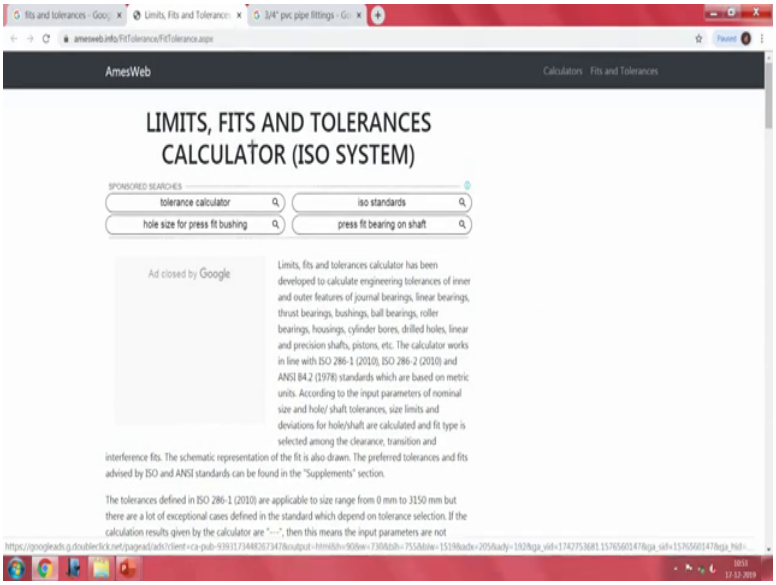
Electronics Equipment Integration and Prototype Building
Dr. N. V. Chalapathi Rao
Department of Electronic Systems Engineering
Indian Institute of Science, Bengaluru

Lecture - 23
Practical mechanical assemblies

Let me continue the lecture about why we require these limits, then allowances various types of tolerances. One of the first thing you should remember is the application. So, if you look down here, you see here there is this whole thing is about limits, fits and tolerances for the ISO system.

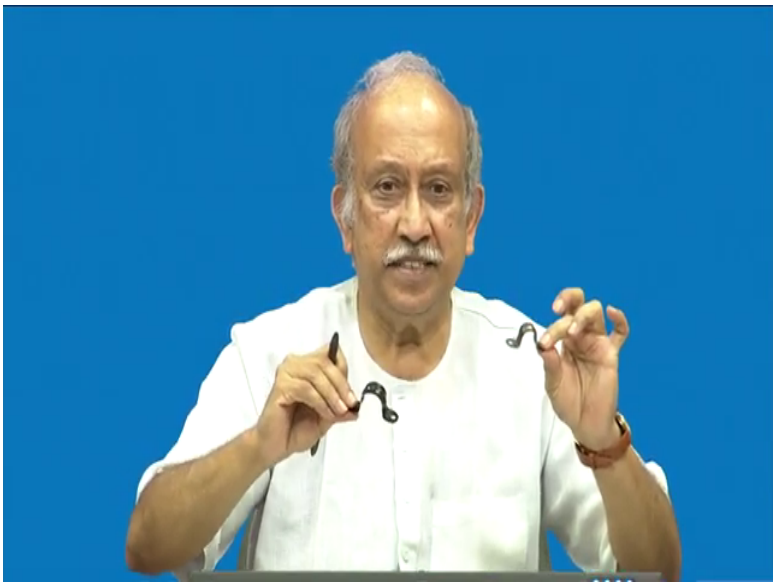
(Refer Slide Time: 00:45)



Parallelly things like what the American standards, then where we come from we were under we had adopted the British standards. Similarly, you have the Japanese industrial standards, then you have the Gost that is Russian standards and huge number of European including din

and VSM and so many other standards have come about it. And the whole thing has been incorporated into eventually, what became the ISO system, because in general things are a little similar in this. So, I thought I will start with a very-very simple thing.

(Refer Slide Time: 01:34)

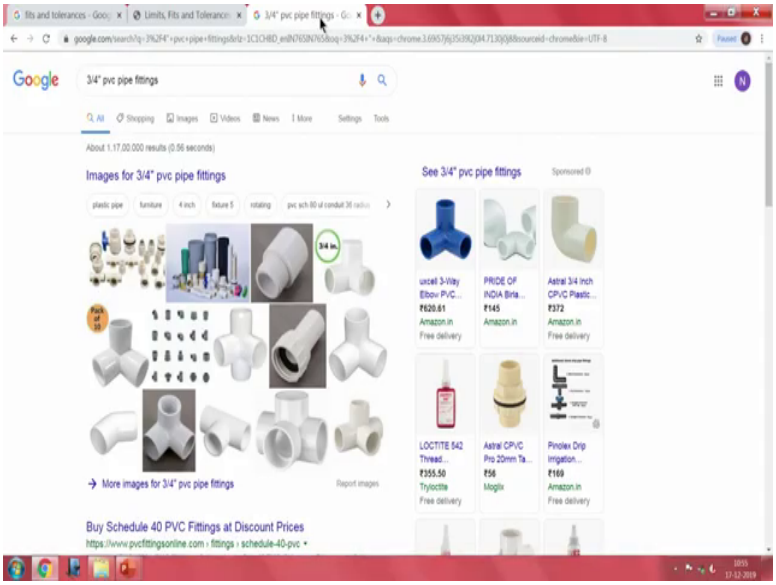


Here, you have; here, you have two tube clamps which look innocuous. It looks like they are very simple and I mean it just fine. Now, you will end up with two different situations when you want to fabricate it in make a drawing for it. Why drawings are important? Suddenly it becomes, because the movement you mention that this is meant for a three quarter inch water pipe and this is meant for a half inch water pipe.

Once again, this is meant for a three quarter inch electrical conduit, this is meant for a half inch hydraulic piping several other things come into picture while, externally it looks nice the

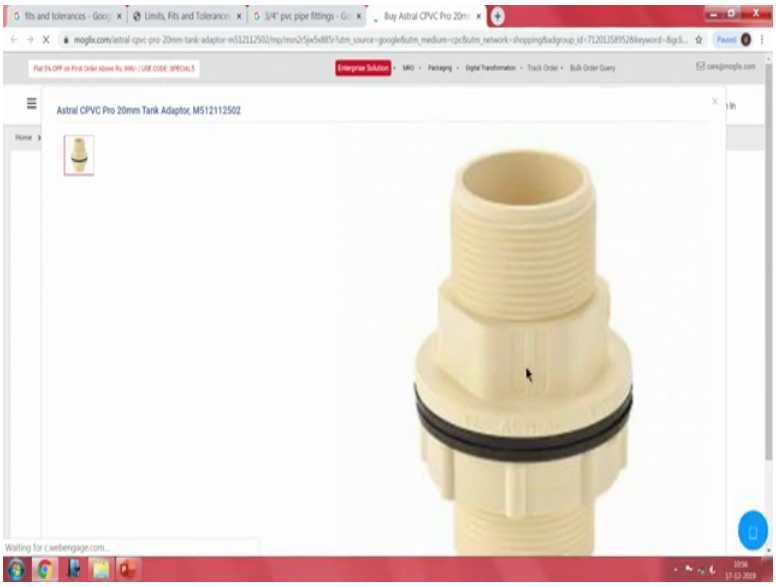
whole mention of the we have a large array of these accessories which come with each of these items.

(Refer Slide Time: 02:28)



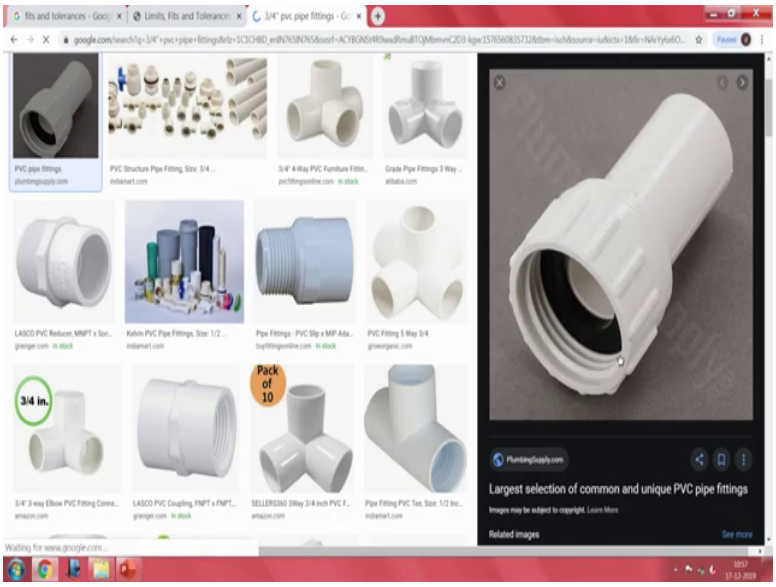
So, one of the things what you will notice is that what is considered a if you look at this picture now.

(Refer Slide Time: 02:50)

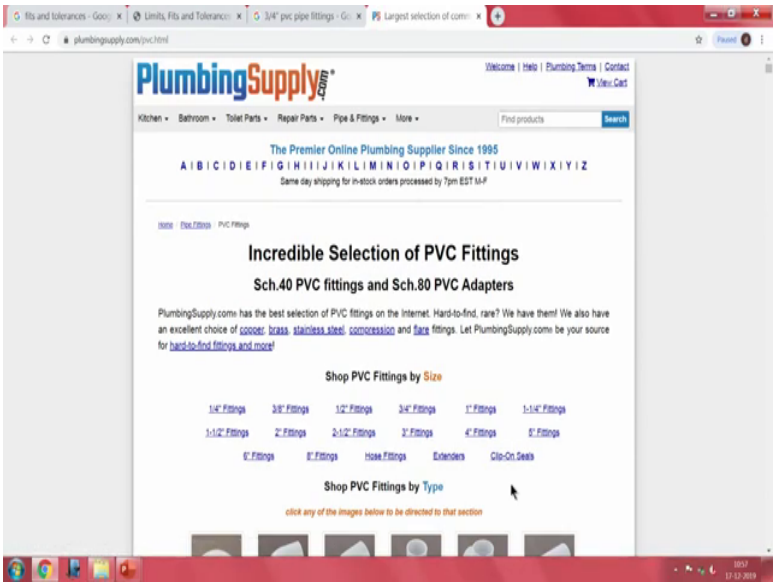


You see here; this is how things are sold. Something is written here, saying this represents a 20 mm, this represents a 20 mm adapter. I do not know, maybe it is meant for a flush tank. Everything is indexed with reference to the internal diameter of the pipe and from the internal diameter of the pipe you have the threats and if it is sold as a set often you have a nut here, then you have a the equivalent ah, there is a flange here, there is a small gasket and the whole thing what do you call is assembled together across a small plate and water is not expected to leak. Whatever happens it is supposed to stay.

(Refer Slide Time: 04:01)

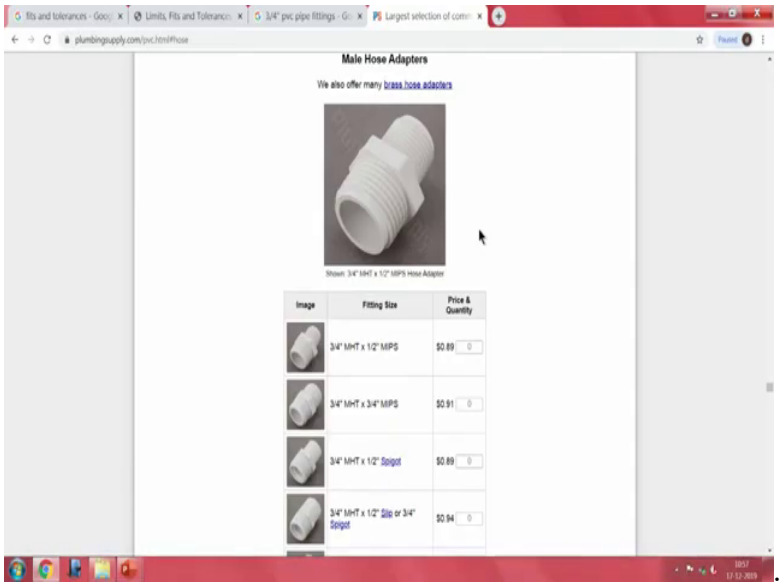


(Refer Slide Time: 04:07)



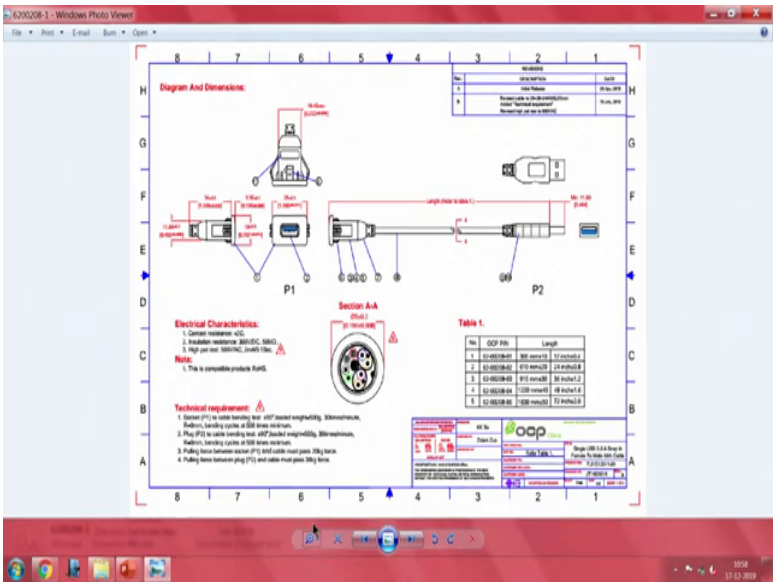
Under all conditions these things are supposed to be interchangeable and if not now, eventually these things have to made with other things which are also often in the market.

(Refer Slide Time: 04:18)



So, you see here why I have picked this is so, you have something saying 3 and a quarter inch to half inch and 3 and a quarter inch to 3 and a quarter inch and all possible combinations are given here. This is where it is very-very critical how do you specify the matching parts and tolerances on these things. You might be wondering why are you stressing on all these things.

(Refer Slide Time: 05:05)



At this point let me show you, even electrical items invariably end up with drawings like this, it looks so, what do you call somewhat scary. What we thought was which is just an electrical a connection, when it has to be manufactured in variably, it will end up with such documentation and in this documentation everything is very very very specified, it is very what do you call almost a contextual, contractual understanding between the supplier and the purchaser.

Hence, when you go to the shop or if you go online and ask for a simple USB extender with all this big thing, it is a simple USB extender, but looks complicated, but when you look at this drawing you see it just does not look like a simple USB extender. On one side you have the header and one side you have the other matching portion and then as you enlarge them you see here a nice, fantastic amount of dimensioning has been given here.

You have seen this which I had shown you earlier saying in one of their designation they have written saying, it is 5 millimeters, 5 is shown there as a diameter symbol and just a 5 is written there and one of the first thing you will notice is you need not worry in what language is written. So, whether you imported from Sweden or you imported from let us say one of the earlier socialist countries or if you now get it from PRC, everybody can read it, nobody can worry about it.

And now further about it is across the 5 millimeter plus or minus, 0.2 millimeters is mentioned there and it is explain what that 0.2 millimeters is you have seen this. In this case, it is translated into the equivalent inch things. So, approximately if you take 25 mm to the inch it comes to 0.2 inches this is the beauty of having various types of drawings. One of them is, there are good electrical characteristics mentioned which we need to understand all the time.

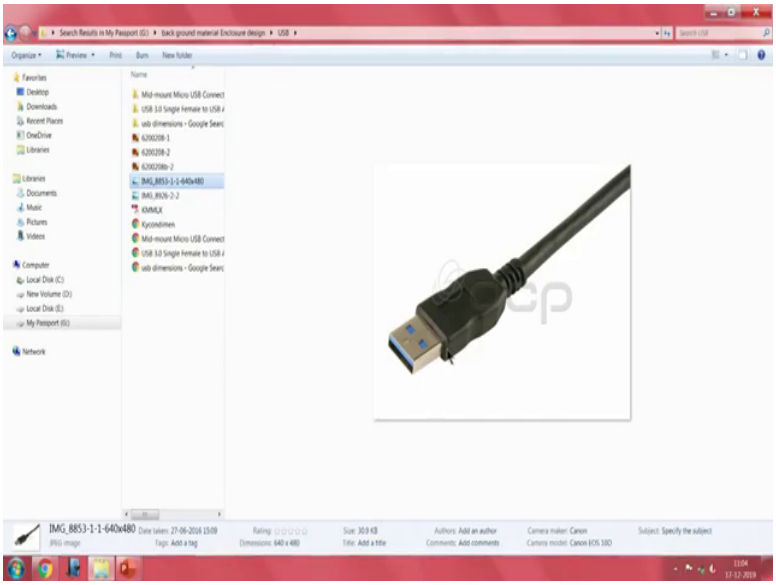
One of the thing is saying it is a 300 volt DC and then they also have given high potential test saying at a specified milliseconds. It will not fail and down here if you see other things regarding what is the bending that it can take 30 times per rate, then what is the bending cycles minimum and all these are all guaranteed about it. This is it is not actually a military, this is not a military standard, but this is high grade professional standard that are the reason why, if you buy an automobile, I am sure if you run it for 500000 kilometers.

The electrical generally it does not fail only a few bulbs fail other things fail, but the now these days we have the Indian management unit which continues to work. And the new devices under the what do you call dashboard, you also have another connector which I had covered in a earlier thing.

They bring the what do you call your connector a pant which is fitted in that it is connected to that and it will give you real time all the conditions of the program which are there and with all the new sophisticated things, these things have become although more important. What we used to think is a relatively simple thing about just go to the market and get a connector suddenly has improved dramatically.

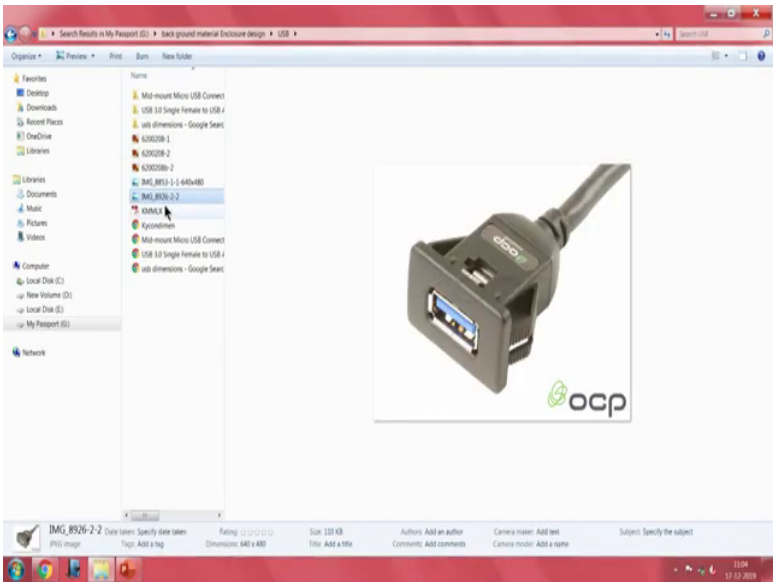
You see here there is a small part number and related to the part number is length of these thing. So, you have something which was this a what you call 30 centimeter, 60, then you have 90 and so on like this, know equivalent 1.8 meters, 1.2 meters. All these things are available in, the most important thing is they are interchangeable, you can get an alternate source in case this fails and where the documentation is there and things are there things generally, there is very little chances of things failing.

(Refer Slide Time: 10:32)



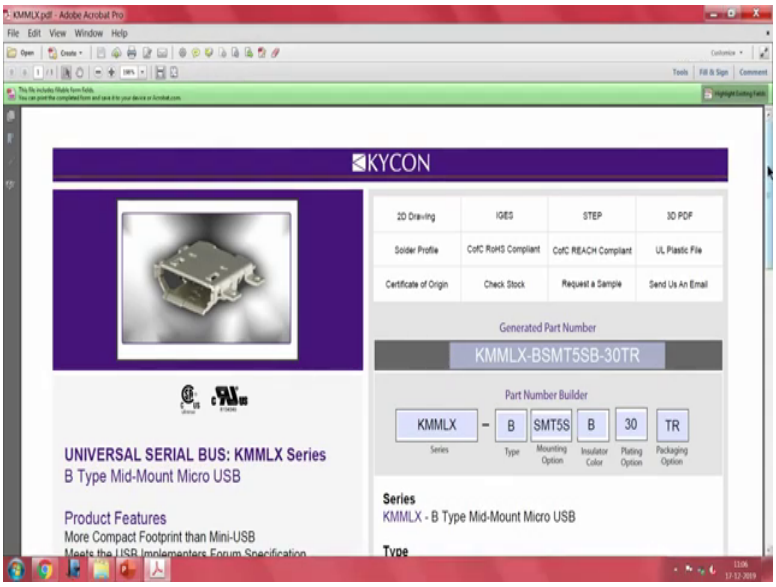
This looks very commonplace, what is called a USB type a, I am a little confused about it, but I will call it a you know plug the other, know is the what do you call other side the probably the matching part.

(Refer Slide Time: 10:48)

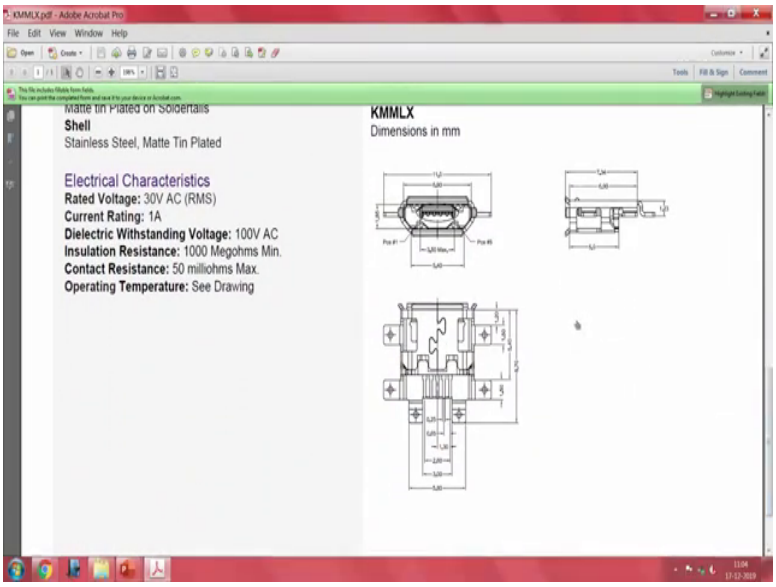


So, one is called a header and other is called a plug. These things if you see carefully, huge amount of documentation and all of these things come with large amount of documentation.

(Refer Slide Time: 11:01)



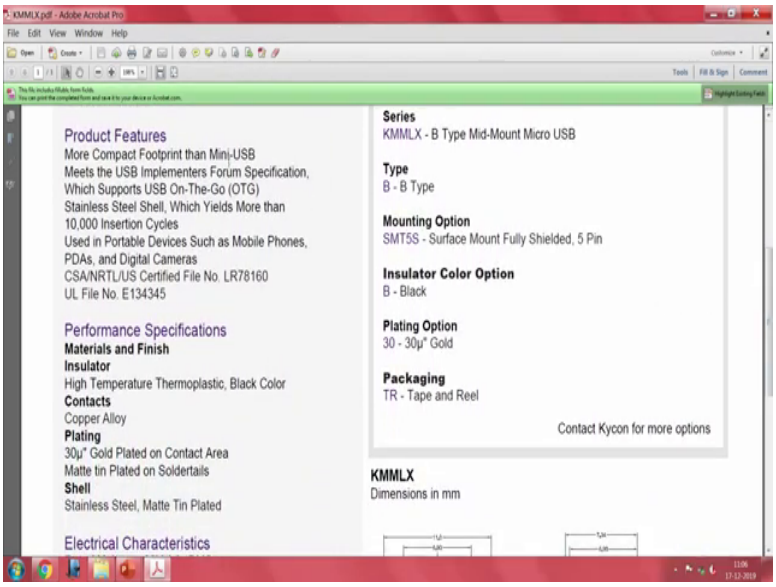
(Refer Slide Time: 11:19)



And what all you would like to use in your design is all already there. Why I am mentioning it is, earlier was somebody had to manually draft all these things, but right now one simple way is in case this one is a what do you call PDF document and you can take all these small screen shots and still make a template and use it in your equipment.

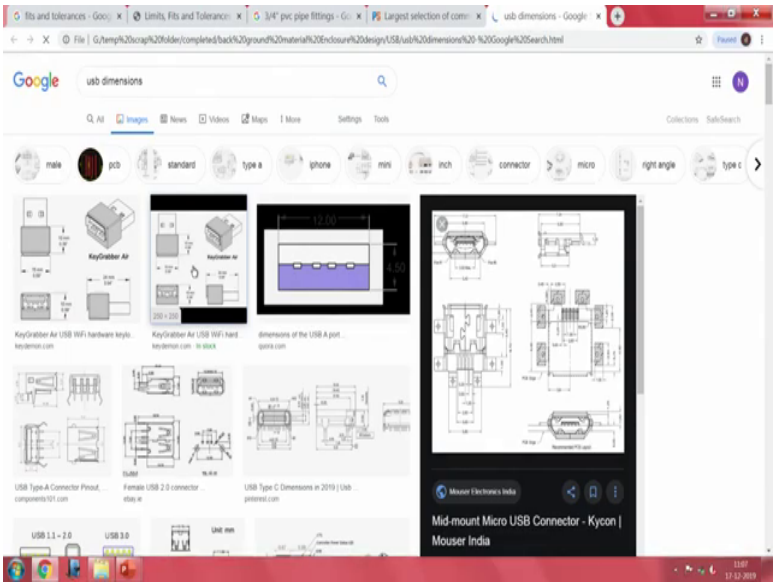
So, when you are trying to make over a layout of the printed circuit board, you can take the plan view and when you are trying to make a panel or other thing which you know, which shows here, we can try to take this, we have bought it, attach all of them together and make sure that this device sits perfectly in your design. Now, forever clarification they have also given a picture, so that it is easier to identify.

(Refer Slide Time: 12:43)



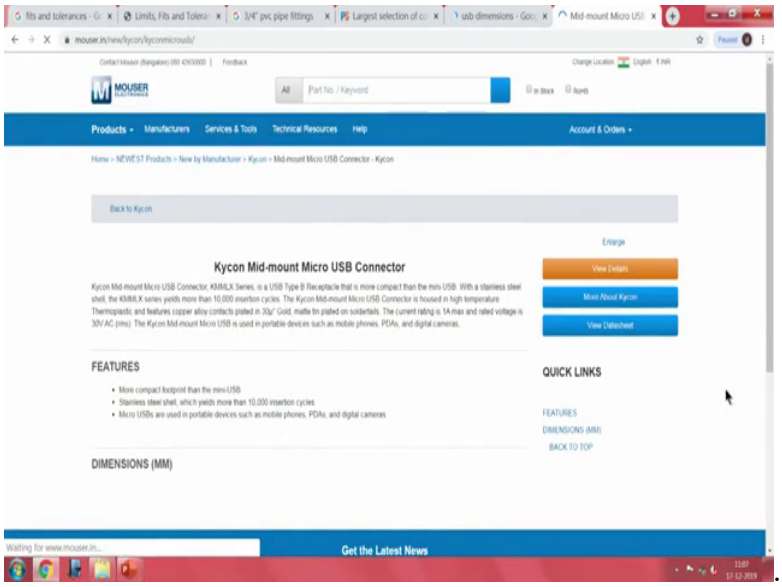
You have seen here various other things have, I have been given here; one of them is what is the material, what are the contact and then 30 microns uh micro inch gold plating and on the solder thing what is the thing including you know tin plating, most important is current rating and so on. All these things is where your technical drawing is very-very critical on one side you have the manufacturing specifications on another side you have all these things where somebody has to use this in a practical design.

(Refer Slide Time: 13:28)

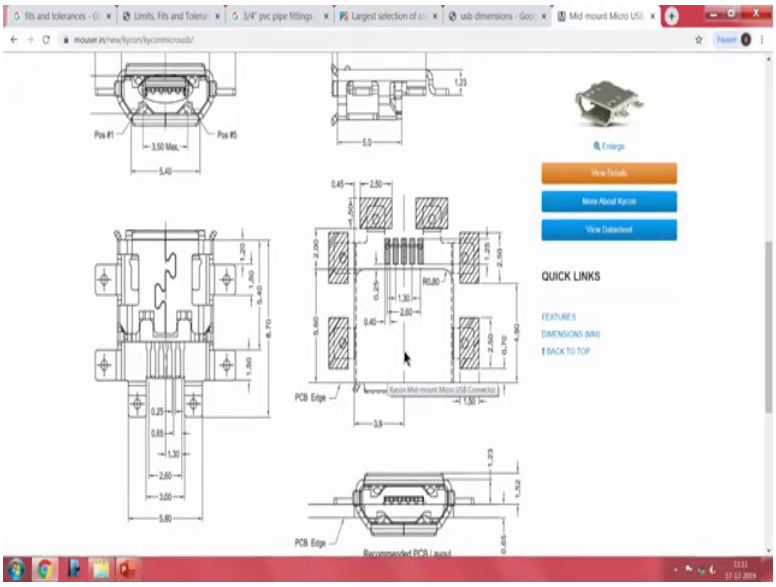


Typically, I just gave a such. When I gave the such last time see how many hits have managed to get. This is the usual dongle one finds, the dongle in the case of various other things and then anything you want, everything you want is available as valid documentation for manufacturing.

(Refer Slide Time: 13:52)



(Refer Slide Time: 13:57)



The one I have shown you earlier was a little related to just to mechanical and then you see here what else is here can you notice. They have given the footprint and solder pads where you had supposed to be solded and this is where the convention helps. There is a dotted line here and then you see here there is a it is called a chain dotted line. Typically, a chain dotted line represents the midpoint between two.

So, if you take the total weight there is approximately the midpoint and they have avoided tolerancing, because this is a contract document it is for you to go and purchase it and then use it in your design. If you now look back to the earlier lecture, I have given you one place I have given you a remote control and in the remote control I have given you key pads where you can place the key pads.

In a similar way just like you can place the key pads wherever you want. In a similar way the product concept team should fix where all these input and output connectors are fixed and when you fix this connectors, part of the layout is already ready. This is slightly different from the development boards which we get. We get raspberry pi, arduino, then we get beaglebone, then we get so many of the other various types of small development PCBs while sometimes the things are so neatly packed and you cannot do better.

If you are thinking of a larger embedded system typically, let us say you have a dishwasher and you would like to use all these things in that in that cases it is not appropriate for you to keep on populating with so many other unwanted hardware. So, what those people will do is, they will take the, they will capture the schematic and probably they will make it into manageable subsystems.

Typically, easiest thing you can to imagine is the power supply versus the processor and after that invariably, because we are working with a very large system, there will be a mortars, there will be blowers, then there will be heaters all of them will be connected via relays. So, sometimes all this information is passed on to a an output board and output board can be intelligent and it is common between several modules. The cost of manufacture is reasonably low.

So, the main power dependent thing is changed. Well supposing there is an output relay is one of the machines may not have a internal heater inside. So, no point in populating due to the huge relay which cost money. So, they will probably omitted or they will not populate the that particular point, because in this case the heating maybe external, there may be hot water available outside and some places you may require other things. In some places the things like separate treated water may be available.

So, you may need a treated water thing is the rinse for the last cycle. All these things the system is conceived at the highest level and as much as possible they will take usable things and then try to put it together. Now, I will come back to the very commonplace example, I

wanted to show, you see here I have to small plans here and you have a look at this device which I have tried to get.

(Refer Slide Time: 18:01)

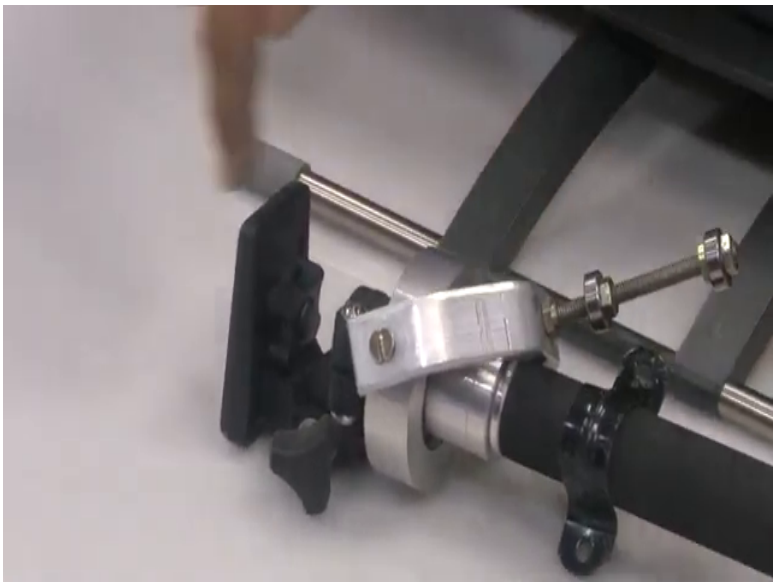
Yeah, this is very interesting thing in case you are all people who enjoy little bit of photography intentionally, I have brought this. You see here, this is a monopoint which I am trying to use and converted into a stabilizer.

You see the diameter there; obviously, I need something here and you see the diameter here, this is something here, both of them. This I have just taken it randomly from the shelf, this I have taken it once again randomly from the shelf, but miraculously have you noticed both of them seem to be fitting extremely well. And now, when I come to this critical point can you see here, these are all this is a very complicated assembly made with there are two small bearings inside this.

(Refer Slide Time: 18:57)

You have seen this, I am able to move it and there is also a one more bearing in this direction.

(Refer Slide Time: 19:05)



This is the vertical direction. So, I will call it the z axis. So, z axis this moves x axis, this moves and intentional layer removed the handle so that I can see the tiny small bearings. So, the outside diameter is 12 mm and the inside board is only 4 millimeters, I am sorry 5 millimeter. So, this whole thing now, the magic is everything here is off the shelf and everything here is completely interchangeable.

So, should I want to buy this and keep it in a large production? I have multiple sources for this, I need not go for very expensive air craft bearings. I can probably select something which is almost commercial, such things know or called off the shelf. So, I have taken off the shelf bearings here and intentionally, I have removed all that so that you can see that there is actually a small bush and all that the thing once the moment I make it.

Now, this thing is fully interchangeable and this is a head, this head also has been made such that I can now take it into any other direction and I have a genuinely universal device all assembled from just off the shelf components which I think now is a medical of a standardization, medical of modern engineering and so on otherwise, nothing fits. It is actually a quite a complicated thing of course, these days they are available at a low price. And now, if you look at this yolk, which has been used here, the yolk has been made considering all the off the shelf components, how much, how much of area is, what you call this angle of operation is required how much of movement is required.

Based on all this, I have a design and the first attempt everything has worked which we are not able to do this a little while back and I will say it is thanks to using of a what you call this engineering with several types of limits and fits.

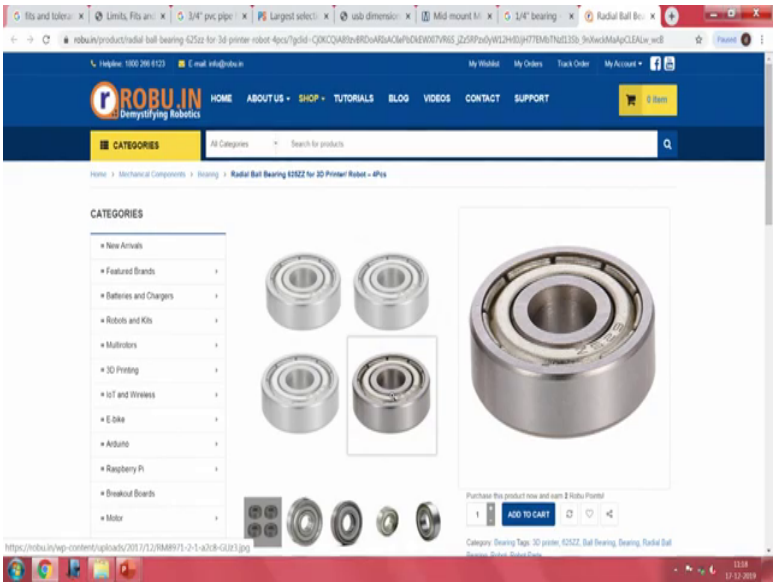
(Refer Slide Time: 21:35)

Now, have a look at even my glasses, you have seen there is very tiny, the screw here is very-very tiny and. In fact, it is a extremely tiny and including these have all been standardized to such an extent and there is a beautiful spring mechanism inside. So, that it bends outside and all of these are mass produced and everything fits the other, only the external parts are made as per any aesthetic design.

Can you say it, there is a something there is a spring inside this and that is coming out and it is operating this and the magic is they are all mass produced and does not cost much is whole frame probably costs 5 dollars and a very professional frame costs maybe the full assembly know well cost you around 200 to 300 hundred dollars.

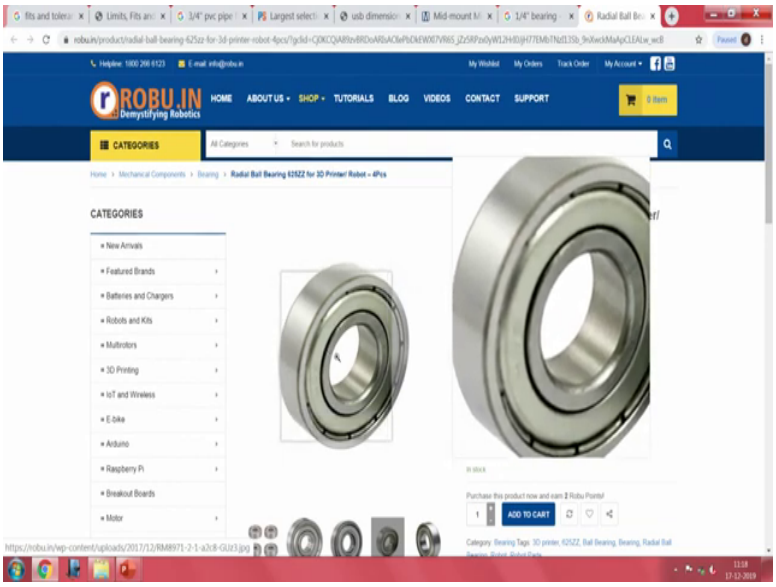
This is a very off the shelf thing except that the prescription glasses are expensive. What makes it interesting is that all of them are there are specific standards about what is the screw, what is the tension in this and how these things nicely managed to fit together. Now, if you look back at the that monitor you see a large number of what are routine things are available off the shelf.

(Refer Slide Time: 23:18)



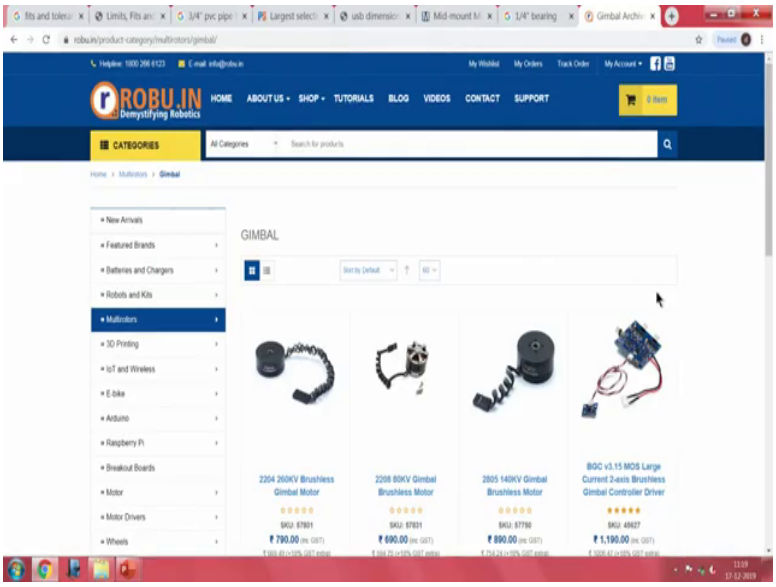
If you see internal diameter is specified as 5 millimeters, outer diameter is specified as 16 millimeters and the width of is it is 5 millimeters. So, these things and in this case it looks like, it also has a nice rays and a device which holds all the balls and place and the main magic is they are all interchangeable.

(Refer Slide Time: 23:46)

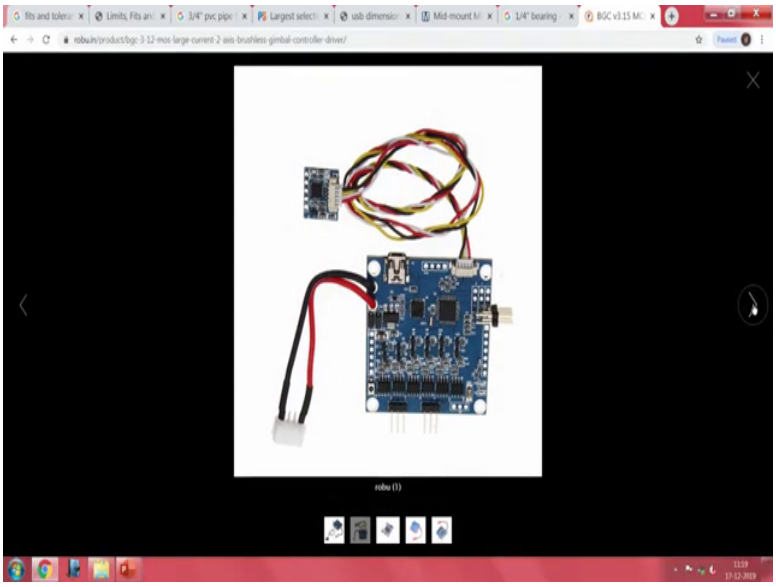


If not this, I have other suppliers who can supply these things, price varies a little, professional quality and branded cost a little more and commercial things do not cost so, much.

(Refer Slide Time: 24:06)

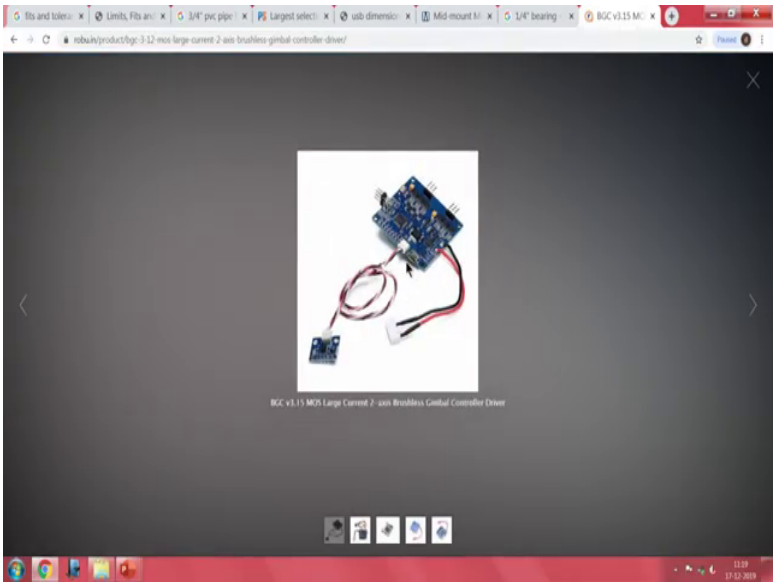


(Refer Slide Time: 23:09)



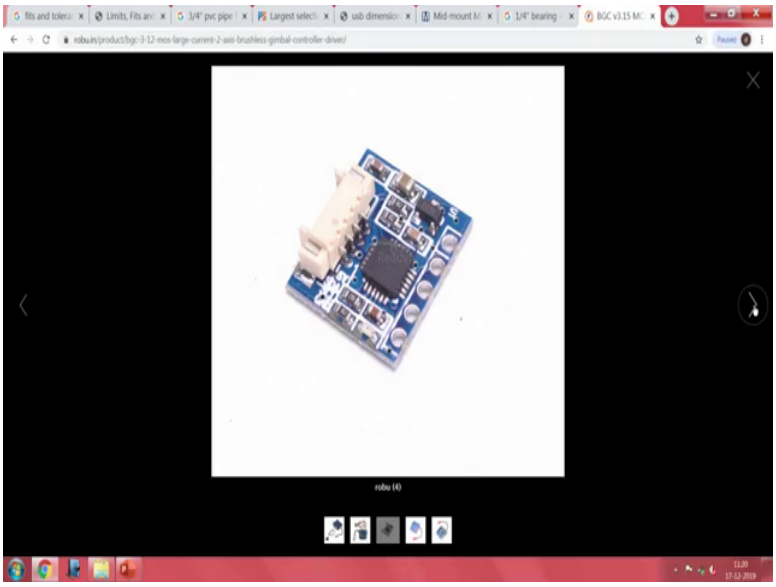
Anything you can think of is probably here. Why I have picked lot of it is, this is a gimbal controller driver and you say and all the directions they have beautiful connectors talk with a another subsystem and you have anything you want already there.

(Refer Slide Time: 24:18)

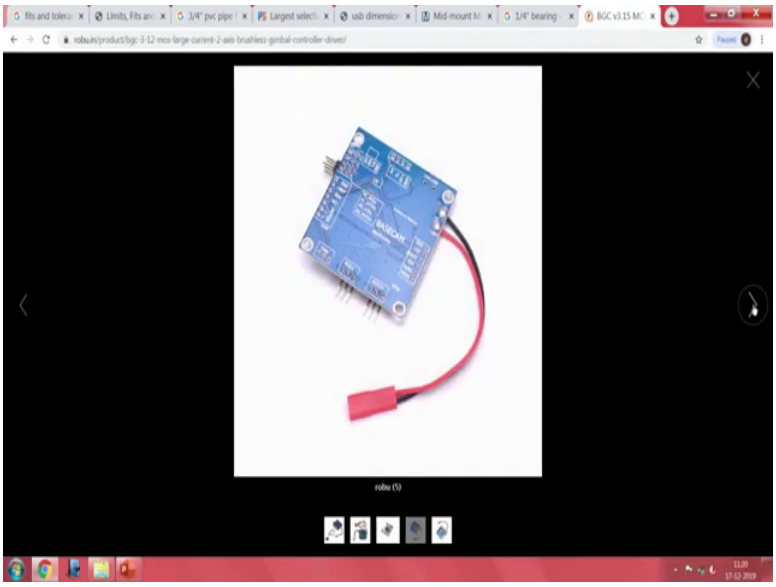


So, you see here there is a small I right now, I avoid, I will avoid the concentrating on the electronics what I wanted to tell you is you see here in the four corners therefore, mounting holes and there are pins for connecting other things. Then this is probably I will not know whether it is a power supply or whatever it is.

(Refer Slide Time: 24:51)

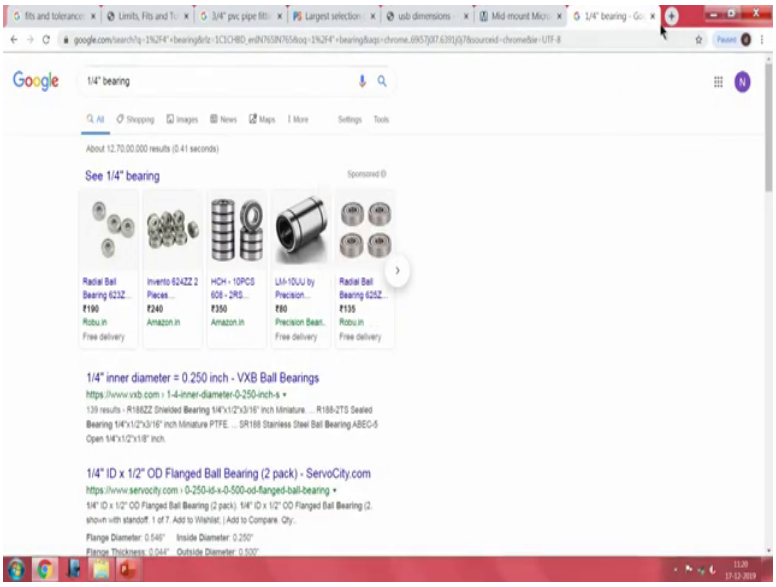


(Refer Slide Time: 24:56)



Everything is standardized, everything is easily available and you see here other things have been written here saying, that is something which controls the roll pitch frontend rare. Everything designation is there and the magic is best part of it is they are all fully interchangeable.

(Refer Slide Time: 25:16)

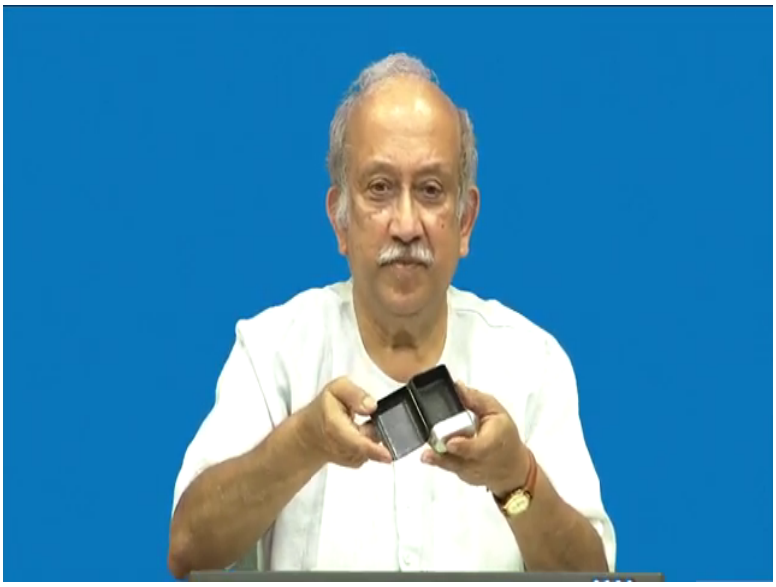


We have been able to achieve a state like this mostly, because of the sticking to limits, fits and tolerances and right now depending on whichever area you are working on and depending on the industry which are associated with. There are huge engineering manuals and data books which are available or handbooks which specify everything that you need to do.

In the building industry you would have notice that we have bricks, we have the old one type of bricks and then in our case we have the new metric bricks which are all typically or 20 mm by 20 mm by 30 mm or 20 by 20 30 into 40 mm and so on all our bricks are standardized and even the aggregate sand and even other things which are used they are also specified saying, this is the grid this should be the maximum this should be the minimum and so on and documentation and industrial practices have been done.

This though it looks like a mechanical job, if you are a product designer it is your obligation to read everything and get it back to this.

(Refer Slide Time: 26:47)



Let me see, show you this. This is a small box for holding my hearing aid instruments, it looks nice, it has a soft thing and all that and I can remove my hearing aid and safely put it. Then there is a place here for storage of the batteries and all and this is where you see here, looks fine. Is it not?

Everything looks fine, except that the bigger medical firm is this is a rubber insert and this one is just a plastic box outside, seen how well this elastomer sits well inside and in our case this is meant for a very expensive hearing instrument and lot of money has been spent on this saying, how you can open it and you can store things inside close and it is generic. The core can be easily changed and we can come with several other products and yes, design is

expensive and the whole unit turns to be expensive, because a limited number are made, not that many hearing aids are made by one manufacturer and as such, because of the fitting and ah, because of the medical and you know one device for each person things have to be very-very specific otherwise it will not go into my ear.

However, when you take things like this is watches, the it looks like technology is fairly is standardized. It is a question of quality control brand building and the type of service which they give you and these are all almost a keepsake type of things. But the background of although of it is documentation, universal fits and tolerances and manufacturing and even though you have an electronic product, it is expected that all these things are taken care of.

I will stop here and continue in the next thing, while I have taken some very general items here, I will tried to take next time, I will tried to take one what you call printed circuit board and try to show you how the interface between an enclosure, the printed circuit board and now we come to the other thing saying from all the sides you have the connectors and after closing it should work with full environmental protection.

So, often we have this IP classes. So, it is expected that if briefly your mobile phone, you walk with your mobile phone in the rain. It is unlikely that it will be affected and you can even take it to the beach, but you cannot drunk it in water. So, these things have all been over the years this, they have been evolved to make sure that hundred percent interchangeability is there and the core of that is documentation just like it is a as a bigger problem of making documentation for your electronic design.

In the case of mechanical design that is also a clear, a small amount of help is on the way, because if you take even if I take my two clamps generically, there are little same. And once if I make the proper inner diameter, proper way of doing and then at what level I would like to clamp it and all scaling it to any other size is easy.

So, once somebody has to work on all these things. Once they have worked on is these two can share a common 3 D solid. This 3 D solid is absolutely, there is no problem and related to this 3 D solid even analysis, in this case if you see very-very carefully, there is a small

embossing here, this is embossing gives that necessary stiffness and also it makes things to be stable and all this, all this is taken care of automatically.

And with the newer packages what I told you, bidirectional assossivity is there see instead of having a 20 mm tube, if I just type the next closer say 25.4 mm yeah all the proportions everything are maintained, everything is adjusted perfectly and you can always fabricate a piece and one of the early lectures, I have shown you sheet metal using CNC.

So, CNC sheet metal also is available, but the focus of it is something a concept you need to have put it into a documentation and documentation is needed when you want to talk with each other, but your CAD files are available and one proper proven CAD file from your design can easily be transferred for mass production.

So, thank you, we will meet again.