Enclosure Design of Electronics Equipment
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Lecture - 25
Detailing in plastic

Hello. So, I am back. If you remember last time I left you about this making a enclosure using non metallic materials. So, we started with what was obviously, this sort of a things saying.

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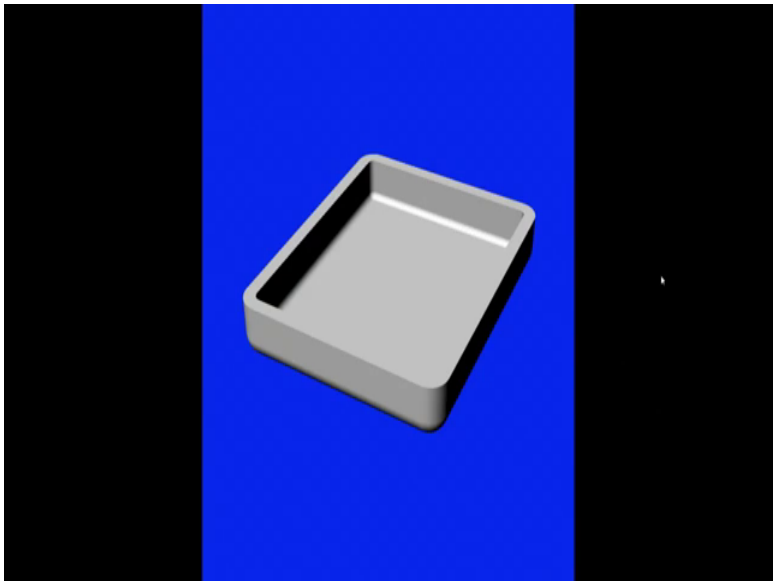

How do we make a cup this is sheet metal I left saying eventually we can replace sheet metal with nonmetallic objects.

Because we have the problem of insulation, and problem of cost, problem of weight problem of a sealing and other things are. So, you see here while this has been addressed at some level at the sheet metal point of you, and sheet metal always depends on bending on the edges and then what happens the corners have to do and all that that was the big 3 acrobat files which I have shown you.

Now, we will come back to how can we make this an plastic. Plastic I mean generally something which is made using a nonmetallic material.

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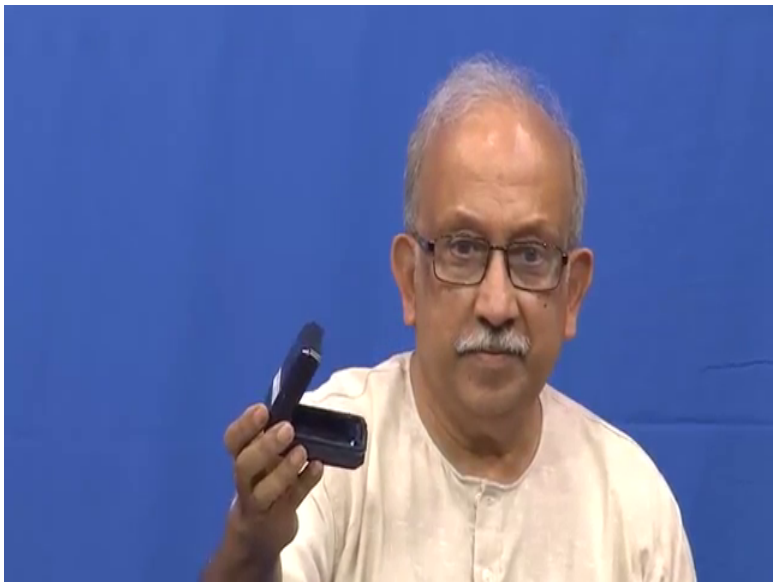

In this case I have my hearing aid case have to them of in fact, saying one has all these edges which are made to look a little different in one fully rounded, and then if you see the amount of detailing because it is an expensive thing the hearing it cause a lot of money depending on which part of the thing and whether you have insurance.

So, extreme care has been taken to make sure that when we open it, it opens clear I have maximum amount of space, I have space here for keeping this small batteries. So, the batteries go here and then this is how it looks like; then I have place here for keeping the actual hearing aid. Now this whole thing has been made in a non metallic material and for some what you calls detailing and semiotics they are all made to look like this. This is not a replacement for metal it is just that it a it carries certain meaning and all that why they make this things can also be easily rounded of.

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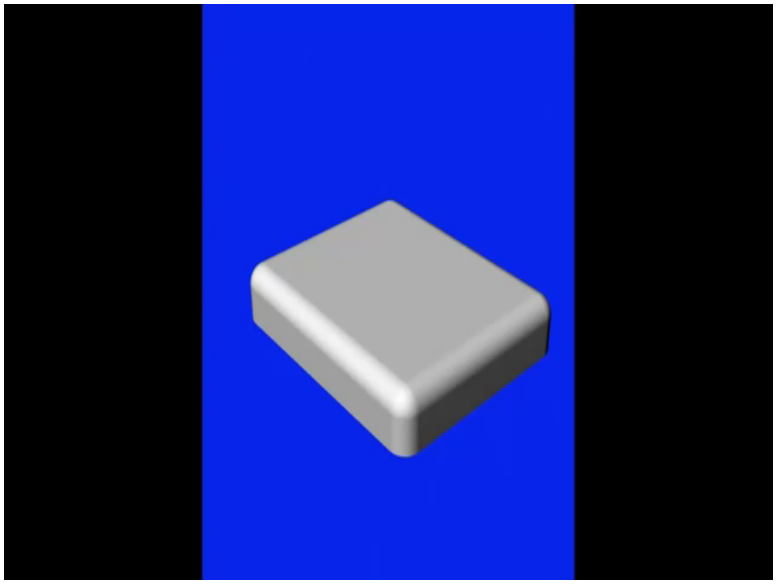

However, when you come to a piece like this, it looks fine from the outside it looks fine and you have all these what you call corners and all this is slightly better corners are better. Only thing is if you want a actually make something which as fully rounded corners like this you involve having to make special deep drawing tools, deep drawing tools are compare to the thickness of the material to make it like a tube things cost money.

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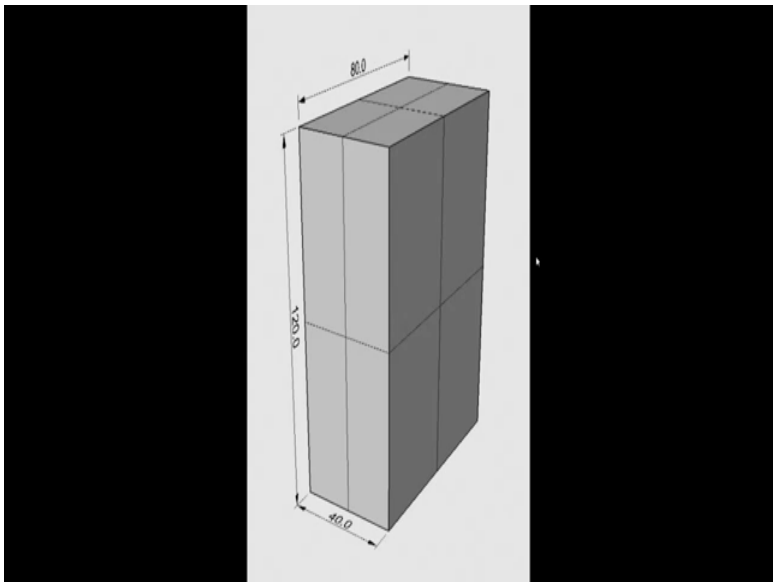

Now we will start with another method by which know by which we try to make.

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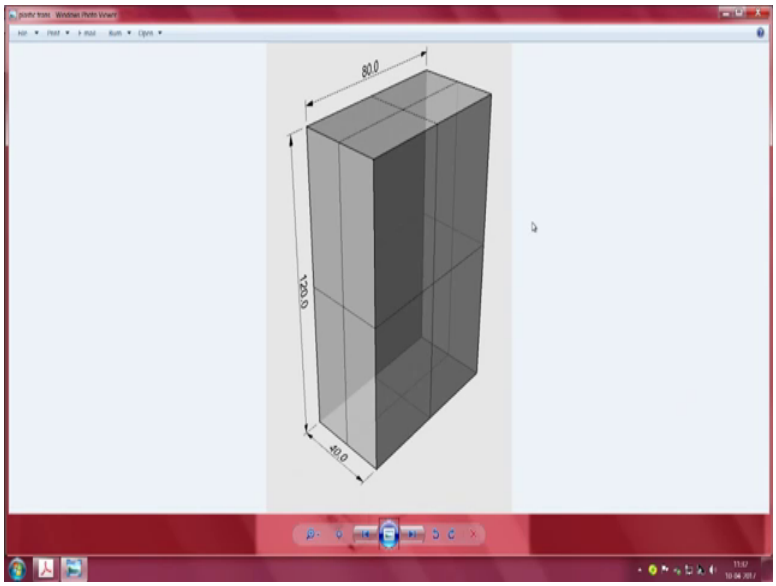

These, what you call a enclosures using the same method as if we would do of working with card board or sheet metal. So, I have started with the hypothetical case where what you say one dimension of these box around 40 millimeters, the other is one 20 by 80 more out of convenience than any this thing.

So, you will notice that we it has invariably all the 6 phases which you can think of. So, one simple way like what I shown you other way is probably to make I will call this left side phase in the front, and the right side phase in one sheet of plastic or card board similarly take the one at the back, that one at the back the one and the top at the bottom and then you have to use and then you match the use together. While at one level it is you will notice that bending is still not possible and you a ended up with these how do you treat the edges.

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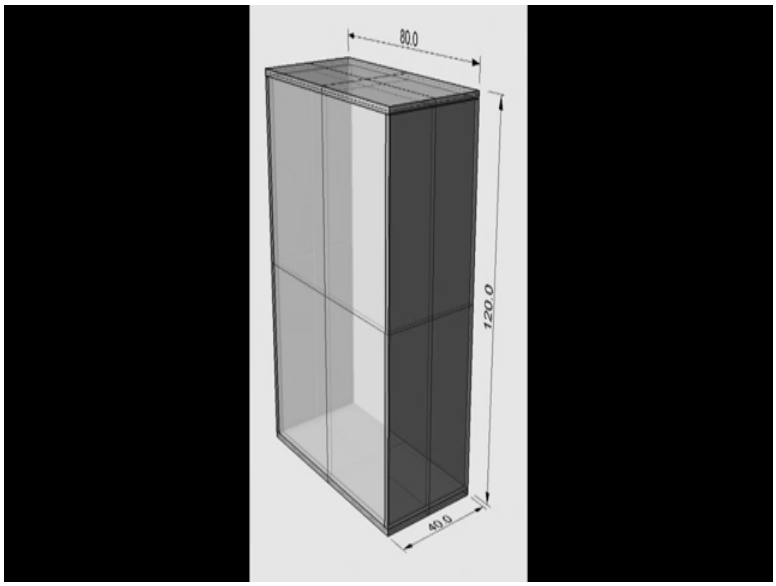

When I started know very conveniently in this drawing, very conveniently I have ignore the thickness, you have seen this 120 80 40 is the final object I need.

In this case are I have taken the external dimensions where then if you wanted to internal dimensions you can also add the thickness very conveniently, at the point at that starting point it tried to avoid this confusion about the thickness.

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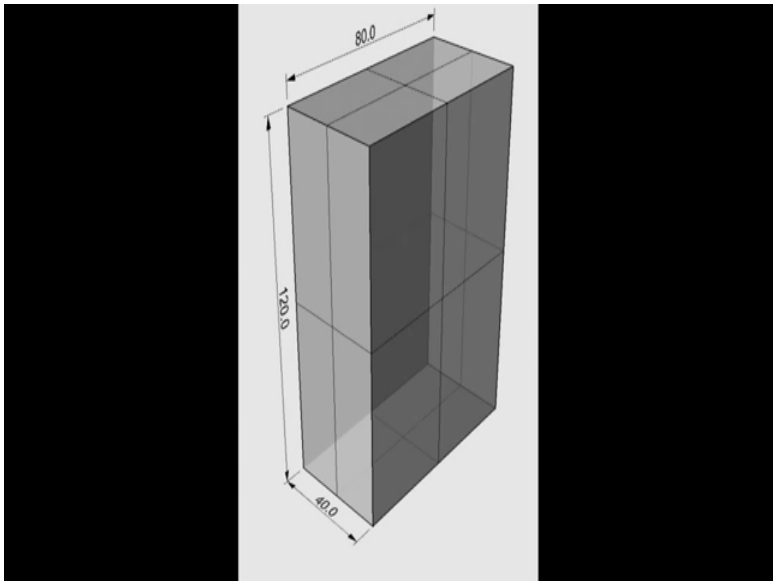

Now when you look at this drawing one of the first thing will notice is obviously, corner needs some over lapping like this. Understand only with this overlapping things will join

like this, and in this case that is small white edge what you see is a high light that is generated from the what you call the rendering program to make this things visible. It is not automatic features of the plastic materials are to use.

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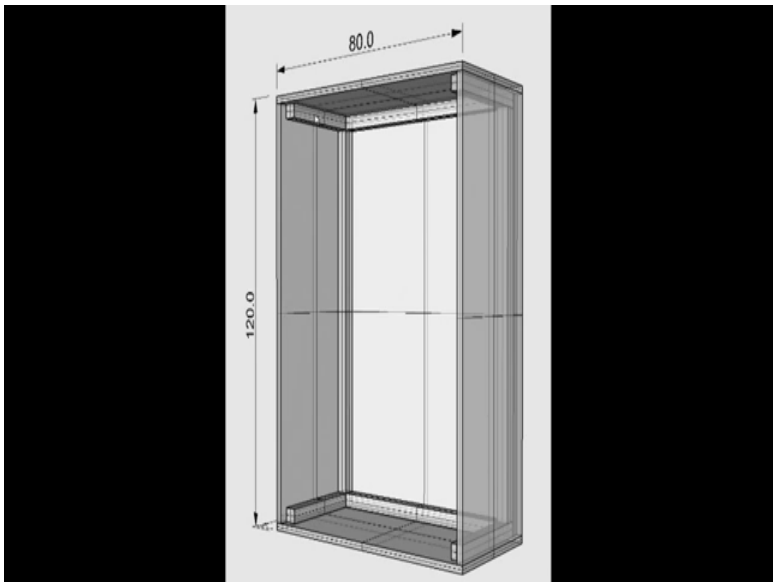

The next slide will show you in case you want to make this a load bearing enclosure you need to probably a reinforce the corners you seen that the corners are reinforced using small rectangular pieces of material, which will ensure that these two things joint together you have a lot more extra space to join. This is exactly how infect if you look at a injection molded piece probably the corners are supported any injection molded piece whenever you have to joints a corners are supported with that now you have see this.

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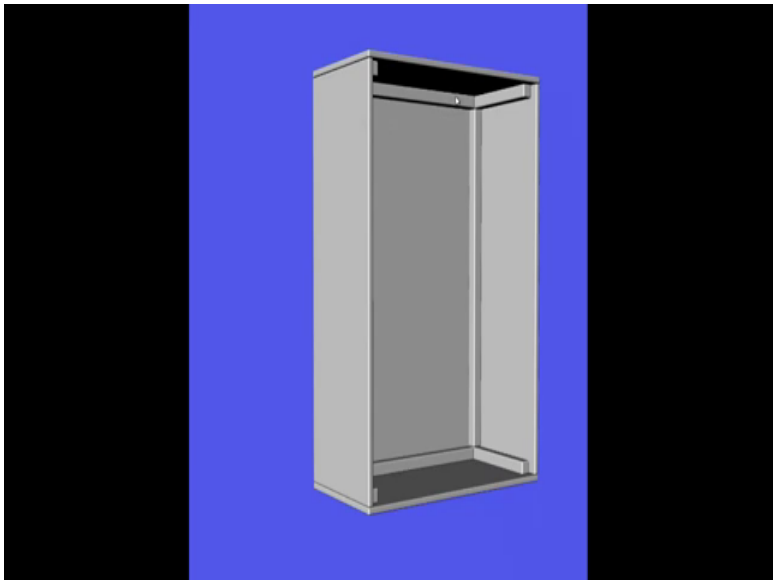

The next slide will show you a little closer view of the same parts, if you see close every edge and suffix nothing here you see in the bottom corner very very interesting details is hidden here. What is the detail hidden there saying those members what you need if you need to have them touch in the corner, you need to take a decision of front saying which are the edges which need to be covered fully, which are the edges which do not need to be covered fully and so on. So, when you come here you have this beautiful corner here.

The next slide will show you the outside will probably continue to be as it is, but for these I have deliberately given a small radius here. So, that it renders properly otherwise it will render it has a small thing now having done these.

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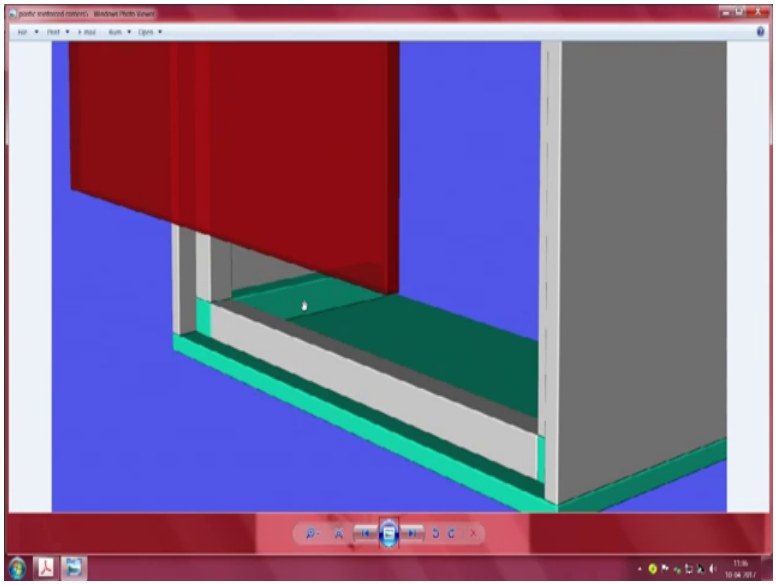

You see here I will come to a corner here, you will see is a very interesting detail here in the corner. The previous slide we have talking to about you take a decision of what fits where, in this case the green representation is for the bottom phase with two of this green corners that are joined here. Why do we need these corners has have a explain to you need them for the strengthening of the corners, and then subsequently I will come with something and then one more I was telling you up front you need to worry or you need to design the corners, you see here this red piece represents either the front or back cover.

In this case it is rare are the bottom cover which will go and sit exactly in the corner here, and wherever two of these materials joint together it is possible for us to use some adhesive or the other, and for further strengthening we can probably use some other fastening devices, and which here comes the small what you call surprise. You can probably even make all these reinforcements in the corner using metallic or any other different material, it could be a an aluminum tube. An aluminum tube will be much stronger only disadvantage being that we cannot directly use an adhesive you to join it.

Now coming back to the type of plastic and things are conventional acrylic and I have sample here see typically.

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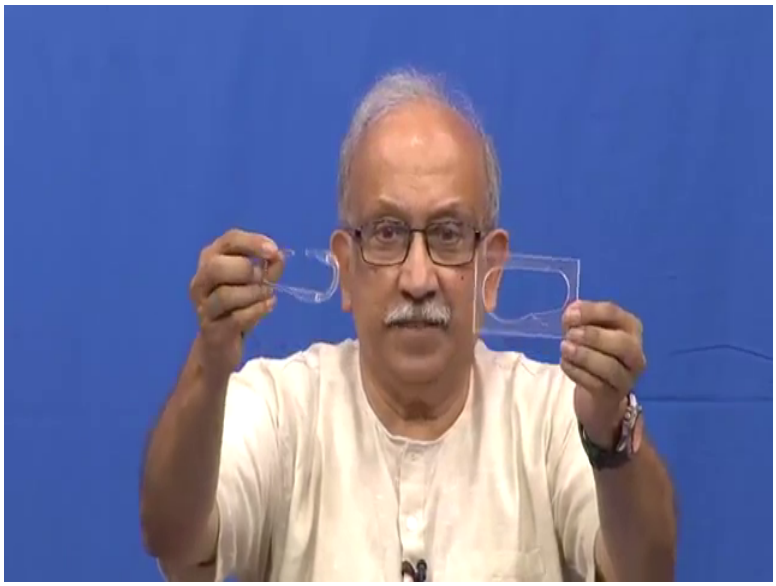

These are all a acrylic samples and I have other samples like this.

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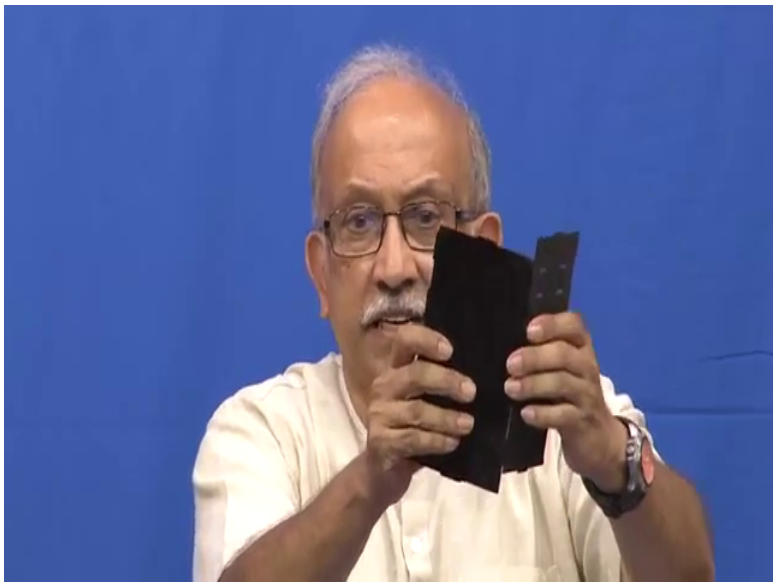

So if you see all these things they are all made with different types of acrylic these thing stick well by dissolving them in a solvent typically in this case it is a same chloroform, which is used to save our lifes seen this nicely I can put one next to the each other and then this is where now I would like to say we try to show this are. All these joints wherever we want we just need to introduce a little bit of that solvent here stood.

So, what was generally made there this gap unless are done by special laser operations, usually a gap will come the movement the gap is there edge all you need to do is put a little bit of the solvent hold it in this same position and then eventually that dissolve well and join. Now is a solvent only solution knows you can use any other thing typically these days people tried to use cyanoacrylate. Cyanoacrylate has some limitations one of them is both these surface should be flat and they should wet well in case both the condition are not possible you can even use any other polyester adhesive. You would have seen. So, many two two component polyester adhesives you can use any of those things.

Next slide as I showed you this is the detail which is there now you see there is a nice thickness of the rare plate the thickness of the rare plate will exactly sit here and then it is possible for made to make it to practically one piece by joining everything together, and then I have a nice enclosure in which I have the bottom member, in have the rare member, then I have these reinforcement also. This is about as good as a molded

enclosure only thing is very laborious and depends on skill skill oriented and if you are a designer probably your energy is better spent in designing for other features whether it is enclosure whether it is thermal or whether electronic engineer.

Or, in case you are an instrumentation person or if you are chemical engineer you would like to concentrate on your basic knowledge not about how to put these things together because somebody has worried about them.

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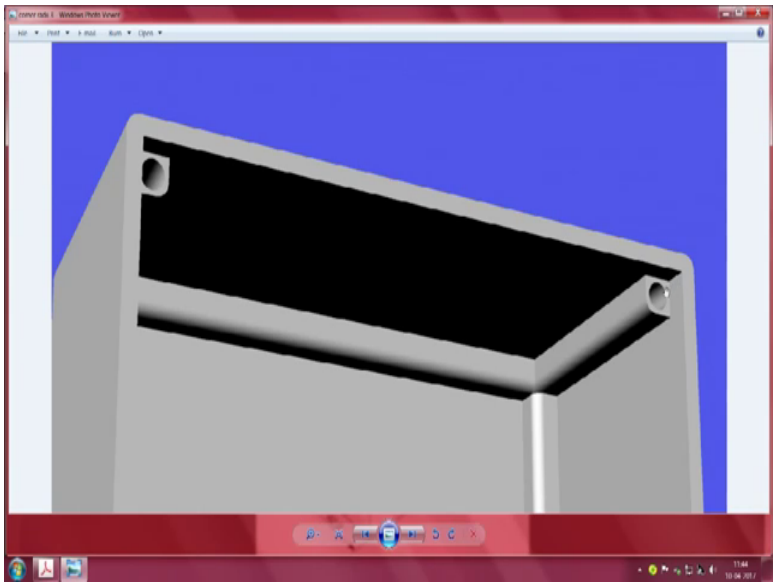

The next slide is going to show you some enhancements we can do in the corner, you see here oh this is a beautiful something here you seen this. So, the mechanical engineer thing it is called filleting. What does filleting does is whenever you have to joint two surfaces like this joint this outsides surface when this surface and this surface or this surface and this surface you fill up the corner this is typically used in the case of castings it is also in the case of welding and so on. Main advantage being you have a tremendous amount of strength and weld that can take place.

And this is exactly what is followed in the case of regular injection molded plastic. This only shown as a matter of what you call saying it is possible to do, but in reality it is not possible to make things like this. In extreme cases where you want to simulate that this has to be passed to a person was doing the molding, you can probably do it by taking a piece like this putting it through a milling machine or what you call through a routing bit

and then try to make a profile and make it sit here and after all the operations over re milling it to make sure it looks a little like the original.

But the reality is probably you know more like this, see what is done here is that filleting has not been done this filleting has difficulty to do and we have a sharp corner here. So, you can still make use of the sharp corner, but however those edges which are visible outside do not have too much of a purpose except getting in the way and do not add to this strength and all that. The filleting in the previous thing was required because this if you do not fillet it in the mould this is a good point for a crack to start forming. Crack not by any other thing whenever soon stressing is done wherever change of section has that chances are the crack will start. So, imagine there is a force coming on this trying to pull the part apart then the crack is likely to start here.

So, in that condition that filleting is required, but however, in our case in the normal case you very rarely do that. So, what people do is the take this long members and using either normal sending or using in a memory or using some other thing some other manufacturing process, they try to round of these edges. Once it is there now you join these now you have a member which is about as strong as you can imagine now you see further things can be done you have seen that I will draw here attention to this corner you seen that this center of this know are a little they try to follow a little saying you maintain a same uniform thickness all around. If it for a molded piece this should have gone a little inside because this outside thickness and our reinforcement also are available.

So, this can go a little outside. In fact, the edge of this circular feature can touch this edge here and touch this edge here and you can make things which are much more when that you see material inside. Now you see here this is only for purposes of illustration I have shown you these things.

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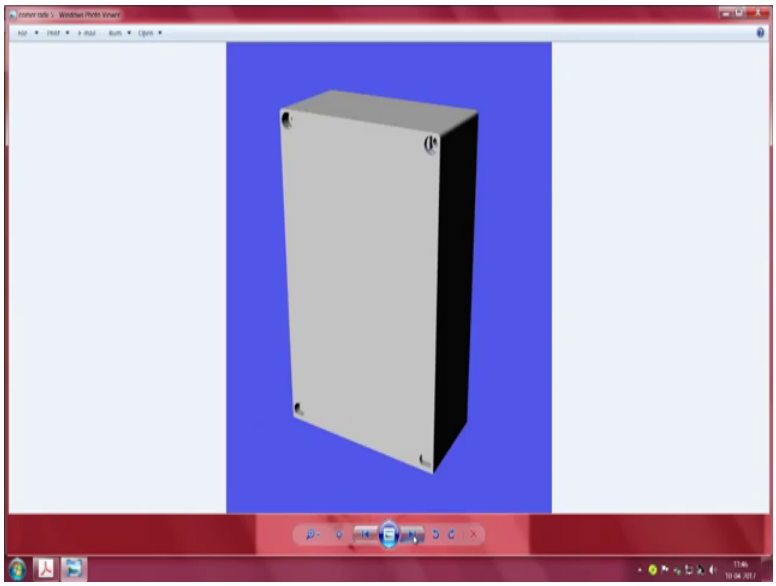

Next slide will show you if you carryout those openings directly it in other side it almost look like a regular molded box, that hole can be drill through probably you can hold it properly in a milling machine, the moment you do this the other extra very nice feature you can notice is if you put a cover and drill through the whole thing and then you put the same reinforcement on this edge, you can probably put a screw here and then hold things together.

And to get over the problem of this being a soft material and then it may not be amenable to threads being cut in it, which is called tapping you can even put a steel insert in to it that steel insert will have threads which are made out of harder materials. So, we have this object now you see here the completed object. Now it is more convenient for us in intentionally I wanted to show you corner how this is your seen this if have member here in my thing I have not taken sufficient care. So, you see here this seems to be visible here. So, get over this problem probably it is much better to make the whole thing in to one what you call homogeneous material and do this last part of this formation there is fabrication process this is called a Counterbore try to make the counterbore.

So, you make all these gussets you put all these things and then you put the other reinforcements make a pilot hole and after that use a milling cutter and end mill to make this nice things here. So, we have something which is as good as the original material we

have chosen with and ready you see here. Main thing is you can follow your heart's content all the design which you are talking about.

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Now, will draw your retention to every common thing I would like to acknowledge the whole the manufacturer these items are items like this are available of the shelf and

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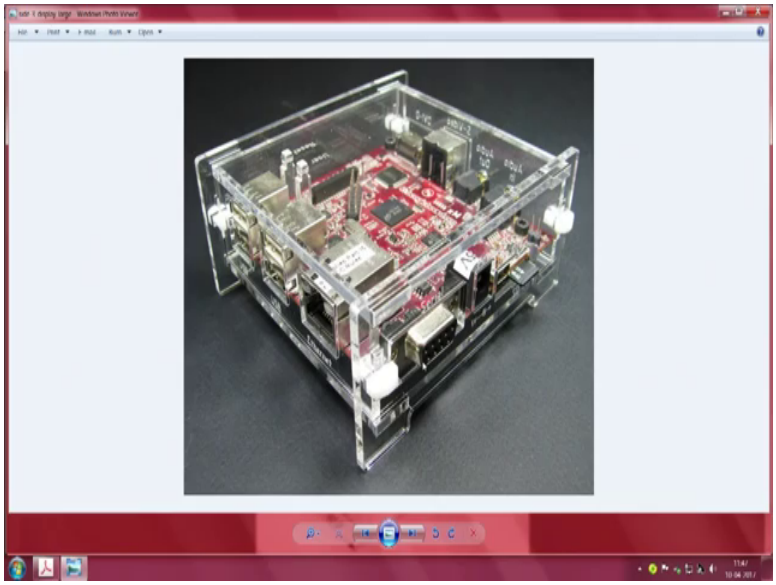

Usually some of you would as seen this also, you seen this very beautiful.

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I like such thing bit of it a lot of reality. Reality is if open source software is available why not have open source hardware. So, beagle board started with this saying you buy beagle board and then you have of course so, many of them, I do not no all the names is one of these early things know and you see here fantastic word the beagle bone they have played very nicely on the loveable beagle and then a bone with which it place. In this case in the case are the open source hardware there talking about hardware which is available after the I mean off the shelf then why not the enclosure for it also open source.

So, I will go back to the beginning and start where it is all started see when we have enclosure like this available why not we also start building things to our requirement and in fact, the very word open source they have ensured that all the plans are available, but then like you it is not easy, it is a highly skilled job to get this things working. So, we will see a small difference between that using adhesive for the corners compare to this type of a construction.

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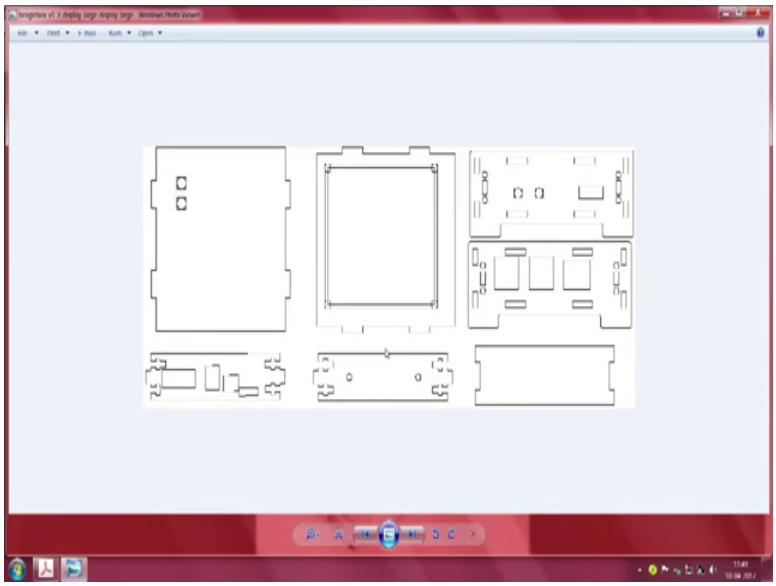

You seen this one are plans for trying to make the whole object from a flat condition.

So, I like to show you we have all this beautiful plates, one thing what you notice is planar thin planar plain. Absolutely you can you see I mean you may not be able to see the thickness that is how planar they are and this can be this is probably 1.2 millimeter sheet. One of the simple ways is trying to make one fit in the other like this, understood I have two things here is you can see the offset either I took fit them inside, and then I try to bend them, and then if I have a proper end piece will fit see here, and somehow hold all of them together before the fall a pad and make a permanent adhesive I have a beautiful box. I will say beautiful enclosure with all the limitations of this is only meant for a prove to type for the proving the basic technology this may or may not be suitable for you for all other thing including the index of rotation classes.

And then can be made with any material you see here I have a beautiful shiny material, this is probably acrylic for this can be done in normal style in you can also do it in polycarbonate so many other materials are there, advantage being everything if design properly fits miraculously.

Disadvantage being if it is easy to put together it will come up are as easily unless it is a very space great component. Now how do you get over this problem? So, several method are there you see here there is a small detail here in the corner this all looks this looks this looks this looks except this small detail here I will try to see if I can go back.

Now if you see carefully this small picture which is given by the manufactures, this is the same thing what I tried to show you. Saying one part goes it the other little bit of an extra projection except in this case while this edges are treated in one way these two sides are made to fit each other in a different way.

So, I will show you another of these examples.

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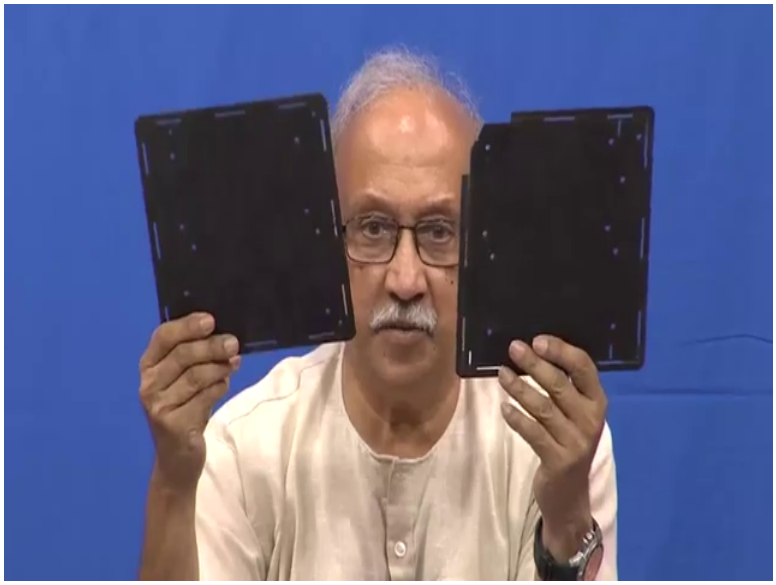

Please have look at this- you are seen this small gross in this these gross the other those member go inside the moment the go inside and project outside the old thing of it coming apart will not be there anymore. It just will not come apart and then we also have a other detailing here there several openings you seen that know several openings here and there is another small key I do not know, and then I do not know if it is broken are actually it is intentional have they actual sample, I try to show you what it is.