Enclosure Design of Electronics Equipment
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Lecture - 41
Understanding

Let us start with if you are to do yourself you can probably be searching for those nuts. I live in a matriculated world. What I meant is, we used the standard full fledged millimetre metric system in all over engineering practices. In our case we use only metric threads, metric threads has certain proportions which are probably not the same as used elsewhere in the world, including I do not know the only thing that I can think of is probably the US, which uses unified national UN threads. Some of them come under UNF some of them come under UNC, but you should remember only the thread pitch designations are generally standardized. And a very large variety of nut dimensions are also available, including height of the nut in the case of this if you see nominal Pitch is M 3.

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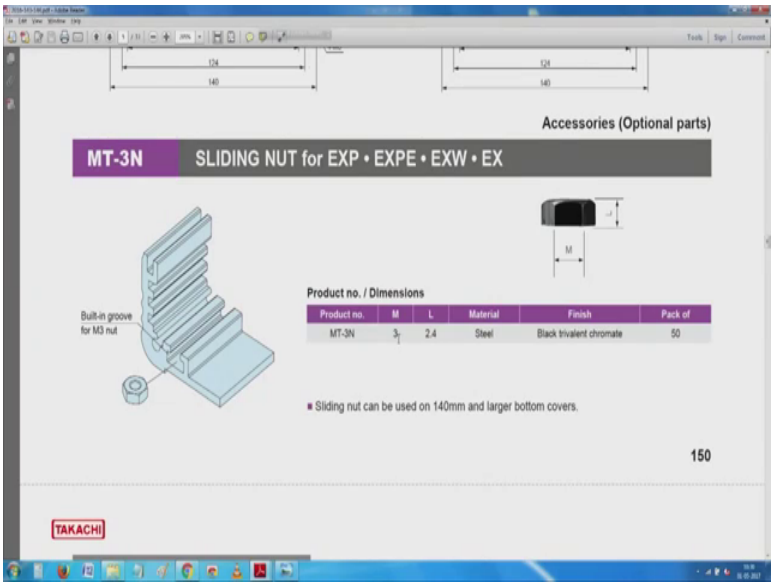

And then the length I am sorry, I do not know why the length, I will call it a height, height is 2.4 millimetres.

If you go back and check things varying a little above and below are also available. And then very critical thing is the size occur as flats here. You see here it has been well adjusted such that the size (Refer Time: 01:52) flat sit is here. And occasionally instead of just a single nut, you have a tapped flat. The same thing you have a rectangular tapped flat which has threads which are tapped inside. So, once you push it inside you can assemble things wherever you want. It is a little more convenient compared to going around you know looking for where the nut is placed. Again positive is we know very well our well known I do not know maybe misinterpreted murphys law.

After having got everything correct if one nut cannot be found you are back where you have started, in those conditions probably you know there position the nuts using a fixture of some sort, you understood it? Looks a little like the plate whatever plate you want to mount and all that. And inside that all the material is removed it is recessed. So, using this you can push the nuts into the proper places you want. And it is not optimum if you are printed circuit board is like this.

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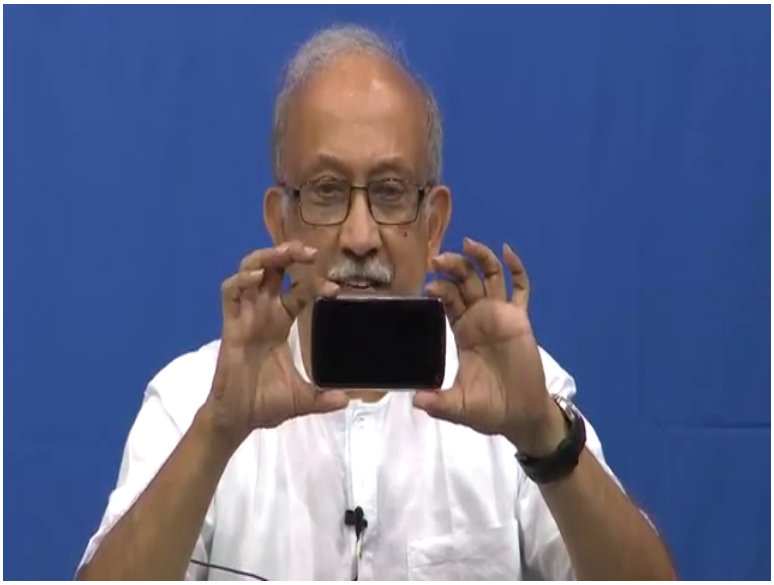

It is very rarely optimum just to stick 4 holes in the corners. It is a reasonably good practice. In reality it is a little suboptimum, that is what is called array points, which will make the overall bending minimum maximum bending will be the minimum when the

case of aerospace components and all that they just generally maintain 0.6 to 0.8 in this direction of the total length of the PCB, similarly 0.6 to 0.8 of the PCB width of the PCB. And have those fashioners assembled somewhere here. In those places an additional adaptor plate may be required for you to hold that thing together. So, there is a very positive thing about it. In the unlikely case of a drop or something, and if the corner shock absorbers are those elastomer mounts take part of the shock still, the total amount of bending that can take place will be the minimum possible.

If you mount out the things properly, so if you see the people in the aircraft or especially the spacecraft industry, they do tremendous amount of simulation and actual field testing, for that stacks of printed circuit board after they are mounted, they are all subjected to military grade test environmental test is, one of them includes giving a quarter sine wave shock and then also searching out for any resonances using a strobe. So, if you were to do all that life is not easy.

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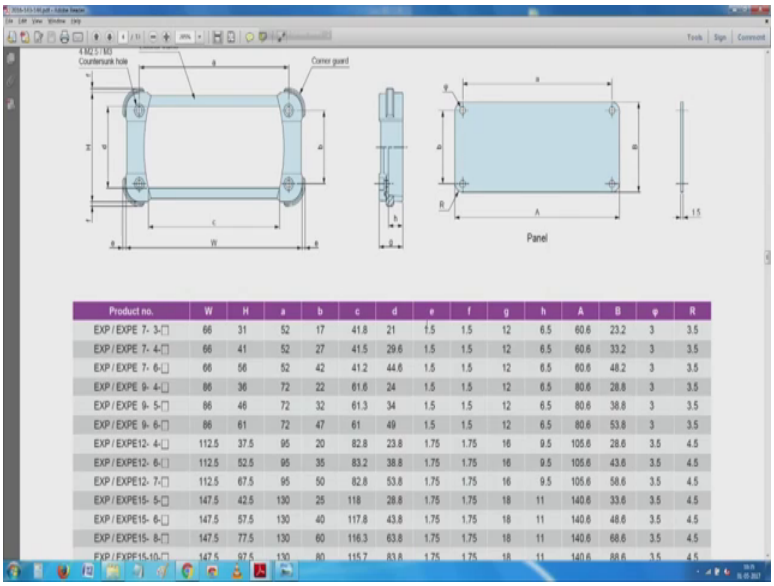

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EXP / EXPE 7- 4-□	66	41	52	27	41.5	29.6	1.5	1.5	12	6.5	60.6	33.2	3	3.5
EXP / EXPE 7- 6-□	66	56	52	42	41.2	44.6	1.5	1.5	12	6.5	60.6	48.2	3	3.5
EXP / EXPE 9- 4-□	86	36	72	22	61.6	24	1.5	1.5	12	6.5	80.6	28.8	3	3.5
EXP / EXPE 9- 5-□	86	46	72	32	61.3	34	1.5	1.5	12	6.5	80.6	38.8	3	3.5
EXP / EXPE 9- 6-□	86	61	72	47	61	49	1.5	1.5	12	6.5	80.6	53.8	3	3.5
EXP / EXPE12- 4-□	112.5	37.5	95	20	82.8	23.8	1.75	1.75	16	9.5	105.6	28.6	3.5	4.5
EXP / EXPE12- 6-□	112.5	52.5	95	35	83.2	38.8	1.75	1.75	16	9.5	105.6	43.6	3.5	4.5
EXP / EXPE12- 7-□	112.5	67.5	95	50	82.8	53.8	1.75	1.75	16	9.5	105.6	58.6	3.5	4.5
EXP / EXPE15- 5-□	147.5	42.5	130	25	118	28.8	1.75	1.75	18	11	140.6	33.6	3.5	4.5
EXP / EXPE15- 6-□	147.5	57.5	130	40	117.8	43.8	1.75	1.75	18	11	140.6	48.6	3.5	4.5
EXP / EXPE15- 8-□	147.5	77.5	130	60	116.3	63.8	1.75	1.75	18	11	140.6	68.6	3.5	4.5
EXP / EXPE15-10-□	147.5	97.5	130	80	115.7	83.8	1.75	1.75	18	11	140.6	88.6	3.5	4.5

That is all I just wanted to tell. So, you see here further kindly be patient with me as to why I keep repeating or reading from here, in between I have pointed out some things to you which are not included directly in the catalogue. But the once you start making you will appreciate that you know, why now they use this? Instead of calling it standard or

not you know it is not a norm it is not a something accepted by the industry or something written and all that, but then engineering has gone into a tremendously.

One small caution is, while at the bottom all these large number of EXPE some all these numbers and all that which are there are not readily available in stock. So, probably you have to start with a drawing. Try to understand how well it is and then one of the subsequent lectures I will probably put you on to a cad what you call exercise by which you will be able to appreciate, why drawings which are supplied with this are very, very useful. In case you cannot get the DX of IGX or STL files for these things STL normally nobody gives whether they give a PDF. Or they give a DXF or occasionally they give the AGX files with it.

We can use AGX files and all the dimensions everything which are given here can easily be taken from here. One thing which has not been mentioned is, they are not tolerances that are listed against it. Elsewhere in the document you will probably find it. Usually this is only a what you call a trade catalogue by which you need to start your design. But once you get all this information you can now get the actual things which is very, very critical about tolerances and all these dimensions, they have just like that very conveniently they have given Opening a by b - a by b looks 72 by 47 with me 130 by 80.

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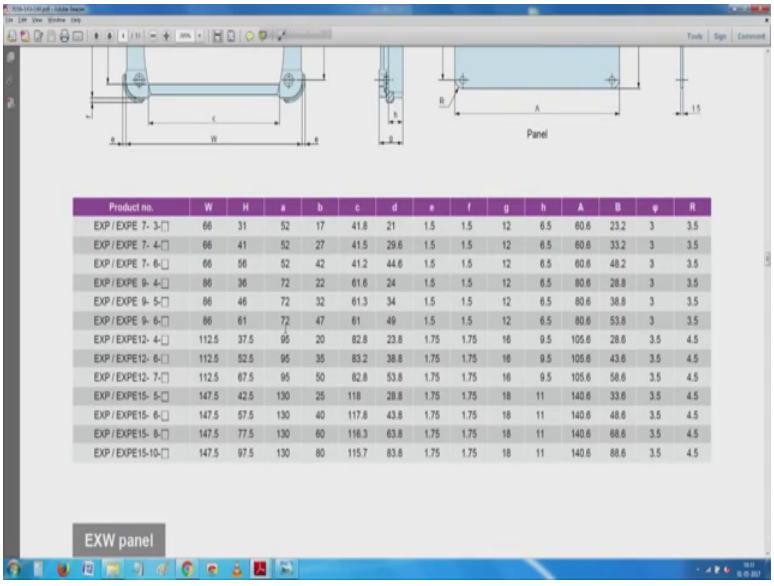

But we need to now work out about the panel. You have seen this minor variation is there. There is a frame and there is a panel which sit is on it. There is another panel which will fully moulded in a single piece. This is for some of you people who are not very familiar.

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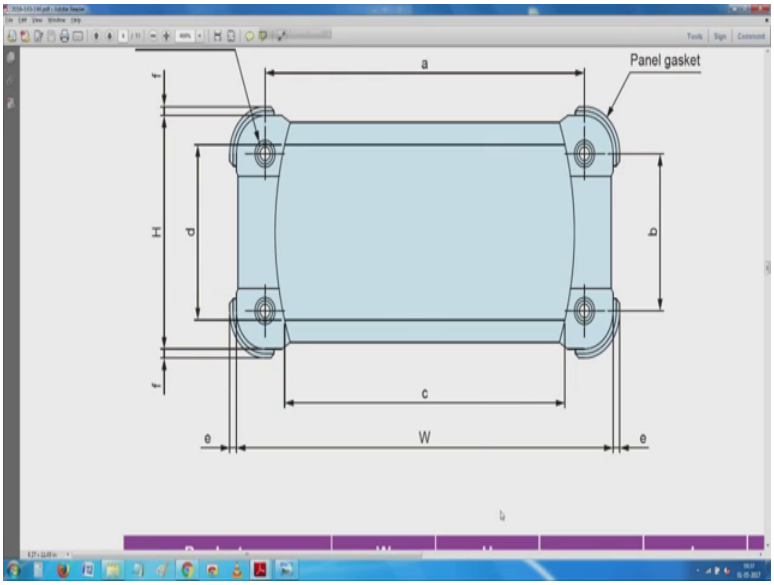

This is standard engineering practice of giving a half section view.

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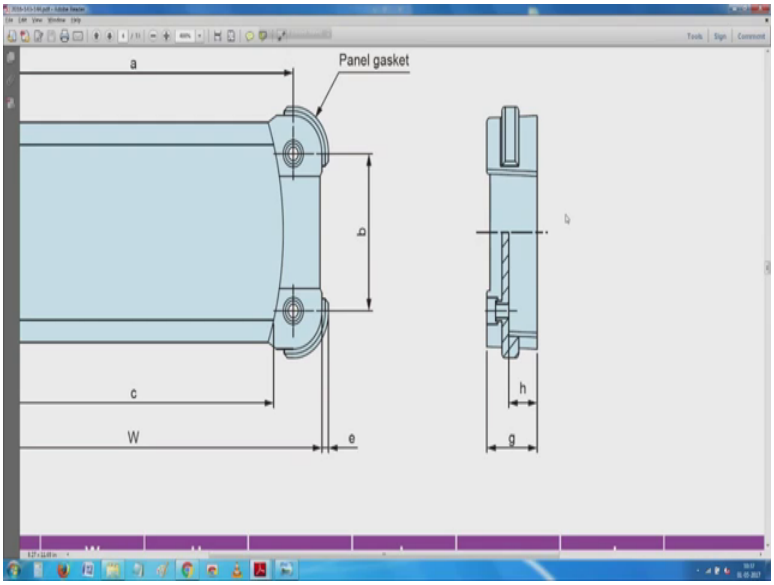

So, the top portion of it shows how it would look when you look at it from the because of symmetry given you look at it from here. And now it looks bottom portion of it shows very, very critical detail which I am happy to point out to you, have you seen it?

So, this it could be ABS as I said the variants of it know, but everything has been adjusted carefully you see this beautiful extra small projection which is there. So, if you are to use the standard fasteners which have come with it including the hexagon headed or l n screw with it ensures a perfect watertight assembly. So, all you need to do is carefully follow a sequence, assemble all the top and bottom parts together and then apply a sufficient clamping force so that both the top and bottom are exactly clamped like this.

You clamp both of the points together, understood this is the bottom is a top exact force you apply and then put the 2 end caps and then tighten the l n screws almost 99.99 percent of it, it will become absolutely waterproof. Occasionally there are tests carried out after this assembly, usually in the process condition to make sure that leakage does not occur so; obviously, one of the easiest way of checking it is assemble the whole thing when it is cold so that cold air is inside, and then maybe you can even fill it with air taken from there. After that immerse it in warm distilled water which is maybe 80 or 90

degrees. Then start expanding inside and then in case there is any leakage you will probably see small air bubbles escaping out.

This is not actually distractive or anything, it is just to maintain the process parameters what you need to do. Probably elsewhere in the document that have given you about the gas kitting lubrican not or gas kitting grease that has to be assembled. That has to be applied before assembly of this I will check in the come in rather. Both of us let us check the actual assembly practice. So, see here there is a beautiful panel here which you can probably carry out all the machining.

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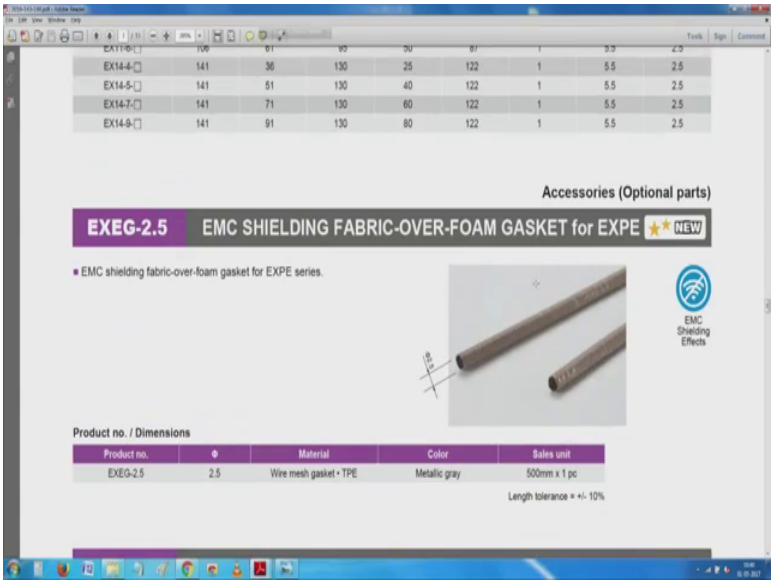

And then you see here most important is EMC shielding fabric over foam gasket. What looked very simple, and it is just a what you call about what look like a rubber beading, it is not just that much. You also have variants of the braided gasket which you need to install in it. And then you see this small thing one of them is it is made with some material TPE, I am not able to recollect exactly what it is. So, 2.5 mm diameter and it comes in a long length of half a metre. So, unit is probably the whole thing you know carefully made into one loop, very rarely they make it continuous loops or if you buy it in a bunch it comes in a tube with so many of them carefully remove it. And generally people lay it out with these specified as I said know in this case it is easy to lay and then

trim it to the correct length so that the top and bottom are fully in contact and then it also makes contact with the front and other thing.

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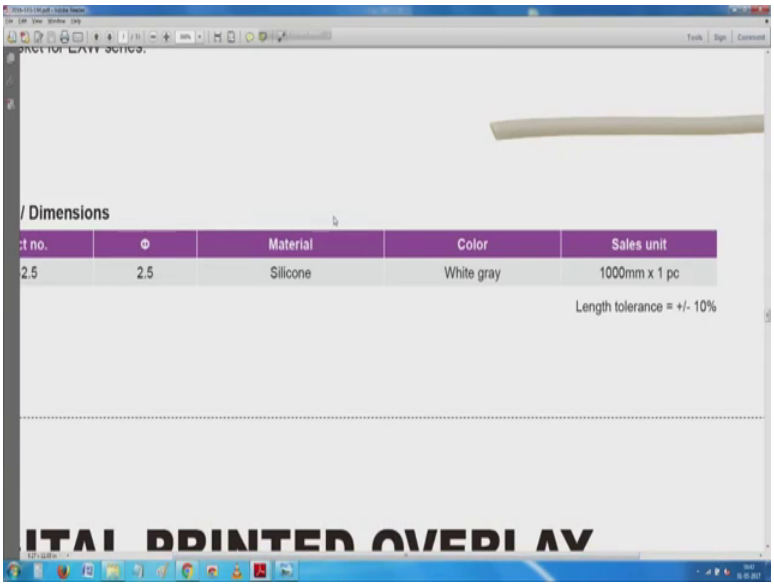

You see here while that is that shielded gasket with the braid. You have also the standard silicone rubber gasket, except that this comes in a metre length. And then you see here length tolerance they have given how can it be 10 percent.

So, if you buy a metre is it likely that you get only 900 millimetres. It varies because of the force applied and probably slightly also in the some environmental conditions, but I have no experience on it. You see the advantage?

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This is not directly related to the packaging which I was talking about; however, most people also give you their own versions of panels. So, if you can standardize your thing things like printing embossing die why new manufacturing process all of them are invariably available from the manufacturers.

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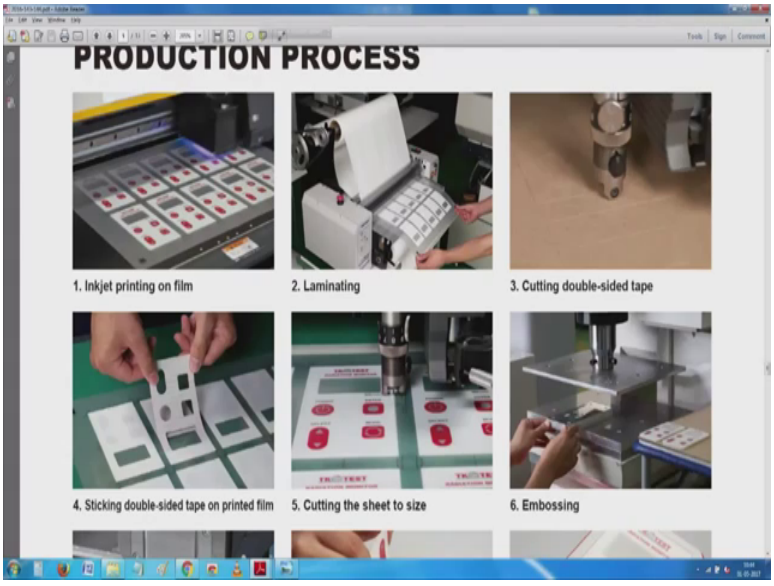

So, those of you who are likely to get into this engineering field you can offer it as a design practice. This is a matter of because I have I do not have it we have my colleagues we often do this manually, because we work in very small numbers maybe a batch of 10 or anything. So, you see here now just like you have your vinyl cutting machines, you have machines which do all these things, see here. Beautiful machining on enclosures is taking place and then you have a large number of beautiful enclosures which are designed by you.

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Manufactured by you can, even what you call take a design registration and the most manufacturers they will respect your other things.

Now, you see while the part about putting all this and front and all that is reasonable what is extremely difficult for a small design house to work on is, see here the beautiful openings and a little bit of that masking for input output devices also the connectors which is important, absolutely important.

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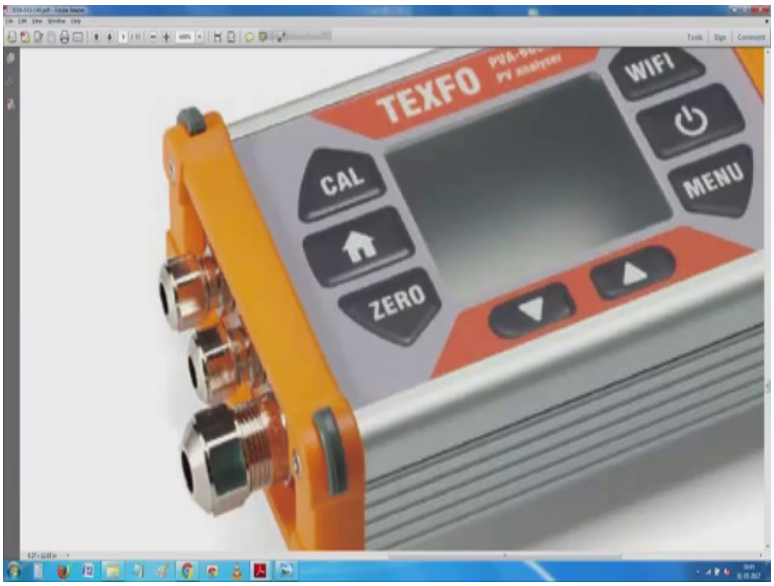

You see here. So, beautiful they may be glinted. So, you may have a (Refer Time: 16:34) you may have a rubber packing or grommets. And everything fits and 100 percent reproducible. So, this is life as it should be made. So, I will again go back to the beginning of the you have seen you have stuff with and gaskets and then material can be all this. So, so many variants of these are available. Life is it is a question of a very

carefully getting prepared upfront for making your design in place. So, this is a matter of detailed high quality printing and all that, this looks I think you need not worry too much about it.

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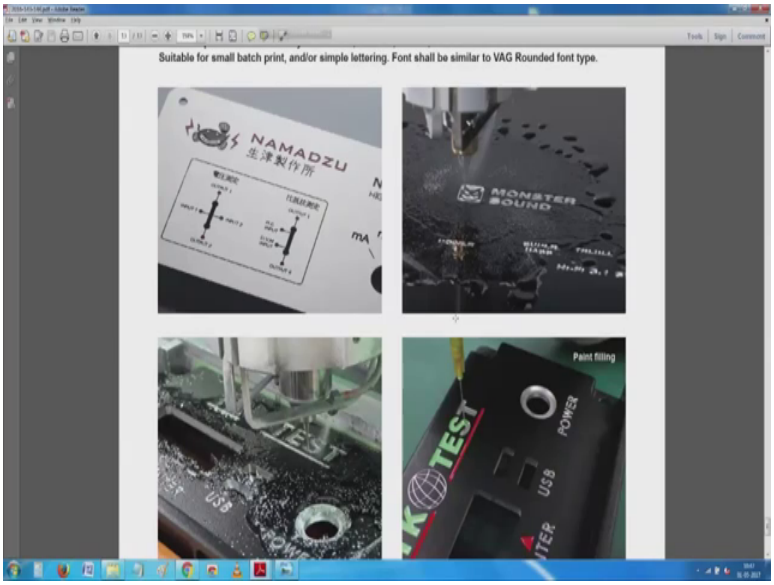

So, anything you want is already included in this. Otherwise you see here even the way the whole thing is held together reproducibility is typically 100 percent. Now you have one more small bit of detailing. In the video which I have pointed out we have shown you a small almost like a table top CNC machine, which has is actually an engraver x and y it has and then also there is zee attachment zee or z attachment plus there is a rotary attachment. Using this things like this all sorts of engraving operations and things to make them very, very professional is done. Well, all that inkjet and all is still under relatively benign atmospheres.

Benign means there is no scrubbing operation on top of it not operated frequently only occasional cases or it is covered only when required somebody needs to open it, and then they try to do everything and it gets closed. In regular long term used and lightly more harsh environments engraving is the preferred way, and then we also have no paint filling. So, in this case there is a small needle which is dispensing the correct paint which eventually, probably will dry up on atmosphere. It is a anaerobic type of thing after you

do it whether it kept in another accelerating with some catalyst thing and then everything hardens, eventually you will have a thick seal which is scrub and waterproof by itself and then likely case that little paint falls out you can always fill it back.

Now, these days laser cutting in all these things are also available. But then you will notice that it probably makes sense only for very large dimensions. One small detail I had forgotten to point out at that thing earlier.

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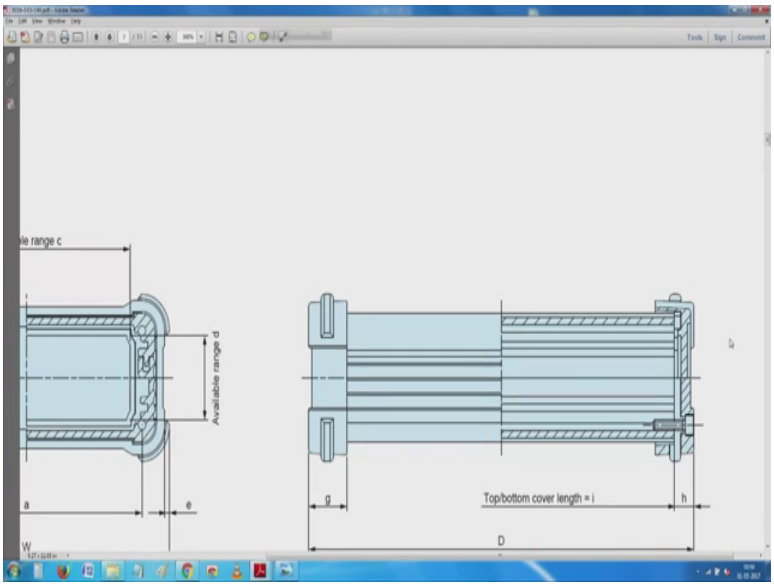

And since we still have a little more time left you see the way the overlap and the way the end cap is fitted here. This is the detail which had taken forward and brought you back to show this here. In this corner you will see that this material also sit is here and that is then your l n screw sit is flash with it. And probably sufficient arrangements have been made and especially with the provided tool if you I mean apply the correct amount of tork. And then probably enough stoppers and all are available here and you see the gentle slope is there here, gentle slope. So, the gasket that sit is here sit is flush against it and eventually the whole thing sit is neat extremely neat and flush. So, under most conditions it leads to the promise of the IP 65 which they are talking about.

So, my own what you call I am sure it is (Refer Time: 22:13) advice only let us start with

it. And even where you feel it is likely to be not exposed to this extreme things and all that. At least the first one or 2 pieces which go to the field for testing, you probably need to use one of these and (Refer Time: 22:36) that is what we have been doing for a long time. If you remember I have been showing you some boxes and all right from the beginning including an aluminium what you call straight away, but box from outside including (Refer Time: 22:50) and others including ABS enclosure, which start most of our things with that because overall we have found out things all cheap. And if you scout around even in case in the unlikely case that you run short of quick supply of these materials generally they about fall into the same shapes and sizes and all that. If not the person you have started with there are other alternate manufacturers who try to give us these materials.

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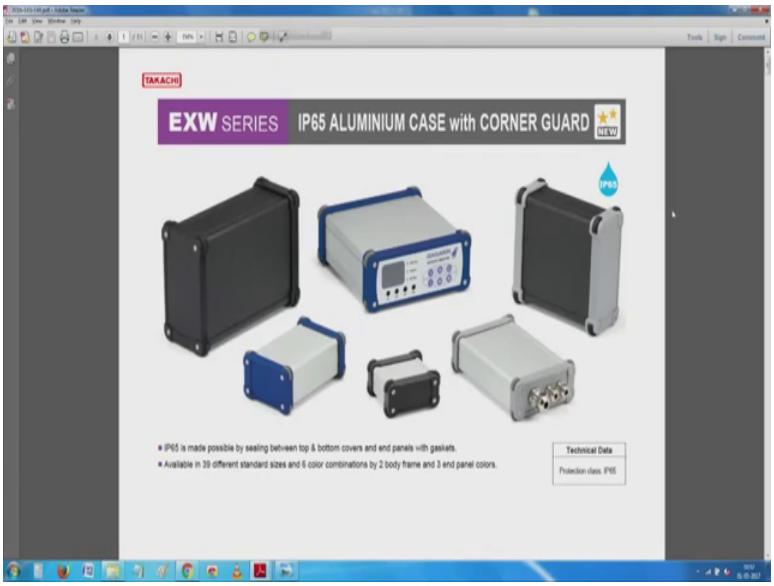

You see practically anything you want is probably available ok.

So, I think I will stop here, again with the standard acknowledgement that yes have seen this here including.

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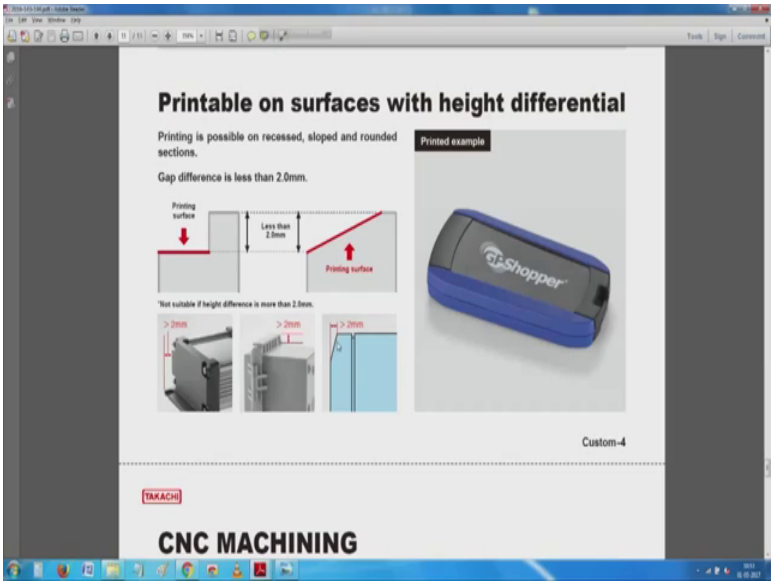

All sorts of any small slopes all of them can be taken care of. And then of course, CNC machining these days is where why that particular CNC machining and engraving have been included is, in case we use a any package there are standard packages and then use it for the case of your design you can easily extract by using that layer or overlay techniques dimensions that can be required for all your machining operations in all 3 x 3 planes that is x y x z and y z planes. And then if you extract it and then pass it on to the supplier generally suppliers will help in accepting this convert it to zee codes which machines use for making all these things.

So, the whole thing just like on the electronic side you have automation. Generally when they talk about ADA tools. They talk about the schematic capture and probably making a rats nest and also a little bit of arranging and eventually routing and then multilevel even I have seen you know, some PCBs made here by our students and designed up to 8 layers no problem. But conventionally it is much easier to work about double sided PCBs and then probably start them together through a prepaid or something and the file that was used for making the PCB especially the mounting holes. And in case you have any heat bridges there are some active heat producing components most thing I can imagine is probably a power transistor. Or all of you must be familiar with the 3 terminal regulator, 7915 for the negative 87815 for the positive output. All these come in that small flat

package with a heat sink metallic portion on this. So that details from that PCB e d I software can always be transferred here and it can be used here for carrying out all the operations here.

So, directly if you see the example here see here very neatly some operation is being carried out.

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All to accommodate another printed circuit board which probably have this keys here, looking a little at the openings, I can only make a guess probably it is made for some connector which comes out. And then the 2 flat things on a circular thing typically could be ABNC or TNC or something at the back. So, you assemble it from the top and apply sufficient ark and what you call assemble the whole piece, it works like a charm all the time. And if you use the same file which are used for laying out the PCB most packages can understand the features.

So, if you work with the what you call in connection with the packaging people like us, we now have something which fits usually at the first time. So, it is a good starting point, I have a concept. If I remember in the beginning I told you that we need to probably make a cardboard model. It is easy to make a cardboard model. Because you have the

external dimensions and then you have 2 choices one of them is if you want to try one first piece you can probably go to the third fabrication place. And then attempt to convert this concept into a small enclosure. With all the necessary thing about norching and how the thing join together about bending allowance. And it is a very elaborate lecture on the fastening techniques that is used.

If we just list out something I will show you from the catalogue it is not quite the same. I will try to bring up the pieces and then see if the best we can make a setup saying, this is how something called a rebating stud is used. So, if you are curious just check on the internet and you will get multiple hits about the type of fasteners that are used and the way you assemble things together. So, allow me to end this session here thank you, and I will call it a self improvement exercise. So, what you do is look around anything you have with you, just thinking about because I found this a wireless mouse.

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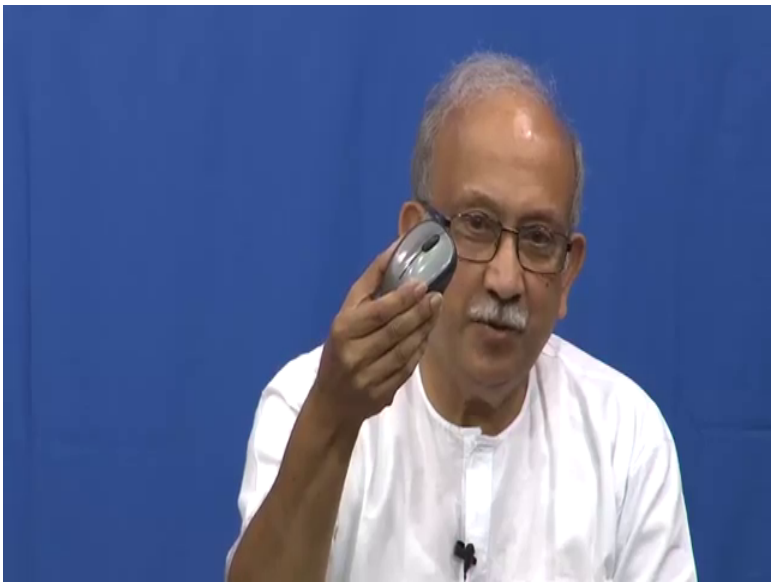

Why can not use this wireless mouse and then see how well I am sure you have enough of these not. So, great working things, open it look for various parts inside. And then if you are a lucky person like us I am sure you have enough floppy drives and probably partly damaged hard drives, open one of them and then have a look at how things have been packaged.

One of the first thing you will notice is very rarely it is a simple rectangular PCB. There will be large openings in side of an the asymmetrical and then whole thing can be put together. So, it is a probably a good time for you know to look into your junk yard and pick out some equipment and I am sure several of you probably have some damaged electronic stuff at home. Have a look at them inside and then why I insisted about this is you can make absolutely watertight equipment by taking things off the shelf. And then the failure will not be because of the packaging, the failure may be because something related to stress or unexpected electrical inputs, in the parts where I live electricity are main source voltage varies tremendously and even So called accumulator batteries the voltage is not that stable. Even if you take a normal lithium ion stuff which you can find inside your mobile nominal is 3.7 volts. But then when it draws heavy current it dips other extreme when charging the voltage sometime goes above 4.2 volts. So, you have a wide variation from 3.5 volts to 4.5 volts these cause damage.

So, thank you. Please stick with us, and then tomorrow I will try to show you a catalogue of some other things.

Thank you.