**Physical Modelling for Electronics Enclosures Using Rapid Prototyping**

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**Lecture - 28**
**Product Clamp Variants**

Hello. Let me continue with the small issues regarding so called 3D printing. Actually 3D printing allows me to stress again has a lot to do with making quick prototypes or also called rapid prototyping. In rapid prototyping 3D printing has got the public attention because you can make things at home. So you can make things at home under several conditions. One of them is you have an idea suddenly and you need to check it out.

It is a little like earlier know people use to sketch and all that; a lot like that. So, every time you cannot what you call; start this thing; you cannot sculpture or anything like that; you note down points. And it started with actually a printer being available at home. So you can compose something on the screen and you can have text printed on that. Later on came Desktop Publishing, desktop printing became desktop publishing.

So when you want to publish in small number you can probably compose all the things and all that and then if you have a printer you can quickly make books. So it made sense and it was logical that we extended to certain parts like this.

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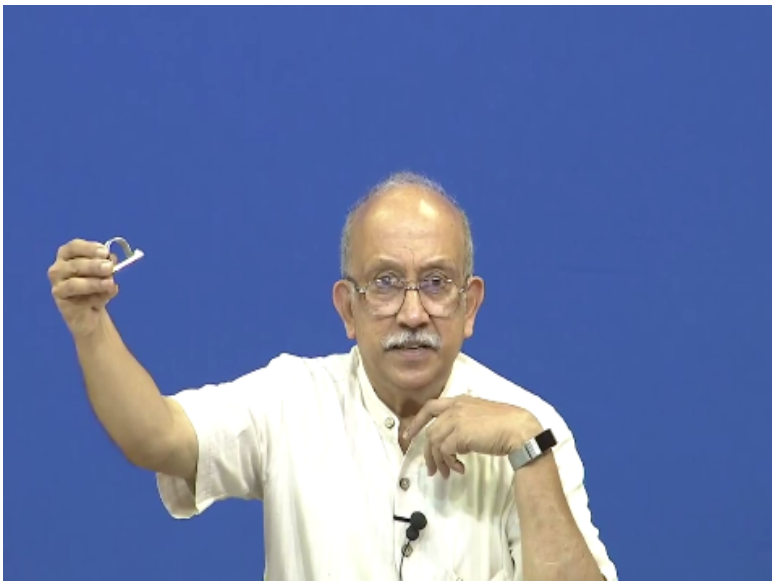

Now have a look at this. Can you see here? So you see here this is a very routine clamp which is likely to find for various plumbing activities. You are likely to find it in your office; in your kitchen; wherever it is; okay let me show it here.

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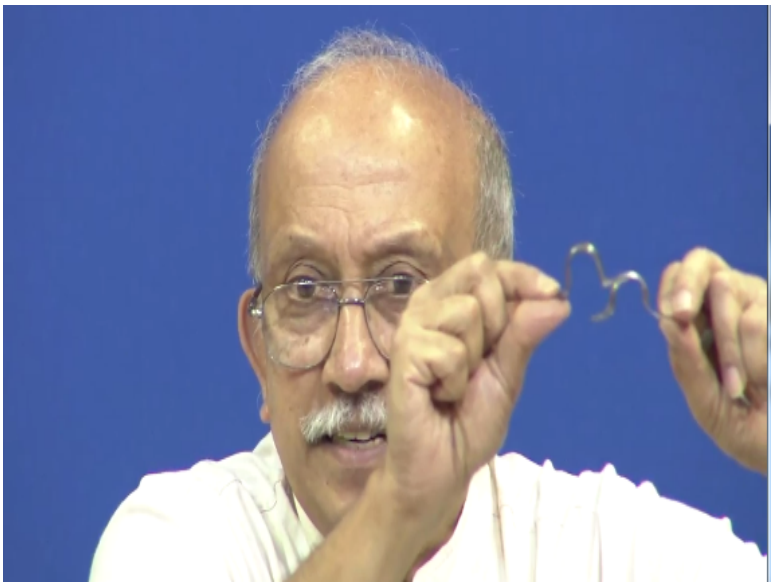

So you see this is a very routine clamp, not a big deal. And in fact this appears a little strong. I cannot bend it. This appears same thing a little weak okay, a little weak. And I have a same clamp about the same dimensions that all with a small variation in various types of detailing here. Can you see small detail is there? And one of the things you see is it is thin extremely thin. This is only probably 0.6 millimeters thin.

So let us say, you need to make some new novel item. So you need to have an idea of what is the purpose of this clamp. And then you see here there are holes drilled here. Can you see here, small holes are there, okay I will just put it here may be you can see it here. Then very critical about the holes is center difference between the two holes. See in this the center distance between the two holes; size of the holes and equally critical is this diameter.

While these are all well known not what is that well known is that; not all applications; it will the same. You see here; there is something here; it is much, much deeper than the other one. This one is this deep; this is very deep and you see the location of the openings also here. If you see the location of the openings they are not actually in line, there is a small offset of 1 diameter. Why it is happened and all that I will come back to that later.

Now let us say, you need to get this piece. This is where 3D printing makes a fantastic advantage for you. Seen that know; you need not around what you call ordering things or waiting and whenever you order things while things are available it should turn out that they are not available in either the material you want and finally the quantity minimum quantity and lead time for it. Now you can go ahead and print it. Please have a look at all these pictures which I have gathered.

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Yeah. See all these beautiful pictures that are available off the internet without any problem.

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I just did a casual search. You see the amount of hits I got and what is otherwise know a very routine clamp; absolutely a routine clamp. And I am sure some of you are familiar with this.

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You need not be what you call bike enthusiast but you will know what it is. Obviously, there is a round tube which passes through. See this is the tube; a tube passes through. Then here something to hold it together; this part of it is okay and then you see here the most critical thing is; he has given a wedge and a locking lever. So this is typically what you can get for adjusting your seat height in a bicycle. So now the thing is absolutely no issue about it.

Anybody can make and this is probably available of the shelf; and first time you will discover that they are very expensive well designed ones where you see there is a gentle curve it is not straight and all these are expensive. Now our issue is; can we now make it; can you now do something and make such things. So we come to the starting point; most important starting point is; what is the function of your part?

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See here, this is a very simple clamp except that it is not the U type clamp which I have shown you. So it has a purpose maybe you have some hanging this thing and then to the edge of another panel or anything this clamp has to take it. So in plumbing we have seen our tubes not long ago everything was made in lead. Then it came with galvanized iron. Then after that at least in some parts of a USA and Europe they use copper. I do not know why it is used.

Some reasons copper seems to be it; mostly because it is easy to bend and you can have full waterproof; drip proof connections which you cannot do with any other material. So no lead, copper is available. Now everything is replaced by PVC. So we have high molecular weight and then various things and all. So these clamps also large number of them are available large number of these clamps are available with this thing.

Now from here allow me to jump to my other monitor to say how we can;

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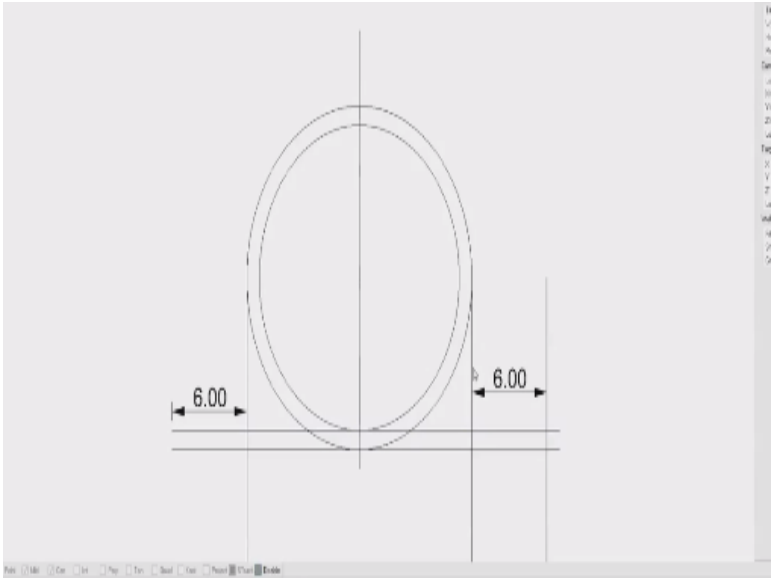


I hope you are able to see. This is probably the starting point of any of our designs. So I will try to undo; get back to where I had started. Yeah. So the starting point is you need to have a circle which shows the item that is being clamped, quite easy; drawing a circle is easy. So, if you know the diameter and so on. In my case, I also have a grid. So using the grid I have been able to create the object. Then, after that comes, I need a thickness of the clamp.

So this is a little bit of what you call search and if you already have made a 3D print, so you know the thicknesses which typically can give you, whatever this think. So after getting this now, we need a place in which we want to clamp the tube and then the same thickness continues. And then I need to make two radial lines here. So far I have; you have seen this—this become to the critical point saying, this is part where our design starts.

Now, using actual dimensions, I have a 6 millimeter place here that is going to be a fringe. Now you will notice that if our pipe is going to sit here, obviously this needs to go up a little. Hey, no, I think the original one was only correct, because the pipe sits here.

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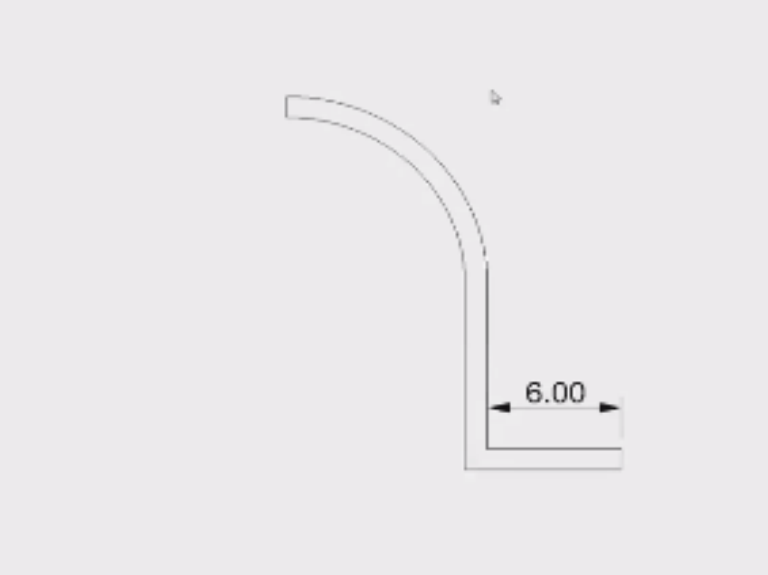


Now, we need to find out how thick our part is going to be; a reasonable starting point. Again I will see what I try to do here. Let me allow me to go a little faster. See, I am already there. I have this; see it has got itself conveniently developed. So as I build one side; I will now say what best I can do here to say, half of my clamp is already ready. So depending on the method of manufacture and how well the software handles these things. One half of the clamp is ready.

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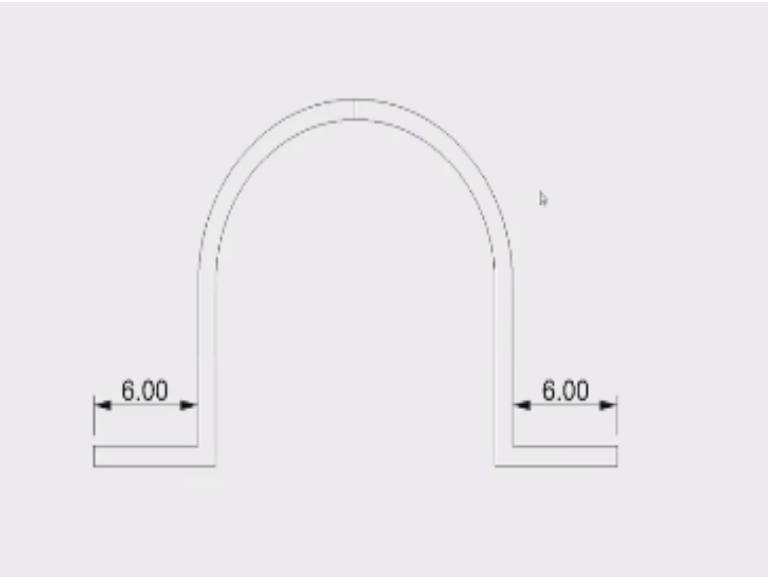


And this I think now I expect there is some resolution problem hence know, that line does not look okay; but it is okay. Now what I do is I try to mirror it. My clamp is ready. Now from here onwards you know; I need to worry a little about the how strong it is going to be or how it is

going to be. So you see here I try to just copy an existing object which is their in; being used in a similar purpose.

Then whether there are some enhancements we can do on this and how it will reflect our prototyping. So one of the simple things here is, you see here; these lines.

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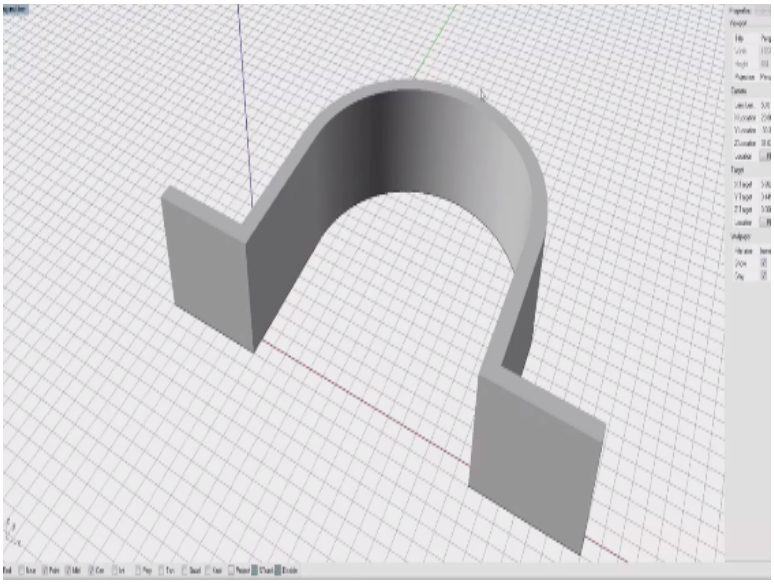

I will join the whole lot. Before that I need to do a small formality of exploding all this. Then, you see here I have all the four curves joined into a single- what you call single entity which is a polyline. Now what I do is, I take this and see whether I can build a solid. My clamp is ready. Now we come to one small; I do not know whether to call it an issue or whatever it is saying, do we provide a hole at this stage or we try to do something else?

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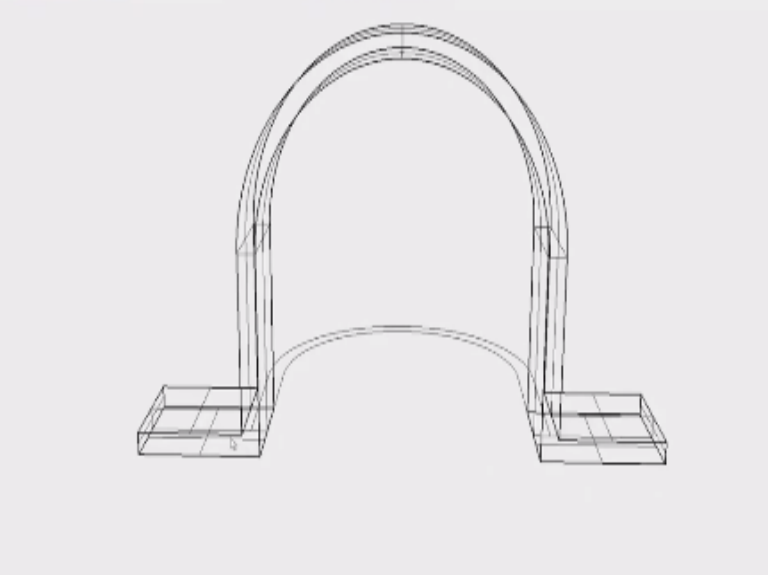

Now the thing being, if I orient it like this and try to build, it has no problem absolutely, chances are it will build properly. Then in this point now I can provide two holes here and these objects build itself without any problem. Except that while building depending on the machine and depending on the structure and all that normally this will be printed without any issue and it will keep printing straight also.

Coming here and taking this depending on the resolution; depending on the type of option and depending on the height chances are lot of support material or the main material maybe used up as a support here. And so you may have an object which leads a little problem. So now obviously, we can as well go back to the original thing where it was lying on its side and if you try to build it like this probably we are better off it.

It builds very well and it just keeps going up, builds well. Only problem being that if you provide holes here, because they are opposite rather you know, orthogonal to the build direction; we may have a little problem. Having now made this part and then if you try to; how to tell, try to use it; one of the first things you will notice is that it is probably not strong enough. You need something which is a little stronger.

Now kindly go to my other monitor in which actual objects are there. Yeah, if you see here you see various objects here. When things come out of plastic, they need to enhance the products by providing some small bit of additional supports. You see this here.

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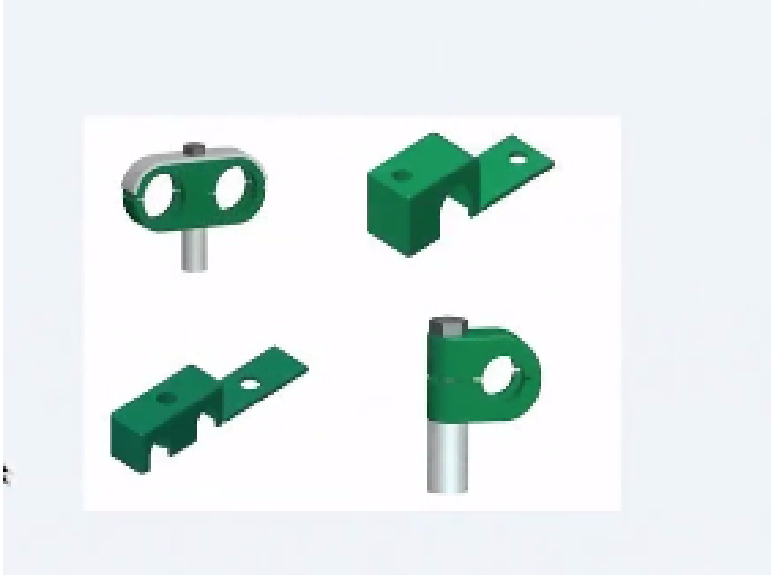

So, have several objects here and way you need to build it. This of course is probably a CAD representation hence it already looks like this. And you see here; there is a center support here with two objects. There is support on one side and one object here, okay. Then, there is a single what you call pipe here; same thing related a little to that is two pipes here. Now these things look convenient and are relatively easy to make.

Now comes our thing you know, we have to need to take a decision saying, what is the function of the part? So if you have.

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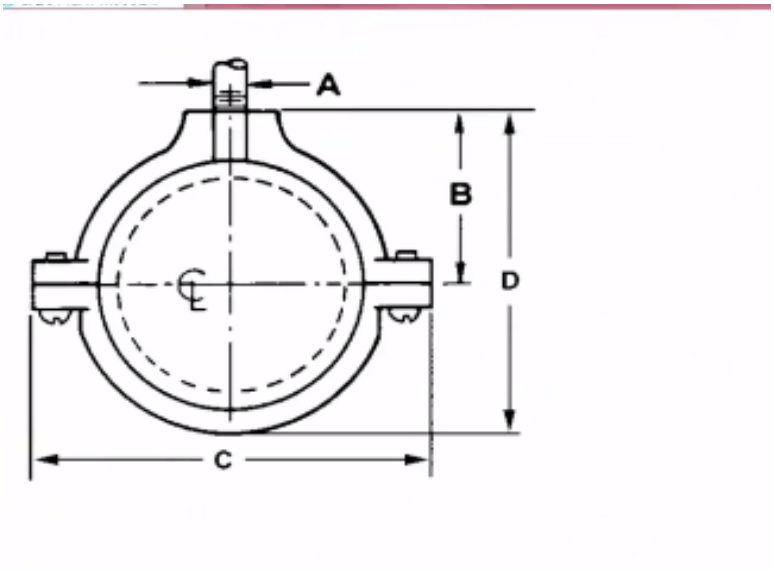


Okay it is some drawing file; okay I have got the drawing file. So if you go to the manufacturers or anybody these are almost generic off the shelf offerings which you can get in all these dimensions. Which is the center line, which is the clamping line and then you have a thread depending on all these dimensions are easily available without any problem. Now you will notice that if you want to make an actually physical part lot of strength is involved.

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You have a look at this; you seeing this here. So various things which I can only understand a little; we have a something which is gripping here and we have a flange here and two of them are there. I am not very yet clear as to what is the function of it. But you will know now after having

spoken about it. This thing is for mounting; this thing is for tightening this. Objects like this; one of the things you will notice is it is one single solid very conveniently built.

We can easily build these things. You understand know. Then, there is a probably an elastomeric sleeve. An Elastomeric sleeve has been pushed inside and this is clamped. So with this, we have an object which is reasonably easy to print. And you need not go searching in the market. And especially with certain things like tubes and pipes some tubes and pipes come with inner dimension mentioned about it because that is the fluid carrying capacity.

So I have half inch pipes, three quarter inch pipes then 1 inch pipes or in case of millimeters we have 15, 20 and 25 mm pipes where the inside diameter is fixed. The gauge can vary. Now when the gauge varies you need to make this outside. See in this, got my point know saying, things which have which carry fluids normally have the issue of being specified with the inside diameter and usually any jointers; any links and all that can actually go into a 20mm pipe.

So it does not matter what is the outside. However, this clamping arrangement insists on the this thing. I will now close it and go to the other things.

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Now you see this very interesting thing. So a beauty. I am not exactly sure what it is. It is obviously some clamp of some sort and something else you know, saying do not use the torque

more than 7 Newton meters. And you see here; there is a slight offset from this to here or whether this itself know is probably a thread which is partly formed here and partly formed there. See this detailing here; there is something which I can rotate it and mount something else.

Things like this; there is a little bit of common practice because obviously the diameter is fixed. And this diameter is also fixed and then all these things have been done. Using your intuition and using this thing it is possible to keep extending on these objects.

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See here, some more of these things. And this is something interesting here. They have provided a floating ball joint. These whole assembly; assembly like these are very convenient for us to make it in rapid prototyping. You can create this ball; leave a small gap maybe 0.5 or 0.2mm and then put a support and afterwards if you insert something and then you know twist it you can easily snap off the support and you have a perfectly ball in spherical socket.

So I have a spherical socket then I have a sphere and then inside know I can have anything including a hexagon and everything this whole assembly can easily be made into rapid prototyping job. So you have a little bit of detailing here. Can you see? I am not very clear whether you will be able to see; whole job; one shot will come out of rapid prototyping. You remember this?

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Now you see these things. Even in real life even with plastic protection we need to work on strong parts. So if you were to have a small workshop or something or even if you have a simple strip it is possible for you to bend the strip and then give this packing so that it can be made into this.

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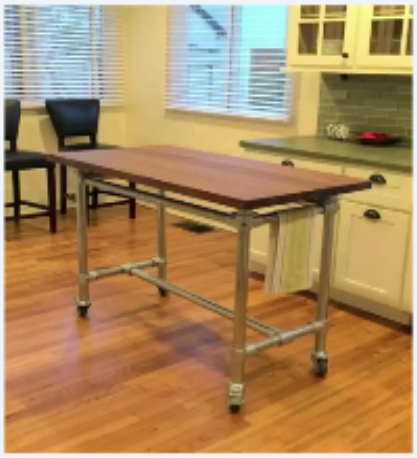

You this, so these are all examples.

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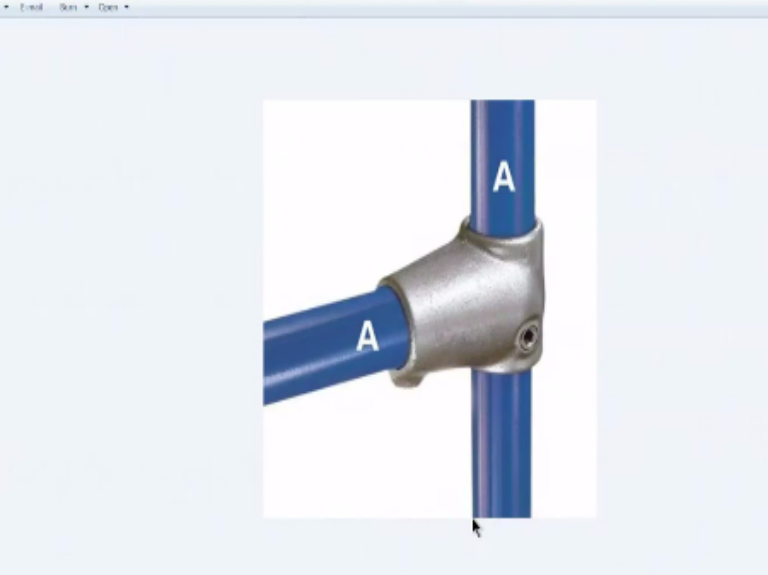


I will get back, you see here. Now can we make it rapid prototyping? Yes, and also no. It will not work under all conditions as a load bearing thing. But, if you are making something to quickly demonstrate to somebody and how strong it is a very much possible for us to make it. So you see here, such beautiful things and then in fact they have made a shelf also. A full fledged trolley has been made.

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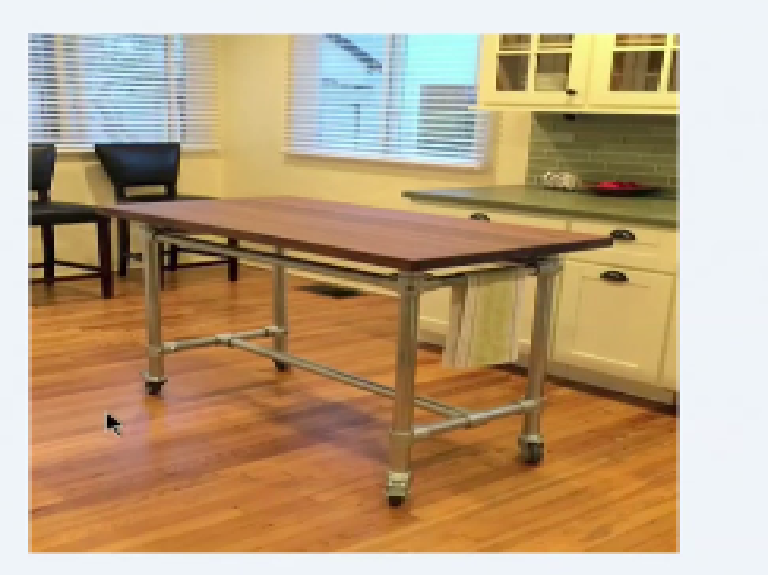

Okay, this uses metallic component and probably by proper redesign and so on, you can always make these things. Here, right now, one component, one component all these you can probably integrate together and make a rapid prototyping or 3D printed object. See I have started here then

I showed you all these then I came back and showed you this. This is very much possible for us. I will stop here. Now madam, if you connect me to this monitor on the other side.

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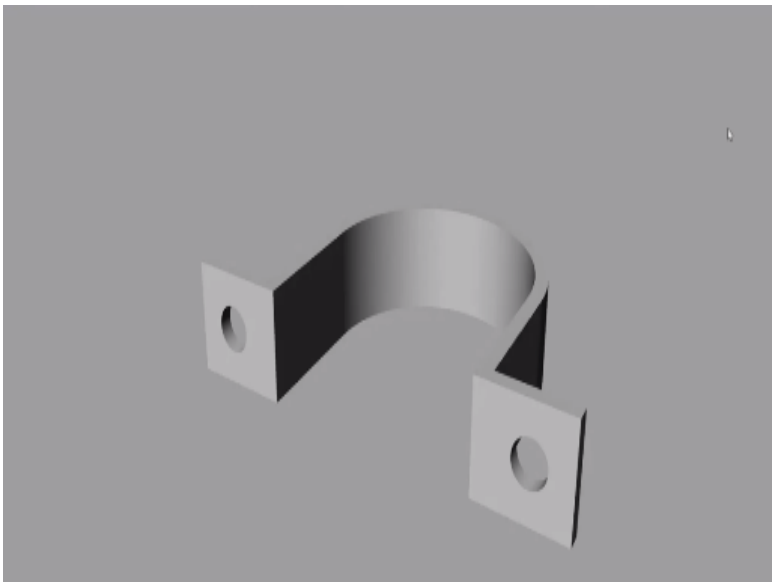

Please have a look at it. We have come to other thing. Nominally, if I remember I have just used a 1mm thing here. And now I will see if I can create a small cylinder. My object is ready. It was very easy. I started with a very nominal diameter then I added a little thickness and I have completed the object. It looks reasonably good. There is absolutely no issue about it at all. And then if I Now, if I can try to make something here.

See here I can rotate it; examine it in all directions and see everything. And unlike in the metal construction I can add a little more; small things to this which will make life little more convenient and easy. I will see whether I can do that now here.

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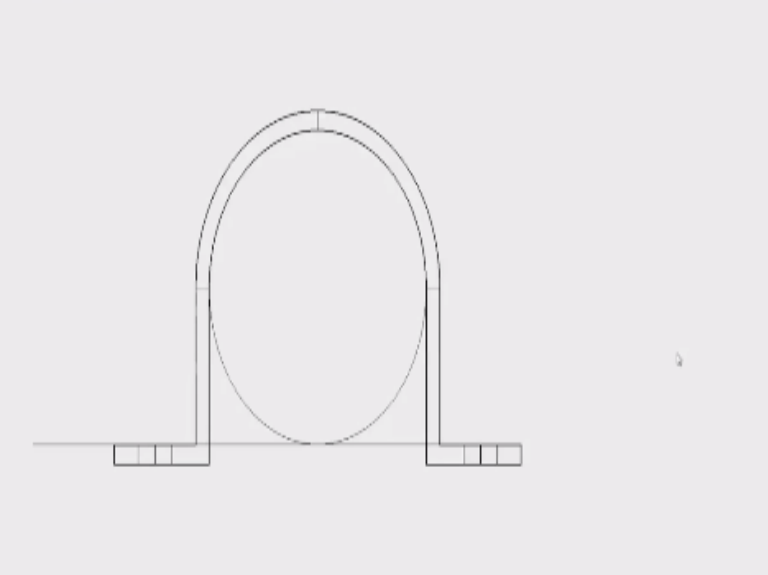

If you remember, we started with a circle here. This is the center of the circle and this is the object which we are trying to clamp. And this is where I had made a mistake at that point. Let me not admit that it is a mistake saying, where does the object sit. Now you see that the object has a small elevation. Is it needed or not, what is the purpose this is where maybe I can now take a call on that.

So let us say this is already carrying a tube and I need to clamp it from there and when I remove the clamp the tube should not fall off which happens often or anything. So, right now what I will do I will try to remove this and I will see, my original construction, see the original construction is still hiding underneath here. These are all lines. Now see here the bottom substrate, it sits very comfortably here. Now it comes here, whether I can add small things here.

Because one of the things is while tightening this may break. Now it is very much possible for me to let it go inside probably back a little material here. I will see what best I can do. If I were to give here a small step like this, I have a small advantage in this. Saying, first of all, it has strength and this corner without compromising on any of the aspects of geometry, fit in geometry so that, after I push it inside here it is very much possible for me it gets located on the tube.

And then I can move it horizontally, saying. Madam, if you can show me the; this main camera again. Show me the main camera.

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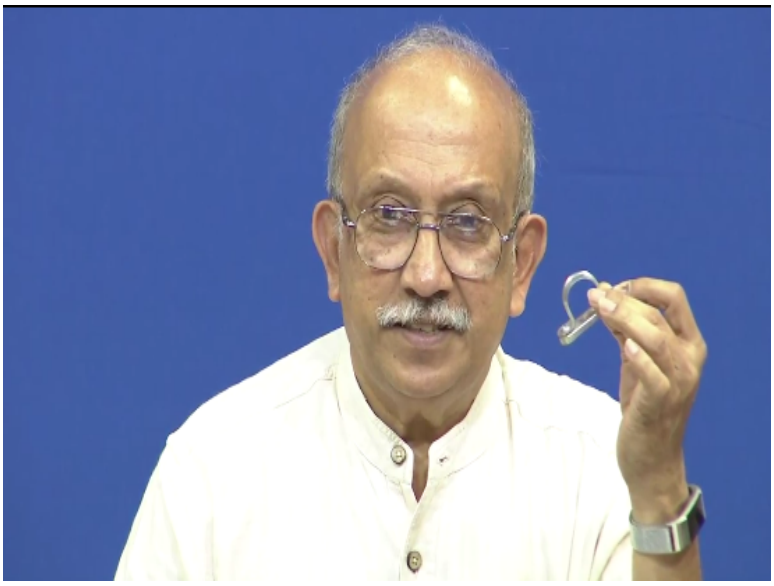

You see here, this is typically something which is used for fixing our conduit wiring. So it has two parts. One part of it is; I have this which is fixed already on the wall, okay. This object is already fixed on the wall by anchor bolt or some other thing role plug. Then my pipe runs across after that from there I put it and move it; I am sorry it is a reverse; and clamp these two screws it is in absolutely.

An object like this; is it possible for me to do something and have it built there. This is where I was trying to do. Now one more thing you will notice is there is because of the wanting to make it rigid they have given a small dimple like thing. And then you see this dimple; it is not a single one and in fact two of them are there. See this there are two of these dimples and both the dimples end up here and there is a radius here. I will not say it is a trial and error object.

The thing being it has evolved over few things. See here, because of making it, insisting that strength is maintained, while doing the drawing it has curled up a little. They have left it as it is. Obviously, some function, more than the function, it does not get damaged; this is fixed on the wall. Now, can I do something and replace these objects by rapid prototyping system. Things like this, where we are trying the concept at the first stage, it makes a lot of sense.

Now you see, as I told you, the thickness is very, very small. The other sheet I have shown you is very thin. It is only 0.6mm. This is slightly better; probably this is around 0.8mm. Still we notice that it needed to have stiffness; it needed these two dimples and additional operations. So in the machine shop or in the fabrication facility when you want to make thing like this you have a sheet which is running onto a tool.

So depending on step repeat type of things you know, whether you make punches here or whether you emboss it first and then you bend it into the shape or you have a tool with; when you feed the strip in one shot, it does this forming and then you probably first need to put a blank, put two pilot holes and then in the next stage the whole thing is formed. Problem is the tools cost a lot of money. And nobody is ready to make any small changes in that.

Let us say, you want 200 or 300 pieces; there is no way of making something, it is just 200 or 300 pieces.