slowly, I am reaching the point I wanted here, seen that except they are still nice model, what you call minor this thing is there, this top know has not aligned itself perfectly but then it is okay, I will you know just put up with it for the moment, I know how to correct it eventually, I will put up with it, so I have got a heat sink devise here and just fine, you know, I think I will improve it, I will just delete it start with the proper heat sink device.

And then again one more time, I will start with the surface which will start with a plane, corner to corner, this is my heat sink proper, this is the cover, I save the Boolean themselves, fine nicely it has got Boolean. Now, I have got a reasonably good looking box with a place for the printed circuit board to sit and then I have got a heat sink which you know will go and press on it, except 2 features here that mounting hole of the printed circuit board has not been transferred here.

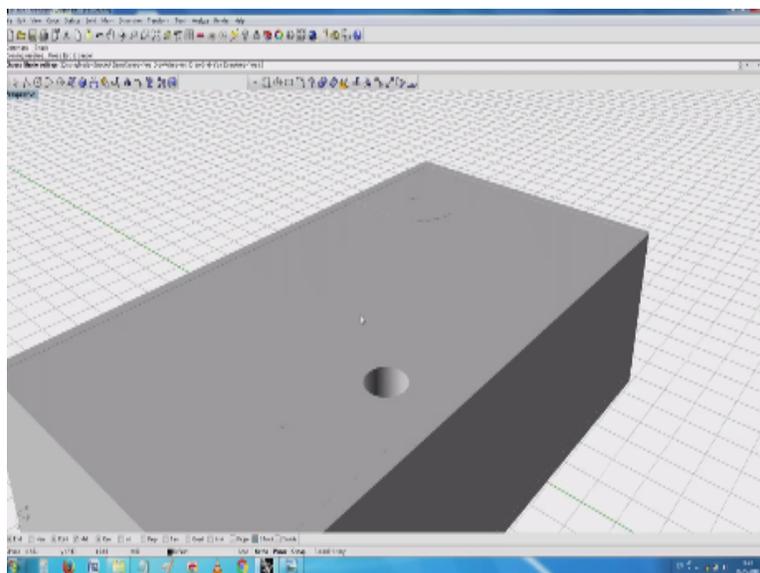
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So, what it will do is; inside I have got the bushes in place, right now I will close the printed circuit board make use of these 2 bushes and then extend these you know holes there. So, what I do is; I try to create a solid using a planar curve, this is the planar curve, same thing happens here, you see here I have got 2 things which will eventually can be made into a this cover, see this is the cover I have created just now.

So, I have transferred those holes to it, then I will do the difference, from here first set of holes, second hole, I will create here.

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See now I have a reasonably good looking completely enclosed box and there is a place here for me to tune the printed circuit board, remember the PCB is being mounted obviously upside down.

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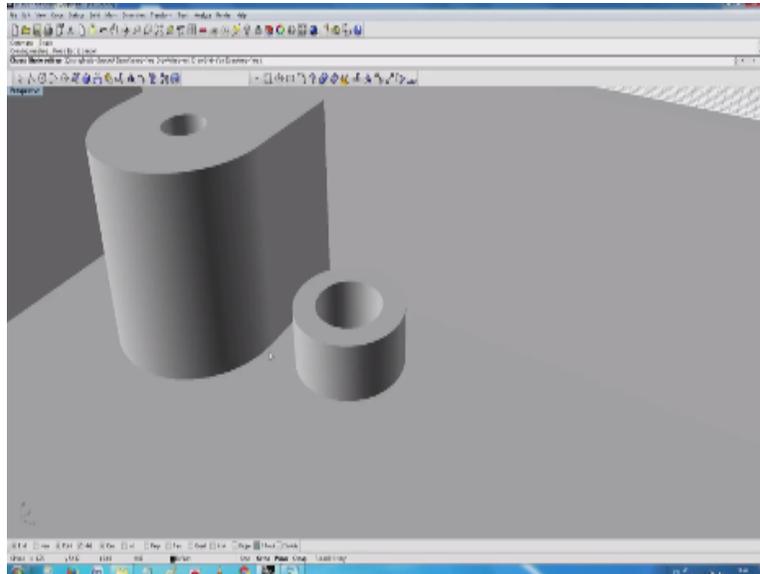
Can you please show this sir, I have a printed circuit board here, heat sink is sitting from here and the other side is where the tuning and so on will come, so the thing is being built upside down like this, this is how the device will come, this will sit here and because I have got this to mounting holes and this boxes will go and sit on the box and the heat sink will sit here and the same holes which are; same holes which are given here are given on top.

Now, I need to take a call and what to insulate inside, though I put a small insulating layer and something which is equally, probably equal important is; do I part the whole thing, after finishing this, there are heat conductive but thermally I mean, thermally conductive but electrically insulating parting compounds are there, so I nicely put everything and then inject the parting, somewhere 2 components, somewhere single component things.

Once you injected and put it together, 2 things it has, intellectual production is only a small part of it that is not the important, more important thing is moment you part it conduction and all will improve, there would not be air pockets at all, any time conduction of that what you call

polyester or any of the resins is much better than air and secondly, it is completely known to any vibration or any shocker anything like that.

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But parting itself is a not, so I have now here you see, I will now just turn it over, okay that is the bottom portion, this is the heat sink point, heat sink has holes, I will now hide this and this is how finally, this is going to be my final job which I am going to fire on the machine, it is a little simple, it looks ready, come an quite nice and all that except the first thing you will notice here is the why is this box so big, is it not big and is it not small and all that.

This is where you have to need a call, logically the just same amount of material which I have left here is option for here typically, a minimum of 4mm; 3 to 4mm is required and this hole is for having a self-tapping screw which goes inside, you understand know, self-tapping screw which goes inside and this one and so on like that. Why I have made it little bigger than normal is; I have a nice area which it sits, the maximum possible area that is I have included here.

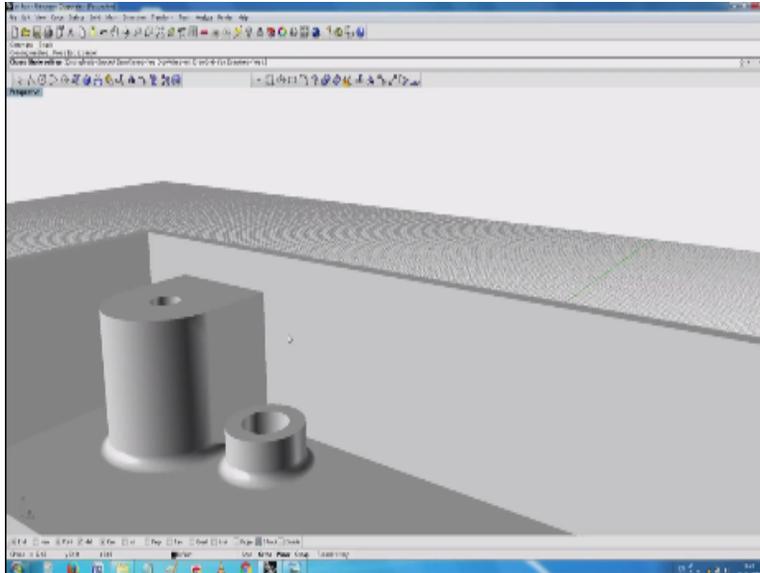
You understand know, so it looks big, there is no reason why it needs to look big, the main difference between here in the injection moulded part is if we were to make a part like this in injection moulding, one of the first things that will happen is because of the larger cross-sectional difference we end up with huge sink marks and the material will not flow it all, it the very poor design for an injection moulding part.

But in the case of making a quick good prototype in our 3D printing, this is probably the best way to make things, you got my point, this is where the slight difference is there. Now, right now I do not know for some reason, this refuses to what you call get union with this, I will see whether it will still continue, still it does not like each other, it got union, no problem. A very good surprise, see I have got a beautiful object here, which is the whole thing is integral everything, know.

Now, only this bottom portion, I will see if I can attach it to this and then I will show you some other interesting objects and which we like here, solid, then we have a union, good, little small error has happened, do not worry too much about it right now, the whole thing has turned out to be a single object because of a little you know, projection probably that thing has happened now, to make this a little more let us say if you were to be made in injection moulding, we will invariably end up with having to give fillets here, otherwise it becomes very, very weak or stress concentration will occur.

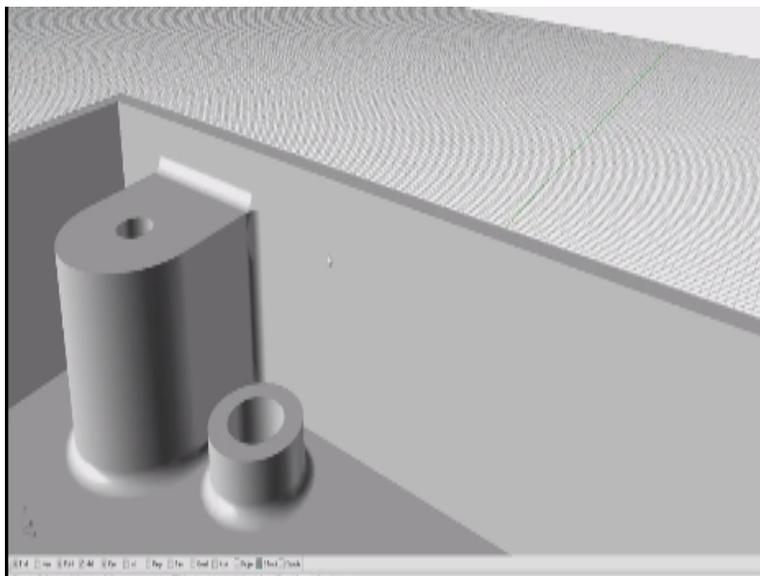
In this case also, if you suspect that there are too much of force coming here or something, it may be possible for us to give fillets okay, loosely, I will try, I will see if it just one surface, I will try to fill it and show you how it comes. Yes, I have a smooth fillet there, you have seen this, I will see now whether I can do a similar fillet here, see here, what looks like an obviously cute fillet has happened there and correspondingly, on the inside thickness.

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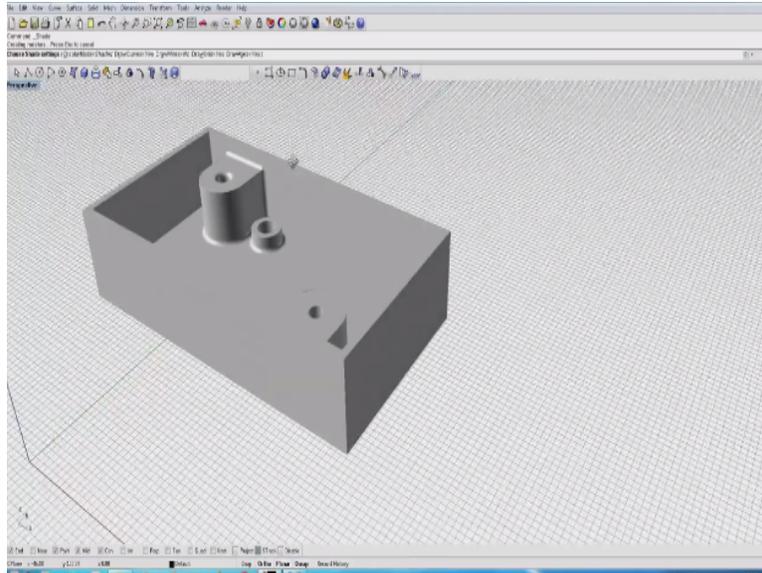
See here in the inside thickness, I have one more time, this is conventionally what you are likely to see in an injection moulded part except that as I told you here, it does not build well and then we come to our these things, so we avoid this things as much as possible, we avoid such things, these are much easier way will be to have steps; steps are much easier to build, even chamfer stone build well.

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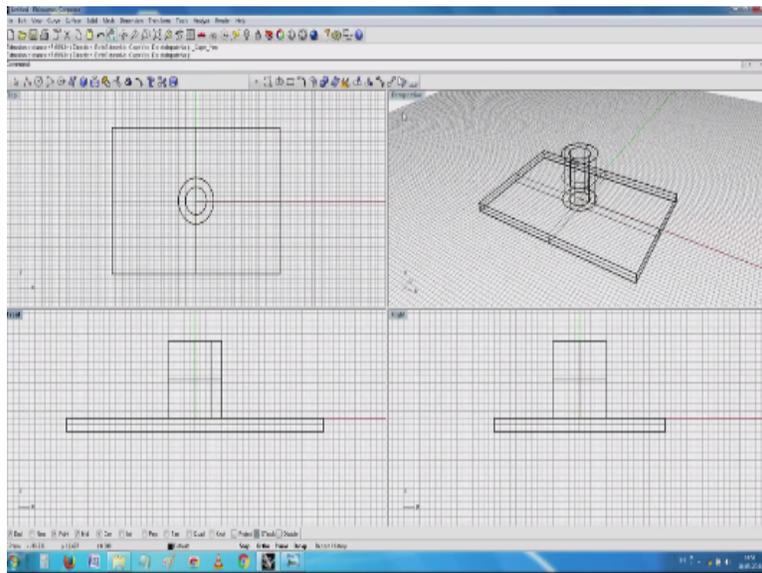
In spite of whatever the manufacturers claim, see here at least it looks nice and it does avoid stress concentration which is likely to occur the same thing as we have in the other thing except here know you to take a little more care to see what best we can do about it.

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See there it looks quite okay, so right now I will stop the; this particular experiment I will stop here, then I try to take on a just a flat base and show you how we can attempt to build these things here.

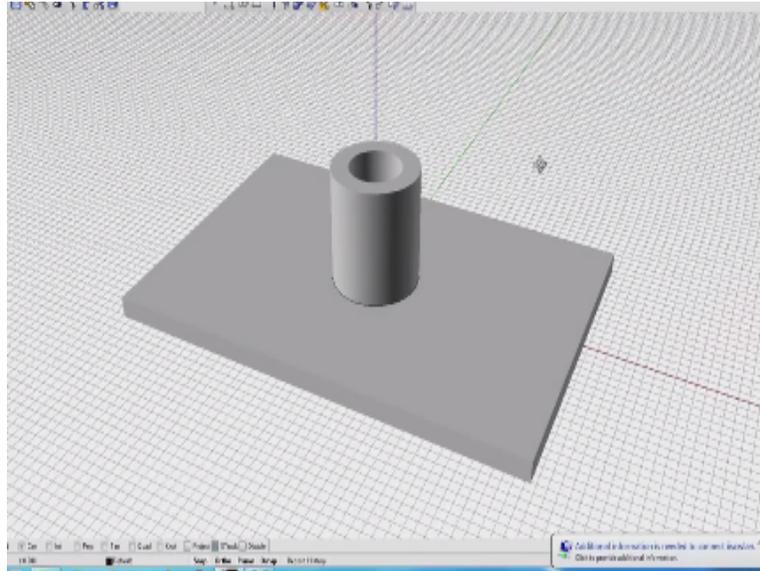
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So, I will start with a fresh drawing instead of; see as before I will start with the you know, what you call a surface probably a plane, I have a beautiful surface here, okay nice surface, then they also will make a small curve to build a; imagine this is the pilot hole and then I represent the material thickness here by this okay, so I am just creating a step here and trying to see how well I can create a solid.

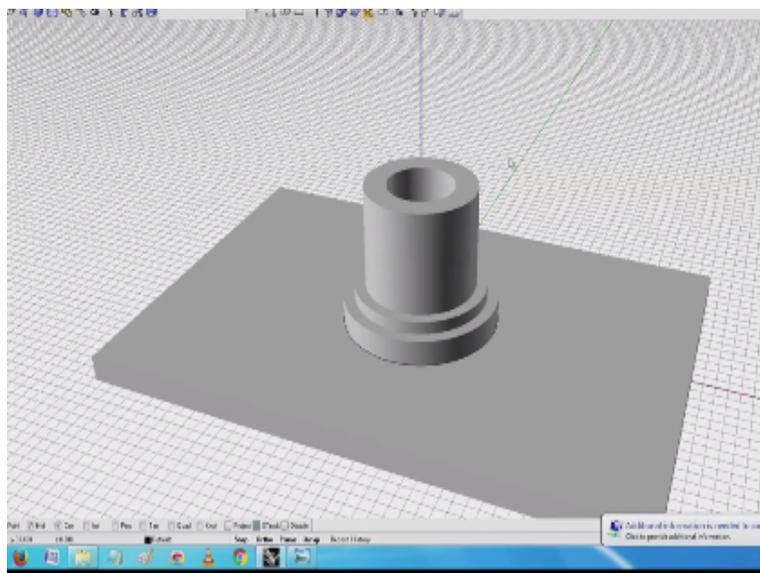
I will use these 2 and create first of all a solid sorry, no, no, it would not build because these are there, so I need to build the other way only, I need to build a solid directly from; I have got a thickness here.

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See, this is a very simple conventional thing here, so this where I thought I will what you call spend a little more time with you, if you are to just fillet it or even chamfer it and do it, it does not build well, instead our rather experience as taught as that I will start here you see that circle is still kept there, I will try to make a small offset out of it.

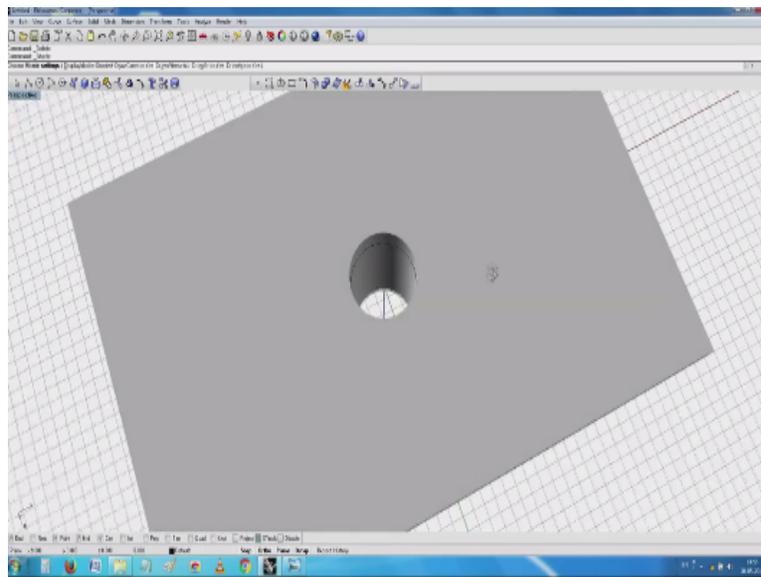
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I will build a small step here, next I will take the next 2 circles, this in general is a much better way of creating a what is equivalent to a fillet, I have just exaggerated intentionally, I have exaggerated it. Generally, if you just have 3 times the resolution they talk about. If it is 0.1mm, say 0.3mm diameter resolution and then the same thing here, if there is the resolution they claim is 0.2mm make something, which is around 0.6 mm width here.

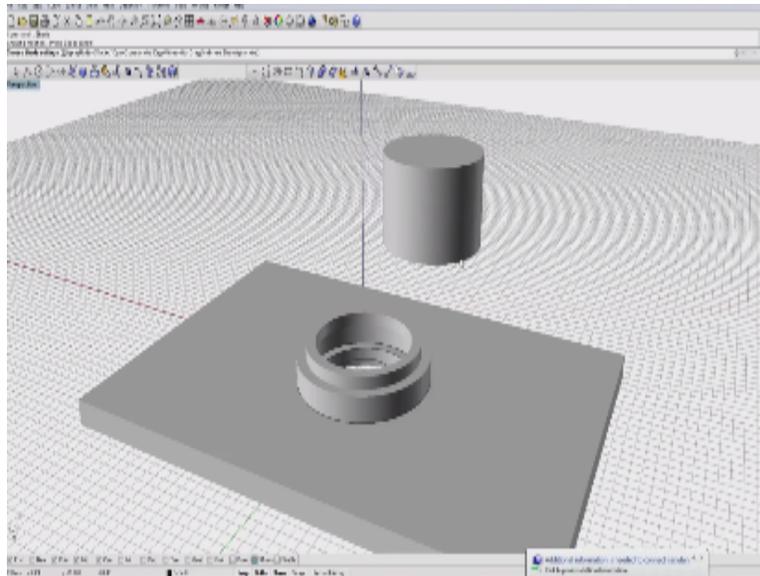
So, we have 0.6 mm width; 0.6mm width here. Now, same thing about the building up the layers, if they say the layer resolution is say some 0.5mm, make at least 1 or 2mm like this. A device, what you call thing like this prints continues very well without any problem, you seen this here know prints very very extremely well. Since, I have not union date, I still have an option of playing around with it.

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And see if I can make this hole through, I am just completing that hole there, see I have an opening here, this is probably know what we wanted in we have achieved it, there is no problem at all, I have a beautiful object with an opening like this and once again know, same consideration what we have; generally, would like to have a smooth surface. So, having built up this inside know, we have a little provision here.

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When we see the cross-section we can try to make the cross-section as convenient as possible, so I will probably use this inside if you see I had this whole thing know, I will see if I can use it for creating one more thing here saying, I will create a solid using one more of this planar curves, I have a planer curve here and directly. Now, when you turn it over and see a similar type of a structure which I created that side.

Now, I have managed to create here, we have this here, oh, something is stuck inside, I will see if I can remove it, now the opening here, only the cylinder I can do properly, now I need to take the cylinder out and the other side and see, I have a projection like this here on the other side know similarly, I have a step there like that. Instead of depending on a chamfer, I will try to make a bigger and bigger these things here.

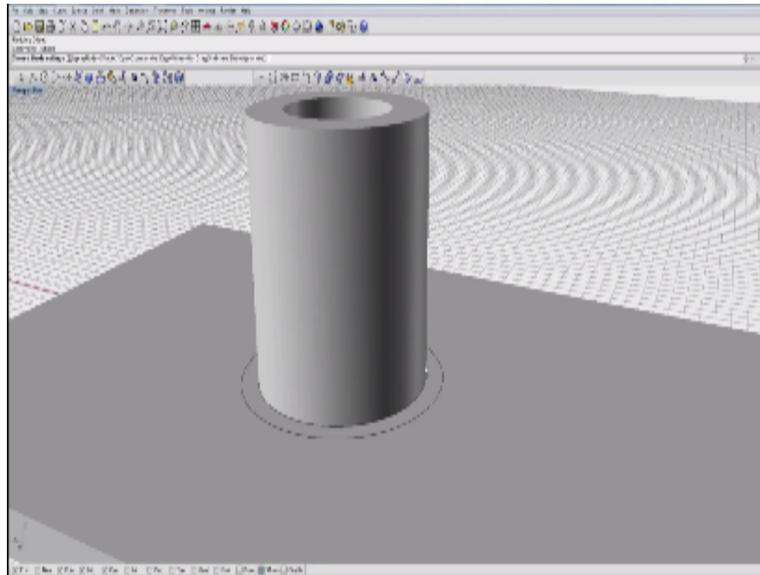
And try to just like have a structure here, I can have a similar structure on the opposite that complement of it right now, because of some my monitor problem, I am not able to judge what is happening anyway, let me check here, no, I have lost one of the objects which I have created, I am slightly better, I have this projection on the other side, then I have a depression here.

And instead of creating a full-fledged chamfer, I am able to make something like this, I can make it in further steps, so I will just try to go out and see whether, instead of taking it so deep, yeah, I think I am slightly better this time, you have seen this know, I can see what look like obviously a

few steps here and another side I have this and then whatever I wanted to construct know that cylinder with an opening inside, is an easy for me to now construct the whole thing.

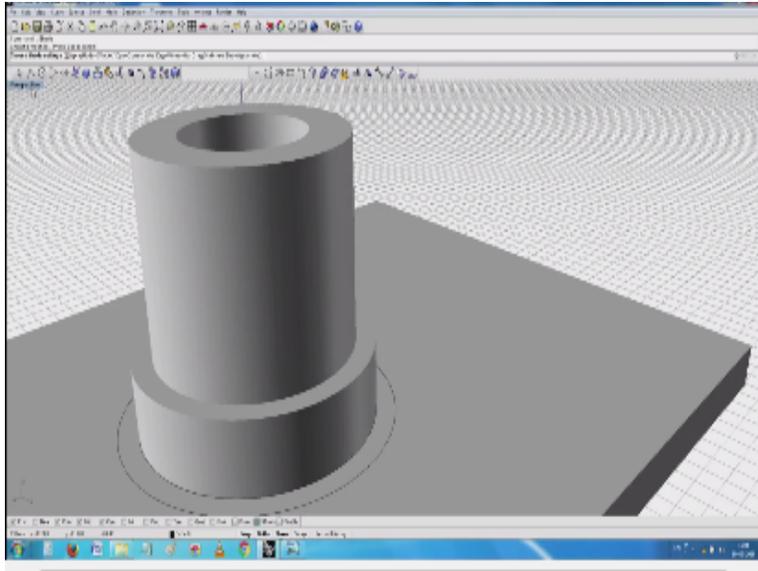
And then, this is the bass which has talking you about, the issue here is instead of creating a chamfer, so if I go back right from where I have started, I hope it will undo all the way back to very beginning.

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See, I started here saying this may lead to a little bit of stress concentration here, so some crack may start and all that I need to fill up these area, instead of filling it up with an automatic command, which I have already available for me.

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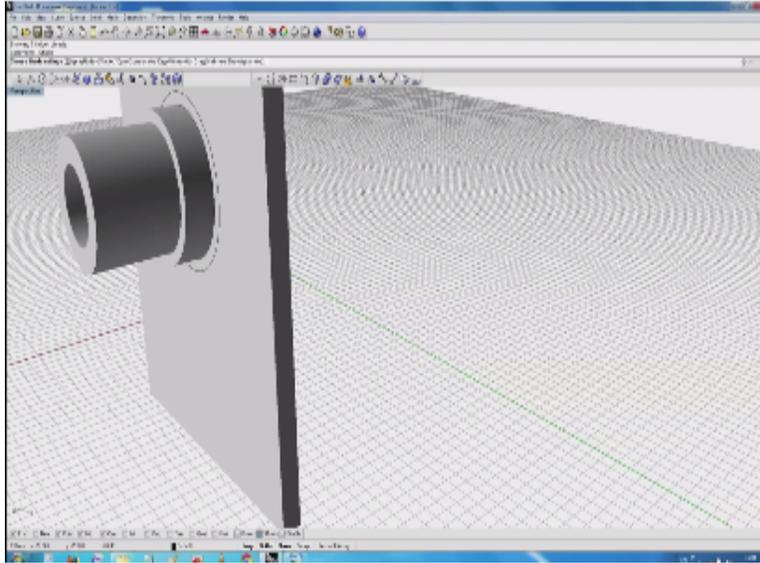


So, if I Boolean these 2, I have a beautiful command which will help me in what looks quite good here in convenient is unfortunately in the case of building, it is not very convenient, so I just wanted what I wanted to tell you is; I will try to make a small what you call, I have an edge here say, I take this curve, this curve and start building a thing like this know, features like this and even just a simple 1 and 2 thickness devices will be sufficient for me.

And on the other side, same way instead of it being projected out the similar object can be taken to the other side and if you subtracted from there, I have features which are relatively stable, relatively good, relatively easy to build, if you are building it like this vertically, from here know, right now which is being built vertically like this, there is no issue, these things will build very well.

Because the device will come here, do everything like that now, let us say in the horizontal direction and then it is covered like this, we end up with serious problems of material and so on like that there, you need to any horizontal openings the same thing imagine this was on the horizontal direction instead of being like this.

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Imagine now, this it is still tricky to build, so a lot of support material is there, a lot of waste material is there, a lot of other way for building it and so on is that know. Here, you need to make a little bit of what you call, you were on judgement and see how best you can do it and then, I will see if I after we got to the machine, will be able to show you all a few things, so for today let me keep that aside, I have come part of some way unfortunately, things are very rarely so clear.

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Saying, we have insulated part and then we have a conveniently printed circuit board and in this case, the cover of these can itself know an aluminium plate or conductive plate can come and clamp it and then seems to be okay, not true all the time unfortunately.

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Unfortunately, we also occasionally end up with things like this which are metallic components, have a metallic component here, I think all of you know what it is, it is a some power device, some switching device and then it needs to be attached to the printed circuit board and then we have a heat sink also here, so how do you deal with these things in rapid prototyping is; do it in 2 stages.

So, you have the printed circuit board, you do everything you assemble the printed circuit board makes some arrangement, you have here, now we have a small lug here which earlier was being soldered into the PCB, the same things which is being soldered into the PCB. This is integrated into the printed circuit board, we make some arrangements probably, make a small gap here such that it sits comfortably here, stand know, it sits comfortably here.

And then, we have also holes and the material can flow through that so, we have a printed circuit board which sits inside, then we have a heat sink which comes out and this is integrated with the that whatever build material we have. So, parts like this which have thermal or electrical functions somehow, we need to make provision for us in our model like that saying, do I make grooves here, when the printed circuit board comes here.

Let us say this comes already attached to this here, we make a groove that it goes and sits inside, alternatively leave a gap, do not worry about the groove or anything, just leave a gap and ensure

that sits here. So that the heat sink will sit outside, then we can have another cover over it and so on, so this is a little tough but it is little easy also, so I will just; this particular thing, I will just stop here.