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

Lecture - 25
Solid modelling

Let me continue with where I stopped last time, a lot of these will help only if you actually have practical application and firsthand knowledge about it; but then everybody need not do the same mistakes and do the same thing. If you do a class of what you call activities, then you can probably extrapolate or interpolate. Today, I am going to continue with my example which I started last time; please have a look at the, this monitor from and you note the place where it has been taken from.

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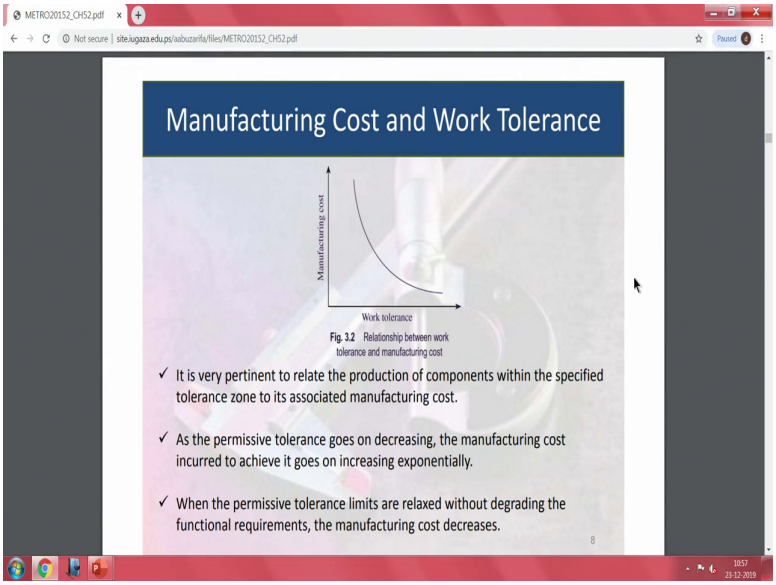

See we end up with this peculiar condition saying, manufacturing cost and somehow this work and tolerances are very much related; which we have too would have seen, that is the reason why handmade closely fitted items are very very expensive. And have a look at the background also; can you see here, this is the vernier which I keep bringing to the class every time and this other one is called a screw gauge. A screw gauge has a you know one more digit of precision and certain type of things can be best covered by a screw gauge, at the back know you have this.

Now you need to know a little about the manufacturing process before finalizing or fixing up a drawing, most important is that; as a initial concept drawing our solid models are very very valid.

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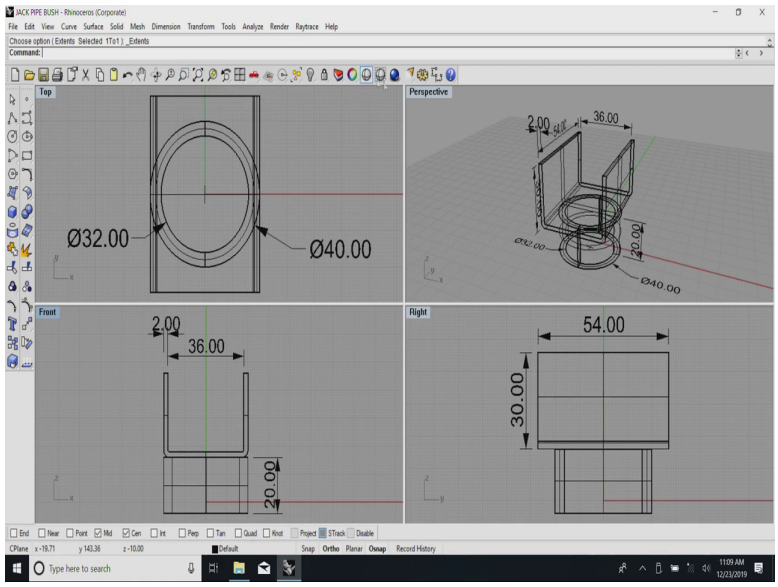

Now, please look at my the earlier solid model which I have done; you will see here, this is where I have started with, it looks fine, absolutely there is no issue about it and things look very well done and so on.

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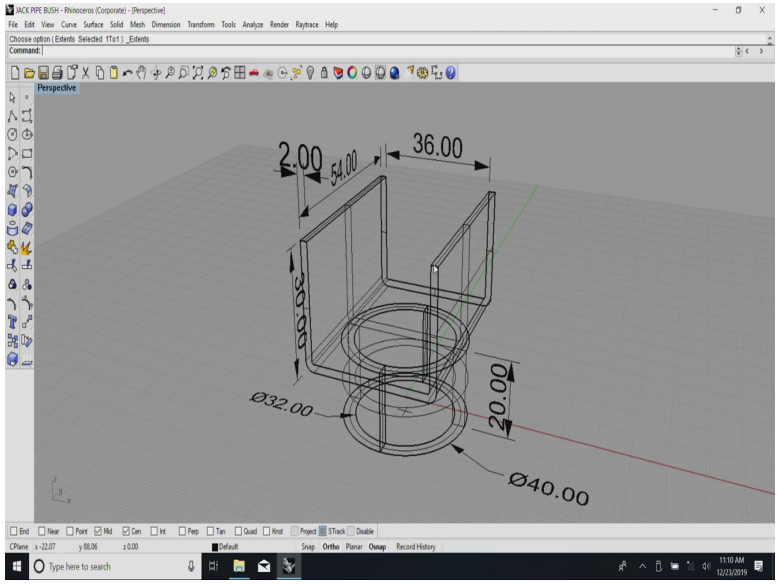

Except that you will notice, this probably make sense only when you are making a very large number of items; where you need to make a blank first of all, which is the developed length. So, in the earlier lecture if you remember, I had covered to you saying you have a 30 mm limb here, then you have a 36 mm limb here and a 30 mm limb here. So, approximately a little something which is a little less than a 100 mm and I started with 50 mm.

So, if you start with a 50 by 100 blank, it is possible for you to format into this shape; either by using the folding machine what we have or some other what you call other production systems.

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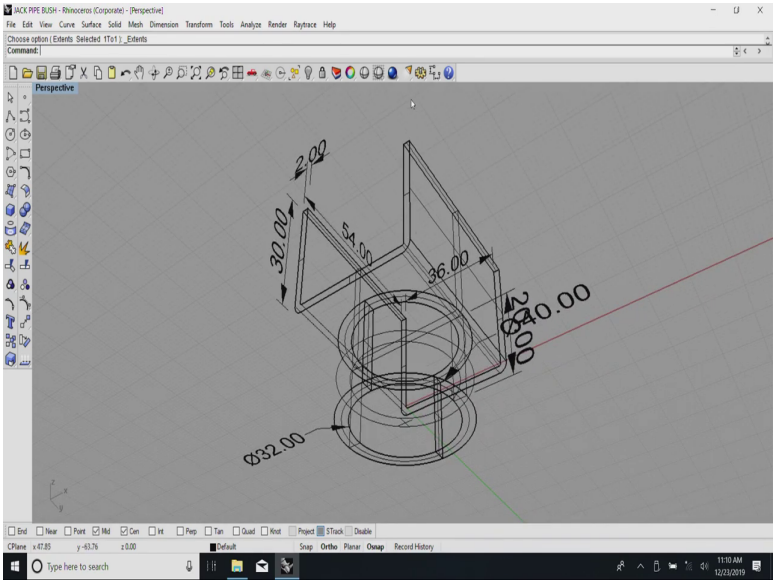

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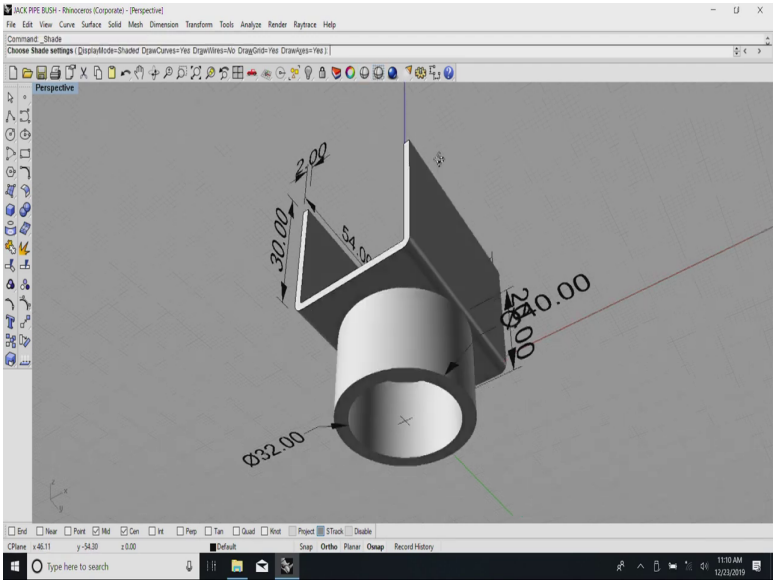

And at the base you notice that, this one is a actually a circular portion probably a pipe. If I take a pipe which has all these things, this is typically a one and a quarter inch ID pipe at the bottom; that is where this, these things come into picture, ok. And depending on the type of the gauge, you have generally you know thick tubes are available.

So, it is possible for us to take one of this hallow these things, then just cut it to length or alternatively if you just part it; parting is a way of taking a long tube and making it to small pieces and somehow by some mechanism try to weld these two things together, you understand know, you just need to weld them here. So, for welding, we need a little bit of area; incidentally my concept was a lot about saying you see, automatically anything we insert here stops there and still permits you to move things around.

And similarly here I can vary the depth as I place without wasting too much material, similarly I can vary the width also. Once I do all this I have a perfect place which fits on top of the jack, which I am going to come back showing it here. But, however, when we took it to the our fabrication facility, one of the things they have pointed out saying; for a one of job it is very very complicated and really this does not require that type of a this much of a what you call setting up and looking for materials and all, instead somebody looked at it from the top, ok.

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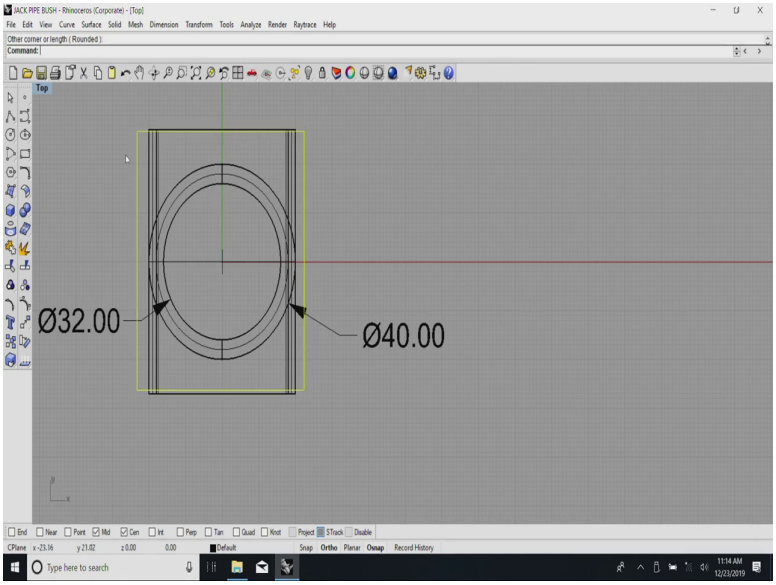

And once they looked at it from the top, they found out all we require is a raw material which is typically something which is a little a block of. So, they searched around found something which is you know it typically follows something like this here.

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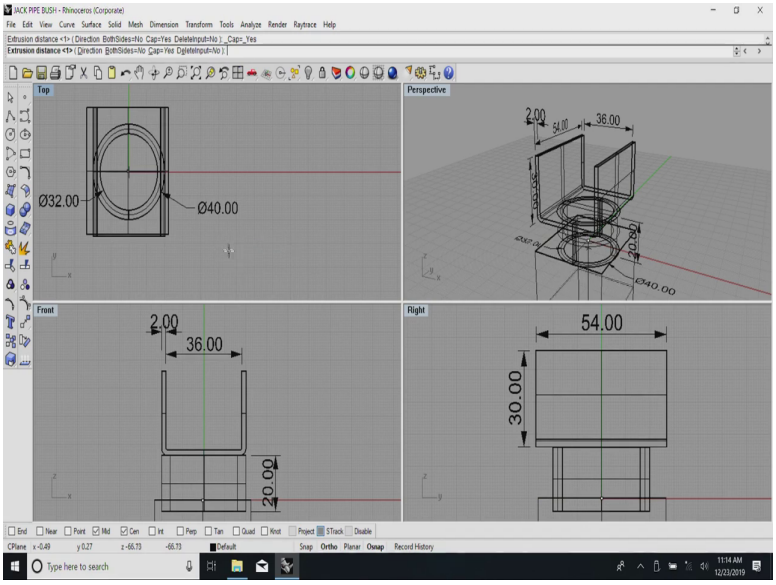

Now, typically in solid modeling steps, I take a thing like this and extrude it to the.

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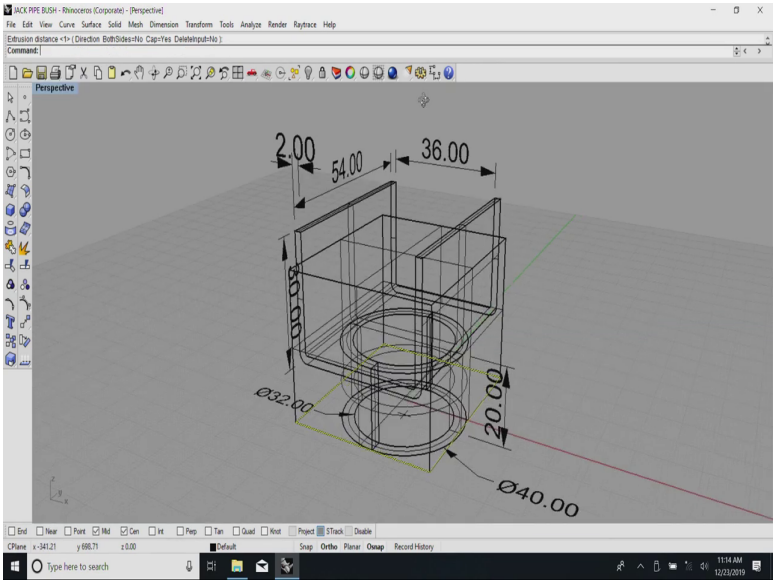

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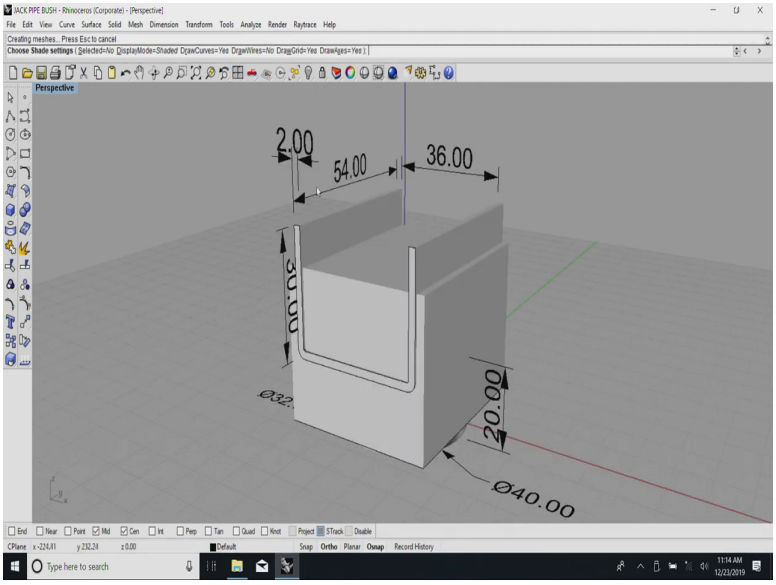

You see here where I have landed up finally, I just have a solid block and all I need to do is now.

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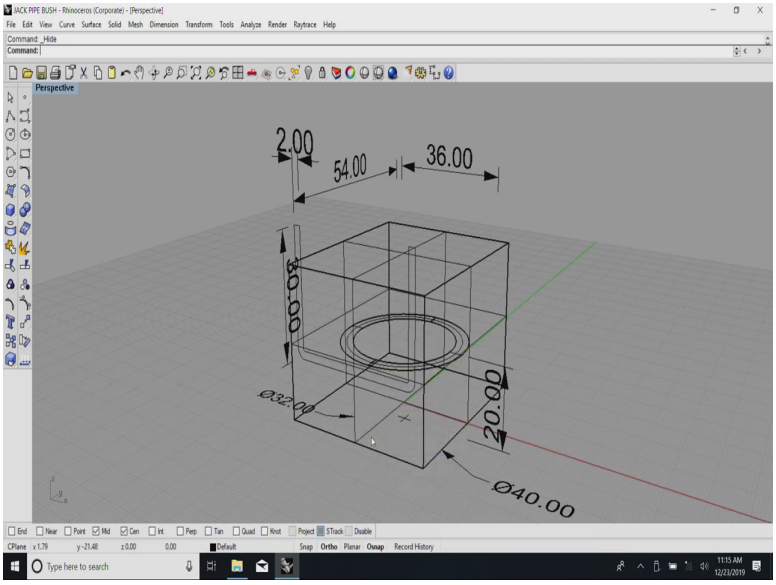

Forget about the piece which has been kept earlier; seen that, it is redundant anymore.

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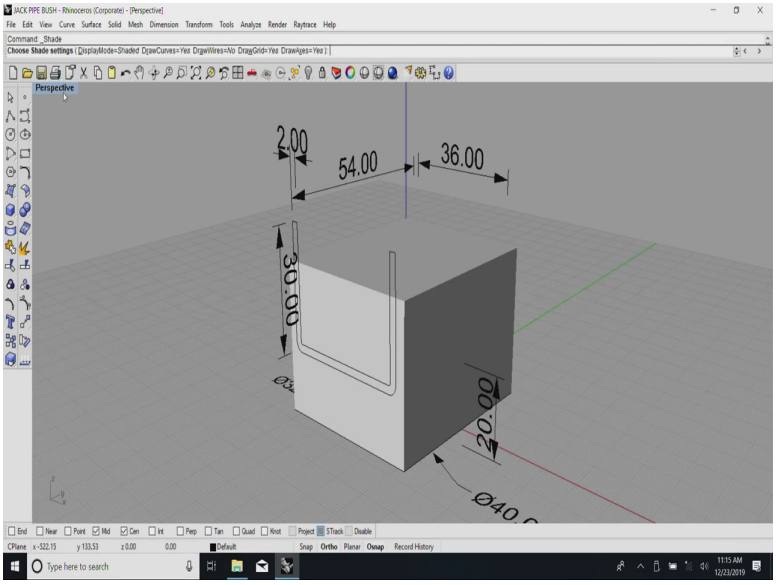

I have this nice block, this has been suggested by our my colleague in the machine shop.

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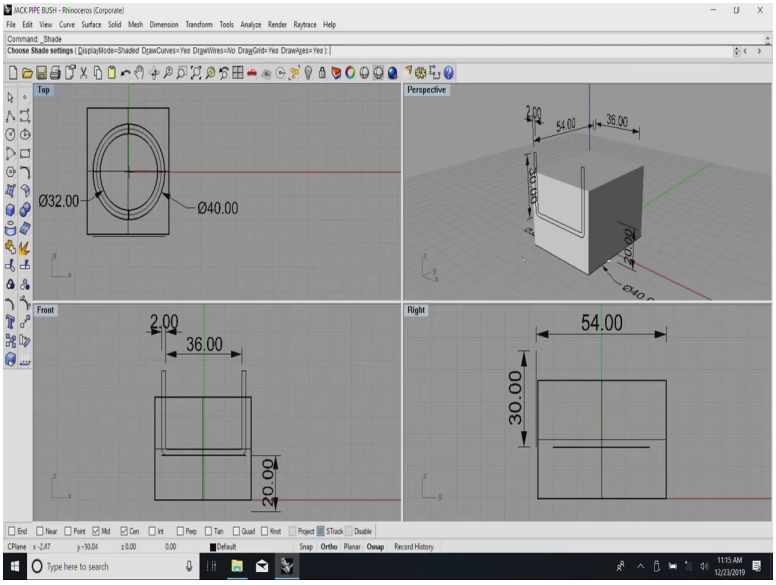

And one of them they said is, it is very easy I just take this block; then using the dimensions which I have already supplied.

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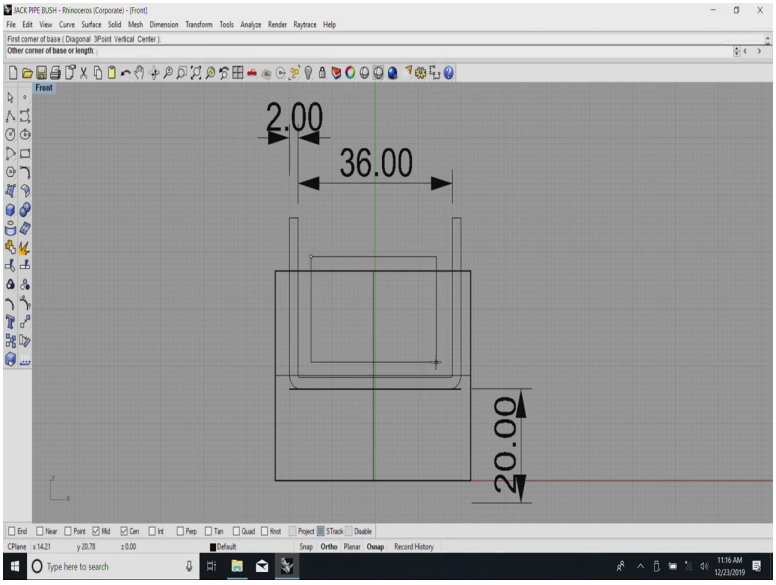

See here I have a 36 mm groove that needs to be cut through that and then actually on measurement it has been found that, what I assumed will be something which is you know say 1 and 3th inch chassis member turned out, it is actually a little smaller than that, I will measure the thing and show, you finish the job.

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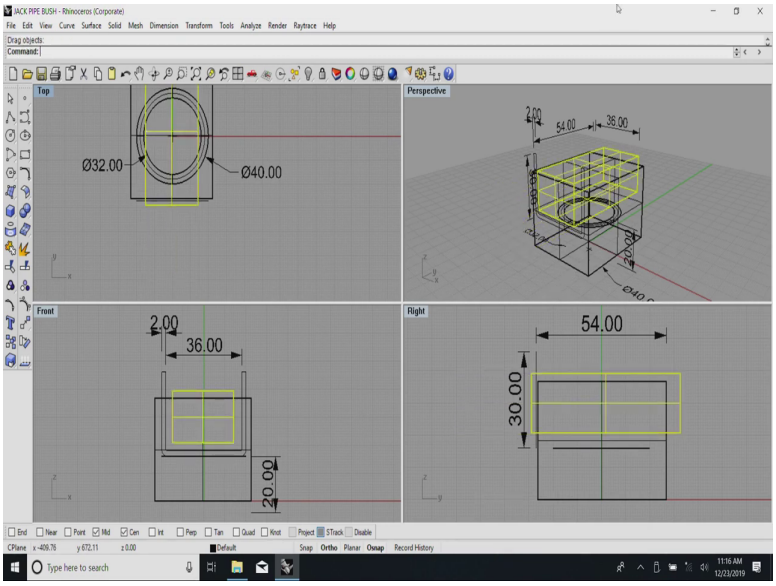

So, what they have done instead I have created one beautiful another solid of; on measurement they found out that the dimensions are given have a small issue.

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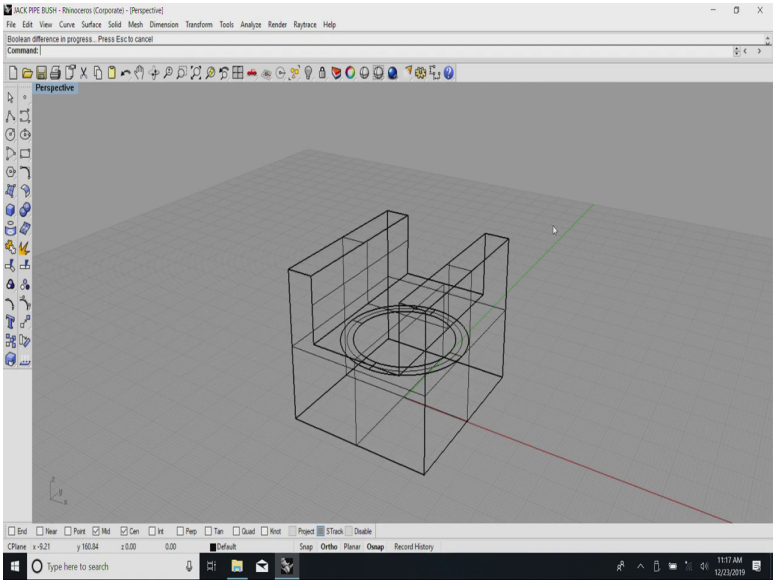

You have seen here, I will just, I am not making it as of now to scale; I will just show you the operation which is very very similar to what one can do in. See, I have made a groove by using a very old shaping machine, alternatively I can use a milling machine and take a, ok.

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We will just see it here, take this block and just mill it across like this. Can you see it here; this is the piece which they have made; they have just taken this block which I have shown you there, I milled out this portion. And on checking they have found out that the external the stock material and the amount of groove required and something which was short coming in my conceptualization; the depth that is required to prevent it from slipping, need not have been so big which I have shown there.

So, what they have done is? They have taken, they have checked with all the available milling cutters and then passed a when milling cutter in about 4 or 5 passes they could get the groove. I feel it is a brilliant, extremely brilliant solution to my concept. Now, you see it is my turn, I need to upgrade my drawing to this whatever is shown here. Now coming to the other side, I

will just lift it a little; can you see there is a small hole there and the hole and all is part of the very convenient to processing that they could do.

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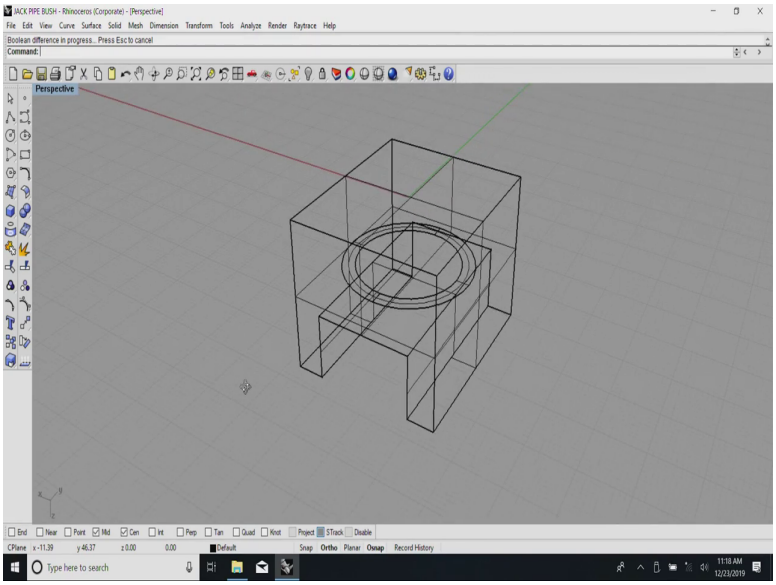

Now, coming back to my solid model here, I will now turn it over this other side and make one more time.

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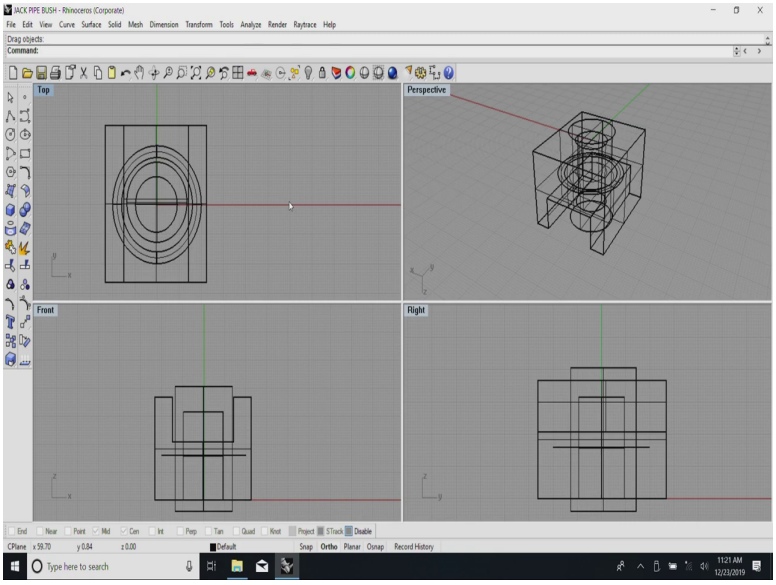

I have two solids. Now, one is the that block which I have started with and two more cylinders which are used to bore a hole through it or to drill a hole through it, depending on the type of machines and things which are available. Luckily they could find a machine which is used for initial operation preparing it.

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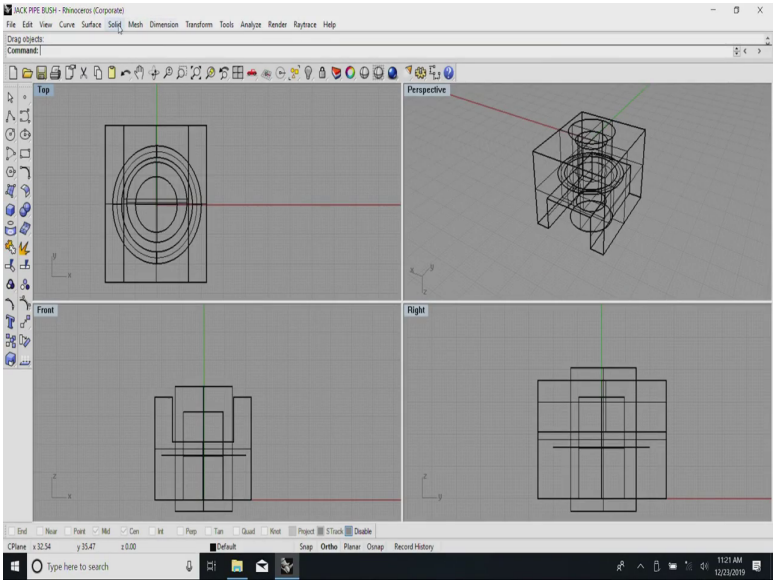

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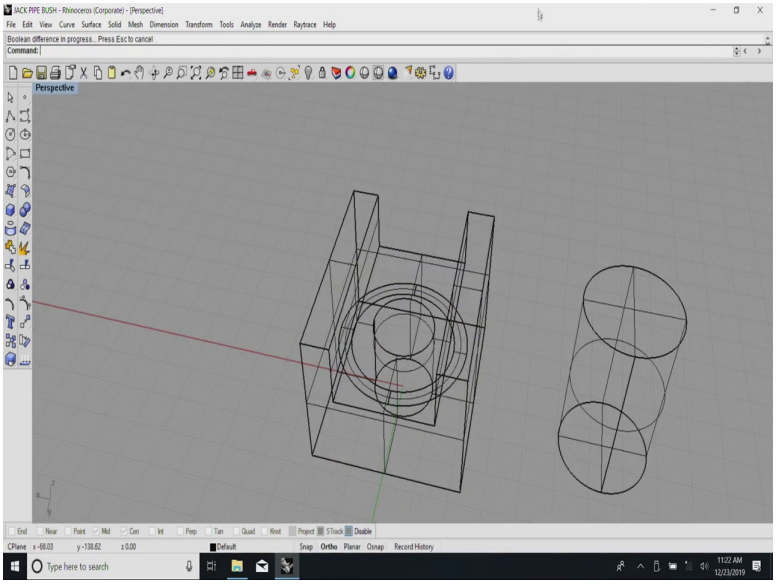

So, using that, they made a hole here first. So, if you see the solid here, they drilled a hole through the available material.

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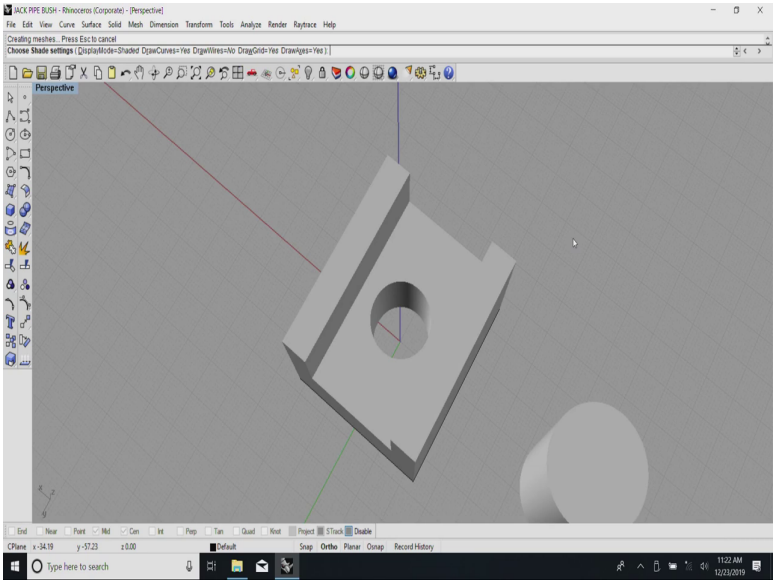

See here using a, a drill blade which is just about sufficient for it to pass through; but smaller than the plunger of the that what you call a jack which has to go inside that. The advantage of this is first of all lot of clothes end mill operation has been avoided and a drill can easily start with this thick materials, you can even fairly start easily with a 6 mm or 8 mm main drill. And in the second operation, they can drill through the hole that is how the hole that is shown there has come about.

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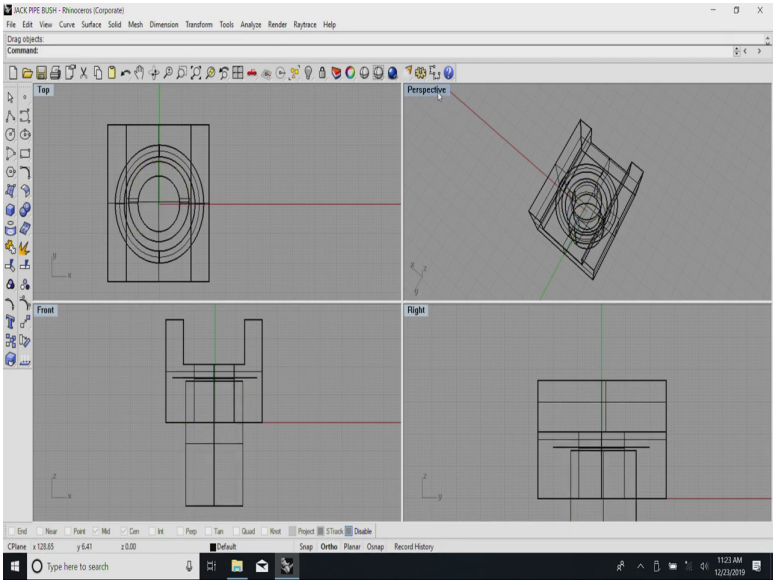

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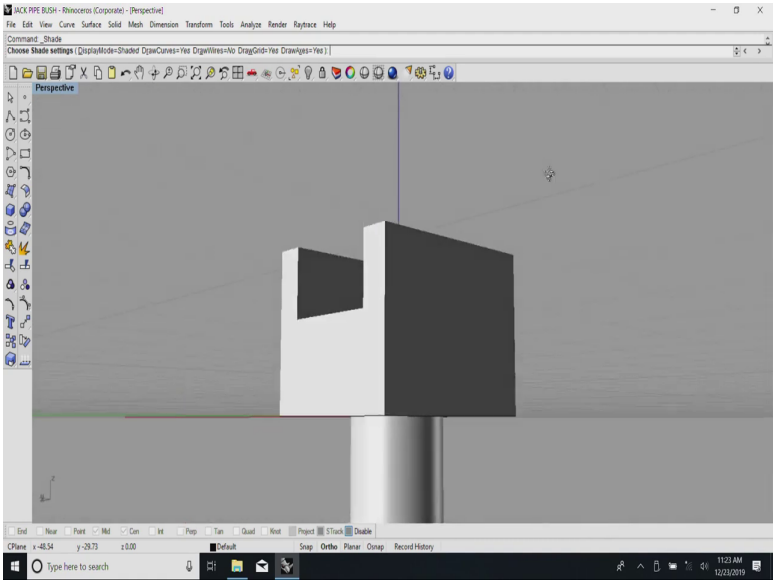

Now, after this, now see here; this is the second operation which has to be you know done a little more accurately.

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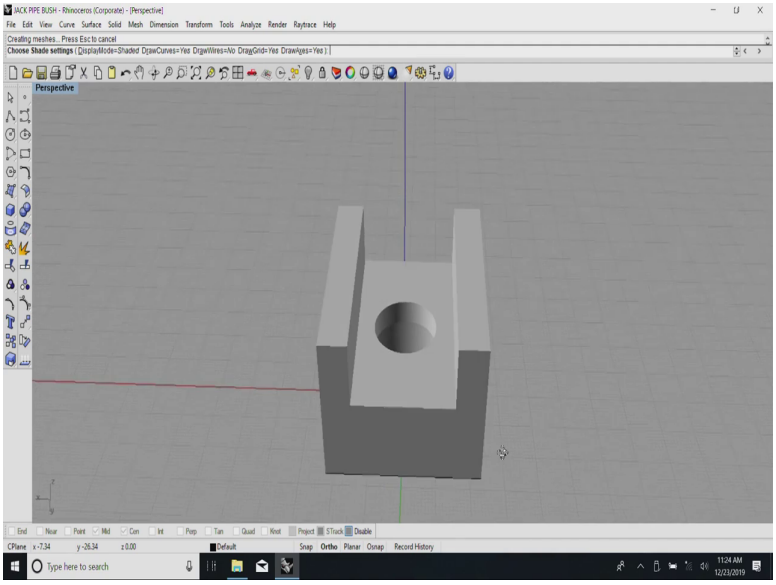

And depending on the you see here I have my beautiful job ready, seen this; compared to what I started with this is much easier, and probably eventually instead of having that sheet metal and one more bush which needs to be parted and somewhere, I can probably use this model directive to make a few 100 pieces. Instead of buying a tube, instead of buying they are since most of these are sold by various weights; I can now optimize it such that, making a few other thing is a much easier and much more convenient at this point.

So, you see here I have my job, you see here this is exactly what they could do; it is a far superior design then what I have thought about, I am happy for it. Fits perfectly and there is an automatic stopper and overall, while this has been made in using a mild steel what you call profile.

Probably it can be done in a simple non ferrous gravity casting and in that case, probably no further operation is required; because at this point anything sits here comfortably in it, at this point probably a little bit of passing a drill which even cleans this hole is the all that is required a little bit of flash may be there, the deflashing you can give it by putting it in a.

There are what you call things called, I will come back to it later; there will be small ball running inside, they keep it and all the small things are removed in that. So, you have a beautiful piece where the starting point was my concept; but eventually optimized such that, we have the job here. Now, this is where the more important thing comes saying; we should not leave it either with what the fabrication shop people have started or we should not leave my drawing as they are, so all this, the drawing needs to updated, because this is the final piece.

And there is nothing wrong in making, in fact two variants of the same thing; one is in case the cost of material is expensive and all the fabrication facilities are there, probably they are the my sheet metal and pipe work thing may still be correct. I mean, I know it is just that I am what you call probably, justifying a bad design which my bad concept like that.

And finally, if you now pass it on to a machine shop, they know how o fabricate it; this is where the concept of value engineering comes place. So, somebody will now work on this which, while I fully agree it is it looks a little like over the wall design, they take a few of these things and see what best can be done and why should we need it as a separate piece, why cannot they then come directly on the chassis.

If there is a chassis, all the chassis requires says two small plates on the side and this can be made to perfectly align there; if the plates are formed properly, anybody can put it under the jack and lift it up. So, one more time engineering has helped us a lot. So, I hope you got the point about this saying, we have a concept; now I have tried to launch the concept with the best of knowledge.

Now, I come back and try to modify the original concept drawing which I have made; which is very easy if you see carefully, if you see the drawing very very carefully, I started with whatever.

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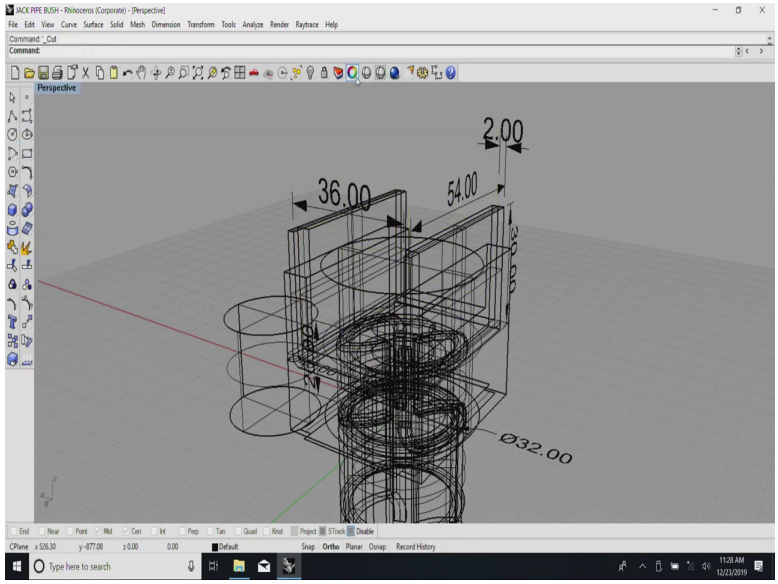

You see here, so many of the stuff is still hiding inside.

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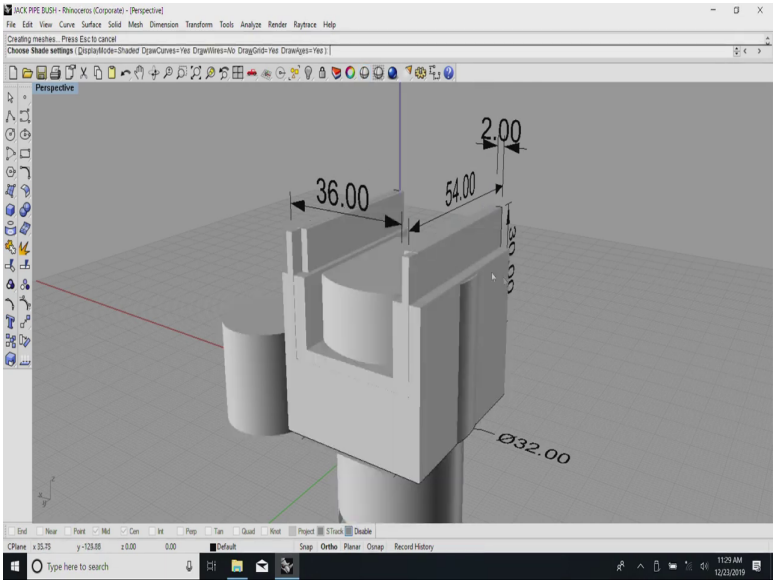

So, both of these are sitting one on the top of the other; there are so many variants sitting on this.

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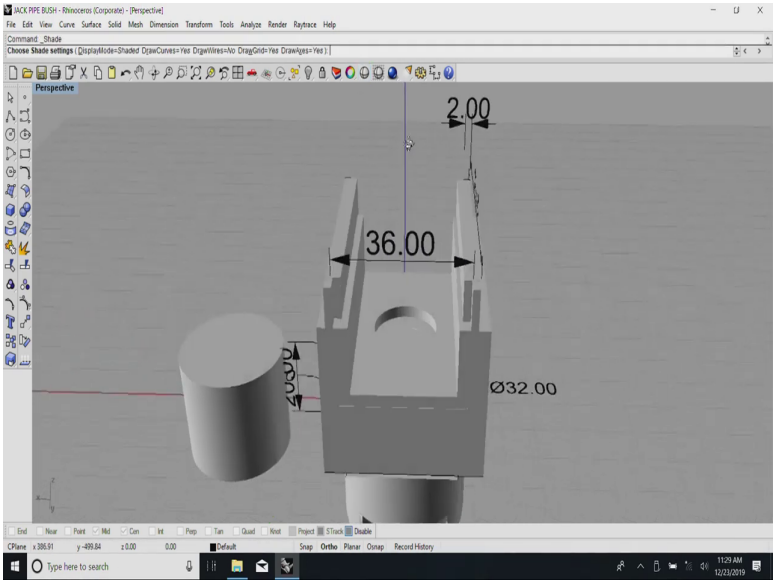

Now I clean up the whole drawing and we have a really two variants of the parts; all possible variants have been worked out here and it is just very very easy for me. All this garbage which I have put is not no longer required, I just delete these things which I do not need; just retain whatever was fabricated in the shop. And so, I have two variants of it; one is my concept which I tried to improve marginally on it, which can be always kept on file, and I have this finally, fabricated drawing which is very easy. So, for each let us say it is a part of some electric vehicle jack at the bottom, I probably require only one or two things of these things.

Now, comes the further advantage for him; if I just carry this along with my toolbox inside the vehicle, most of these jacks already come with a standard dimensions. You see here, this is probably a 1 inch plunger which goes there; I just need to carry this adapter, and when I put the adapter, it is a part of my toolbox. And unlikely case I might needing it, all I need is this, I

put on top of any 1 inch jack; put it on top of the plunger, it is working. I feel this is one way which most of the people do when things go in small quantities; when very large quantities are involved, of course they pass it on to the process people.

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Having done this, now I need to further talk about other things here. If you see here this is a vernier, sir show the side of this thing; see I need to now spend a lot of effort in finding out what should be the correct dimension, what should be the total length of engagement, what should be the dimension here and, what are the clearances we give such that it sits comfortably, ok.

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Then another important thing is which was required for us is saying; I completely miss the requirement for a small grub screw there, that grub screw has multiple things. One of them is it will prevent this from coming off. There is a small change in dimensions here; so if I tighten the grub screw, it will see that it cannot come out easily. Secondly, even see, now it does not come out, this orientation also depending on the way we want easily we can fix the orientation.

So, by adding all the small detailing, now I am much, what you call much more prepared for the job which is it is to 100 percent. Now, somebody can take my file and go and work with it. Now coming here again I will notice that, the way this is fitted to this; you understand the amount of gap that is required is where your limits and fits and tolerances will come. Now, I will now move this to a very very what looks like a mundane this thing.

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See just a round circular piece, I do not even know what it is; except that it looks like a weight, you understand this looks a little like a weight which is required. Probably it is part of some I do not know what it is and where they got it, I do not know it is part of some dumbbells or something like that; which is you shall come to know genuine real, real life problems.

This is called a punch and die, seen this here; one thing you will notice it is ground, perfectly ground on both the directions. And even the outside what looks like a insignificant redundant thing, heavy amount of machining has been done on this as compared this other one. You see here, you can see that it has a beautiful glass surface; this is stock material, it does not nothing like that has been done here.

So, this typically is a die which is used for making openings in sheet metal, and usually they come as a die set and one of the things you will notice is there is a something which will prevent it from moving, an orientation slot. Similarly on top also there is an orientation slot and anyway you cannot see it clearly here; but the dimensions are written here.

I will read if for you, it says 12.82 millimeters diameter and correspondingly this one is a 12 mm punch. This is where another type of clearance has come into picture. This the clearance between these two things is a process parameter, depending on the type of operation, the amount of forces involved, the type of material thickness and the condition of the material, the clearance as between a die and a punch are determined.

This one is meant for one type of operations where 0.32 mm has been given here. These come in a different way. Now the problem comes is how do you designate these things, what you mark on that; which if you remember I told you on the drawing saying, we maintain a nominal dimension saying 10 millimeters and we write H 6 G 6 or K 6 N 6 like that some lettering we do, but the basic dimension is separate same. In these cases, both of these things I wanted to show you; you see here this is a 8 mm device 8.32 is marked here, something 8 is marked here.

Now, you may be as a operator or as a designer you may be confused; why are all these dimensions marked there, that is one way of doing it.

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And this is other one, in other places what they have done; they have marked instead some big letters a 10.5 is marked. Why is 10.5 marked? And the same 10.5 is marked in other places and both of them are still there is a small elements inside. This is one way of doing where you directly mark the whole size or the opening size that we require.

So, persons were looking at the drawing and tooling it up; they need not go around now looking for what should be the clearance, what should be the various other things. Instead we have a box in which all these die and punch sets are stacked and kept, we just pick. So, you have one for 10 millimeters, you have we may have one for 10.3, you have one for 10.5. And the word and sorry the lettering 10.5 is directly marked there; somebody just looks at that 10.5 and picks it up and loads it onto the machine. So, this is very very useful whether you do it manually in small numbers or you load it on a turret press.

In the case of turret press the tools are very different, but there is designation saying; what type of material, what type of clearance to be used and all that. For one type of material they have given a clearance of 0.32 millimeters, which is slightly a little high; but I right now allow me not to what you call not to explain this.

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In this case of materials this is probably I meant for a softer or aluminium materials which we stock. In this the clearance is actually only 100 microns, which it is like taking the difference between a paper shear, difference between a cloth shear and difference between a tin shear. Tin shears and all have a different clearance and that blade angle compared to a paper shear and I think you know about it hobbiesh hobbing scissors how they do and so on like that.

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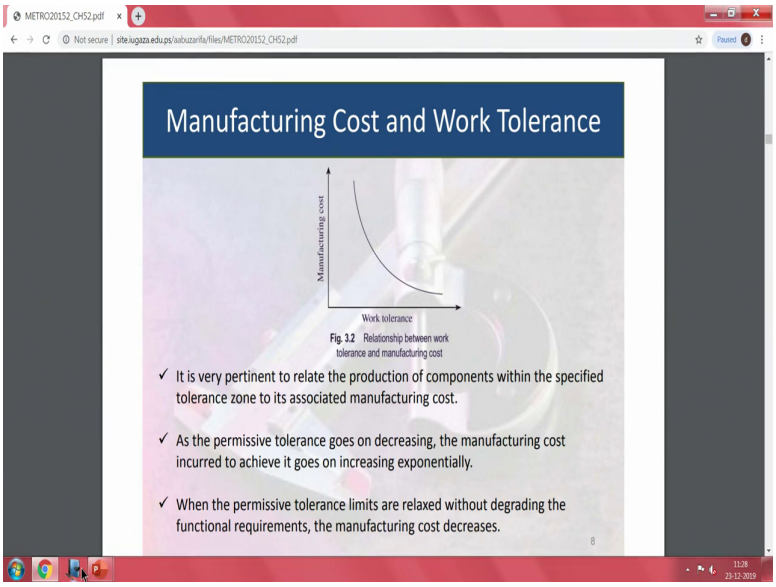

These manufacturing cost and work tolerance is very very important. Seen here, the manufacturing cost comes down or rather it is the other way; the manufacturing cost keeps going up, if you want parts such closer and closer tolerances. There are ways to overcome that, but still the important thing is it is written here; you have seen here, the operative concept is saying, when the permissive tolerance limits are relaxed without degrading functional requirement.

The important thing is functional requirements; this is where the designer tries to make his own what you call gift of judgment, saying where is it we concentrate on, where is it we concentrate and give very close tolerances, where is it that we can permit relatively loose or other tolerances by which we can achieve a lower manufacturing cost.

As if you keep things lower and lower, you end up with ridiculous amount of manufacturing cost to achieve goes on increasing exponentially; the problem is this, the slope now keeps on increasing very very terrible way of doing it. So, two ways of there; you can specify things which have a loose tolerance, but then functionality will be compromised. Or analyze what is creating all this variations and try to control the process; meaning a lot of them may be because of wrong holding of the job, lot of them maybe tool ware.

And instead of waiting for you to observe a variation in the finished part; after a specified number of operations remove, mount a new tool, inspect the older tool and then start reworking or sending it for some other thing. So, process improvement is part of the game here, and why am I talking to you when this thing is about making proto types; because the whatever cost and all are incurred here, eventually reflect in your prototype.

And if you tend to ignore and the final product, the final product prices keep going up; and if you stick to standard or accepted norms in the industry, chances are you will come out extremely well.

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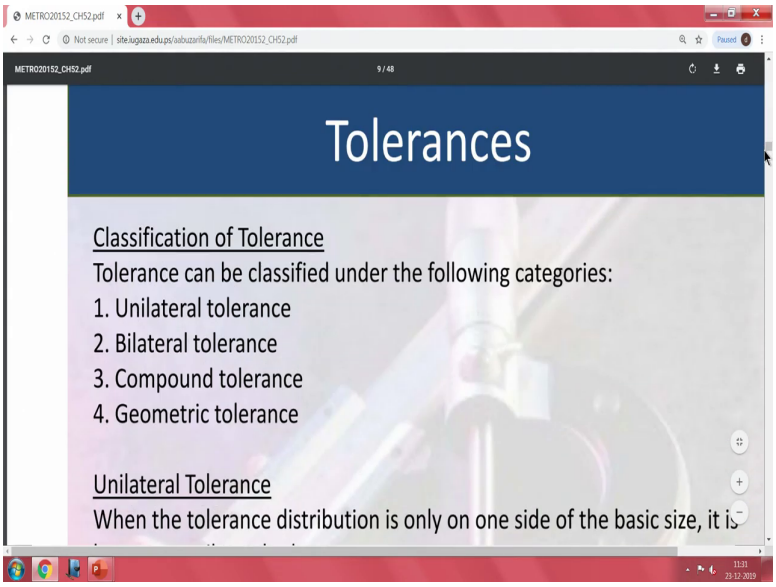

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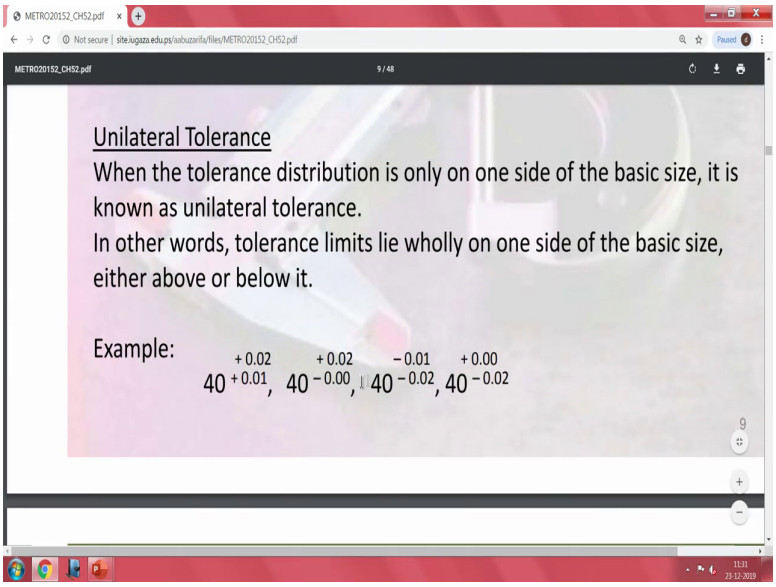

Now, see what our next slide says, this is already covered, if you remember compound, tolerance, geometric, unilateral and all this know; we have, this is where I wanted to tell you in the case of that punch and die also in one of them the basic punch has 12 mm marked on it.

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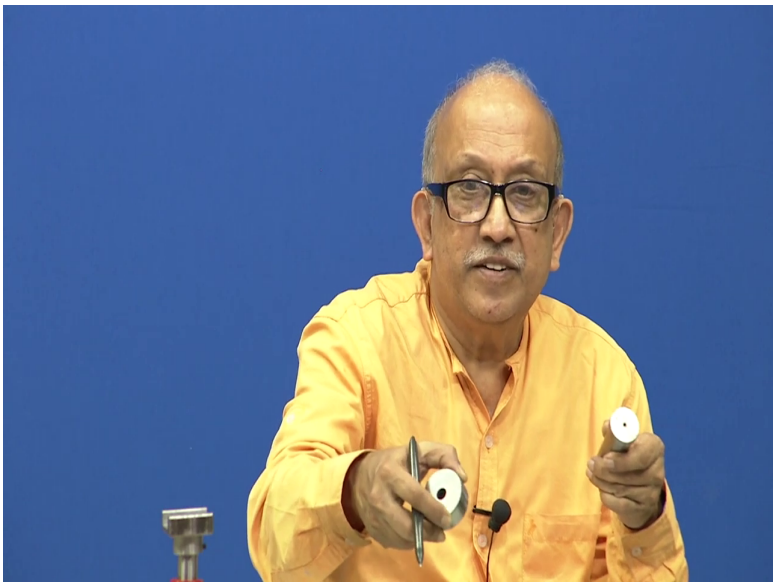

This basic punch has 12 mm marked on it; die has 12.32 marked on it. So, this is fully based on this type of thing.

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Other is, this is a directly nominal system, by which somebody already has calculated all these things. So, I have 10.5, 10.5 marked on both of them, and actually this is 10 point probably either 58 or 10.6; then correctly it does and then other side other process things are maintained there, you have seen that, it is not a just a simple hole, there is a clearance and things are mounted like this.

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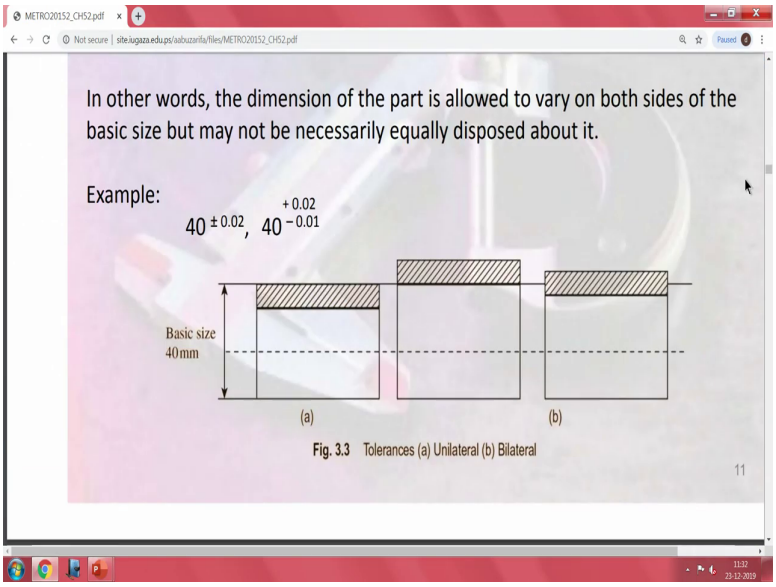

So, if you come back to this main designation here; you will notice that the same thing, which is a repetition of whatever I have been telling you about.

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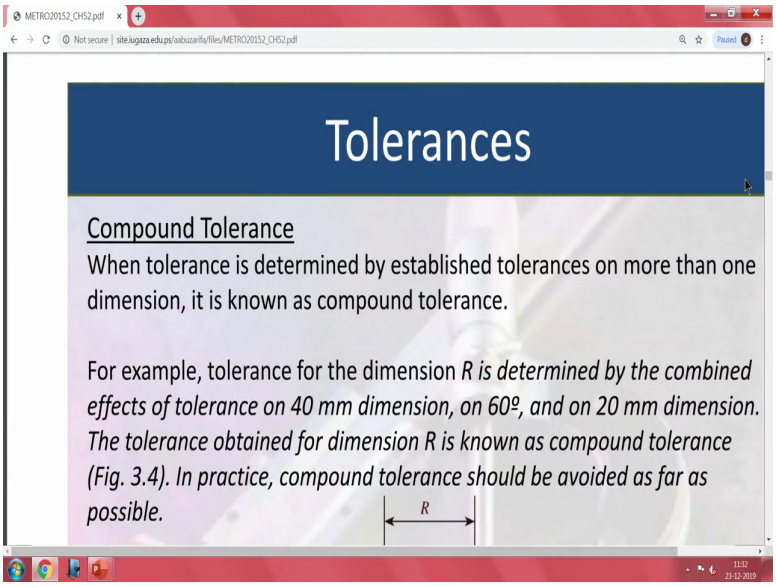

So, my suggestion is go to this the website that is mentioned there.

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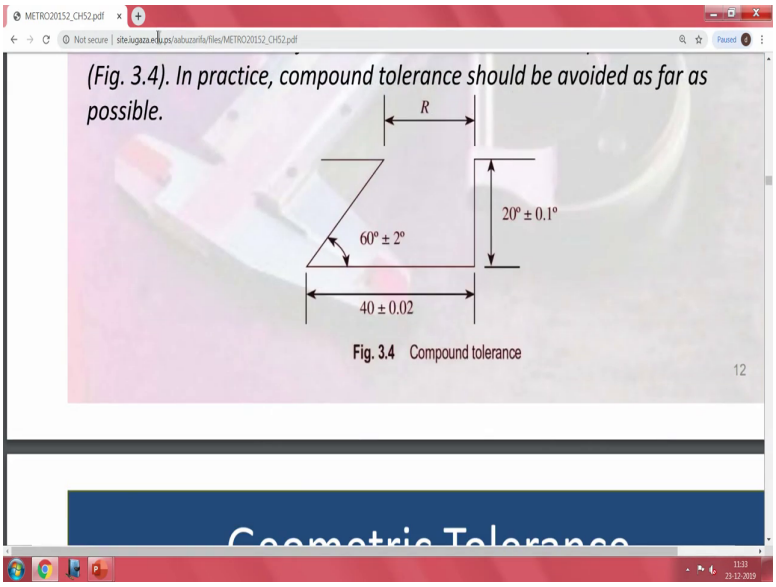

And then try to improve what all you can do.

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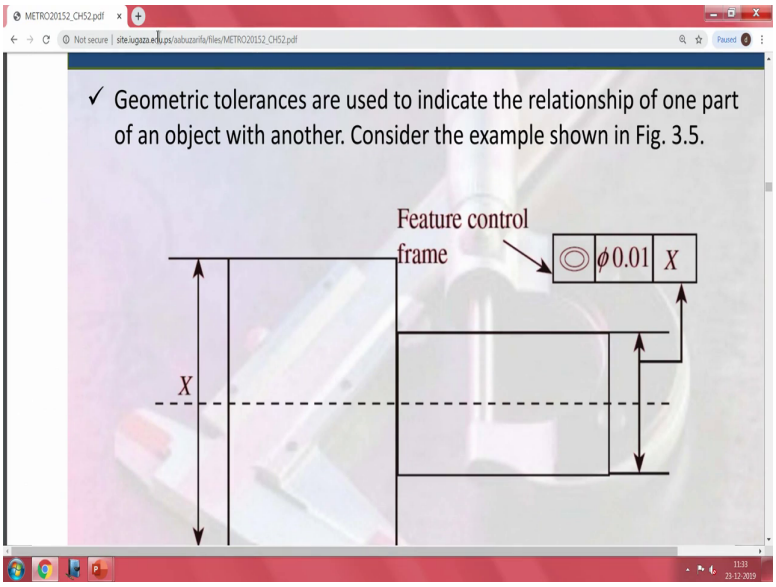

Now, you see here, there is something else which is mentioned here; everything including ovality of the job, whether it should be allowed to be oval and within what level that I mean within what the outer thing and all is there, and other some other item which mentioned here.

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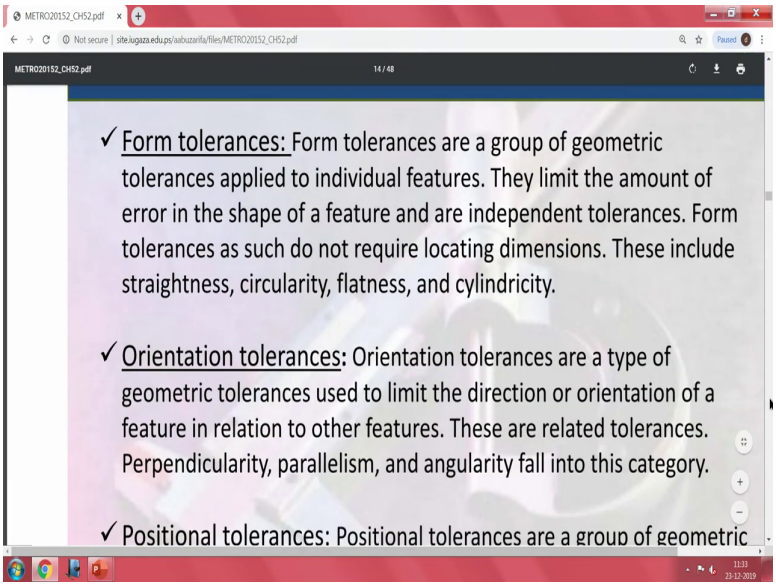

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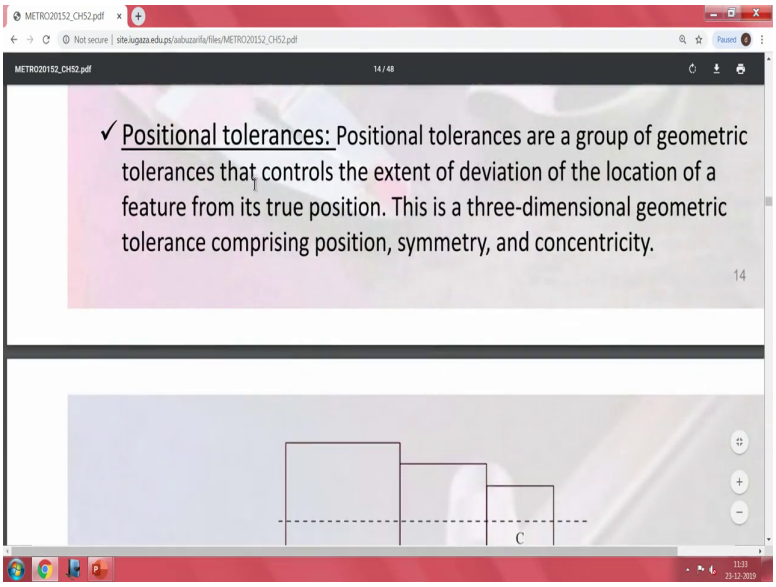

So, you have things like form, orientation, positional.

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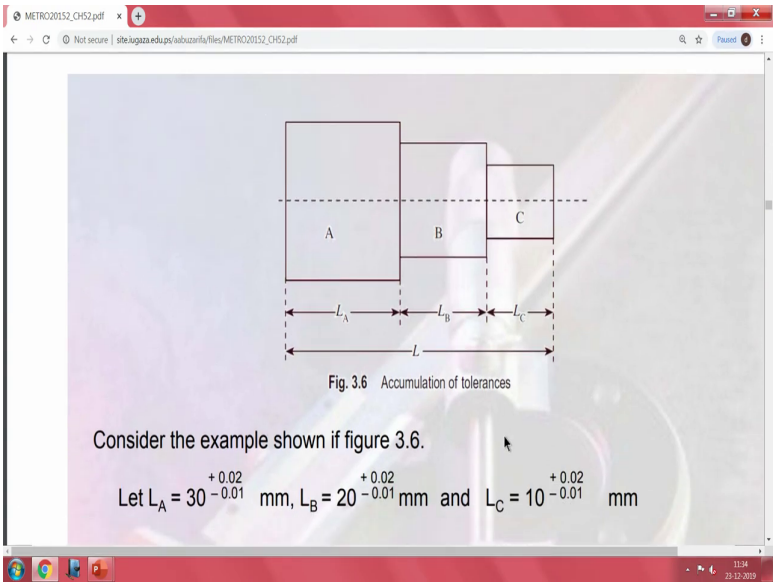

Seen this, so many of these things accumulation of tolerances, which is also very very important. Sometimes what will happen is, if let us say you allow 0.1 millimeter here; plus 0.1 here and plus 0.1 here total ends up with 0.3 millimeters, and similarly it may come down to less than point, I mean the basic minus 0.3 millimeters.

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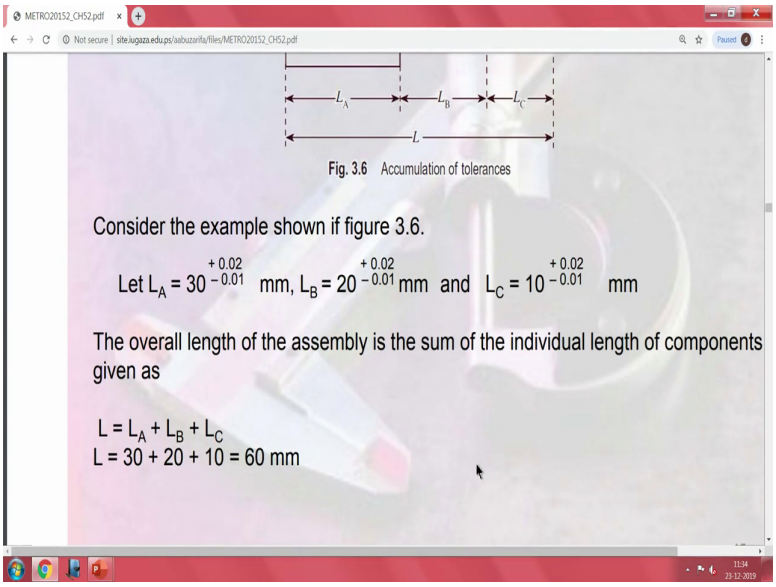

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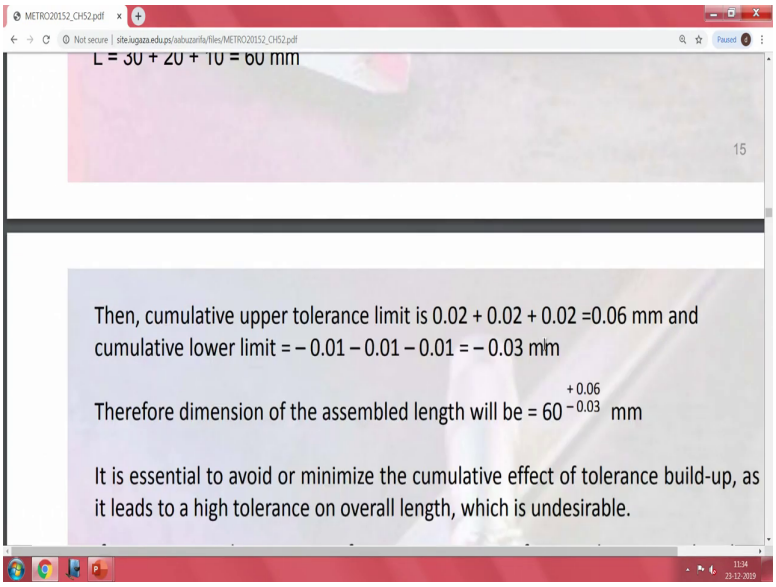

So, is it allowed or how do you take care of these things? You have seen this here, in 60 mm you have ended up with assembled length which could be 60 microns more and less than this thing.

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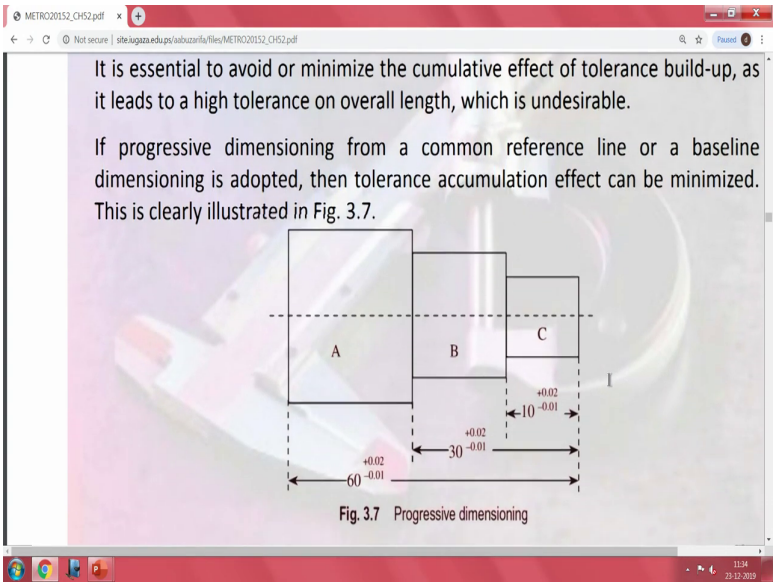

So, what is typically done is; one of the things is left or they are equally divided to make sure that such a thing does not occur. And here instead you see what they have done, they have made progressive dimension; saying from here to here, it should follow this, from here to here it should follow this. And if you see here, here is again it is 20 microns, here it is 20 and it is also 20 like that. So, as you make or progress this thing, a small amount of things can be kept under control.

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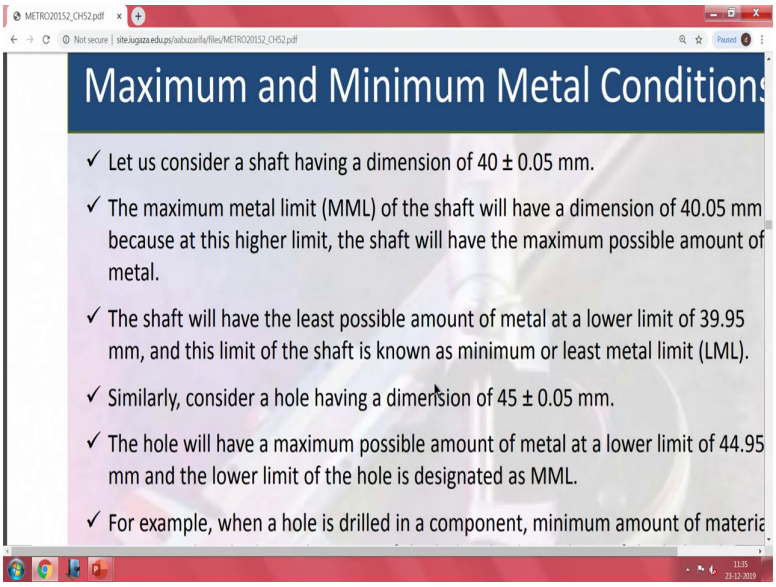

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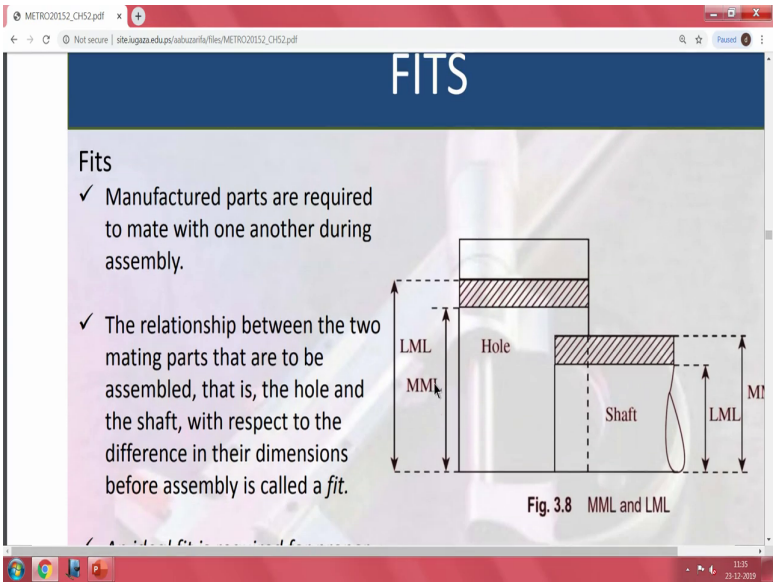

So, when you get a chance, you try to read as based out of this; saying we have the hole base system.

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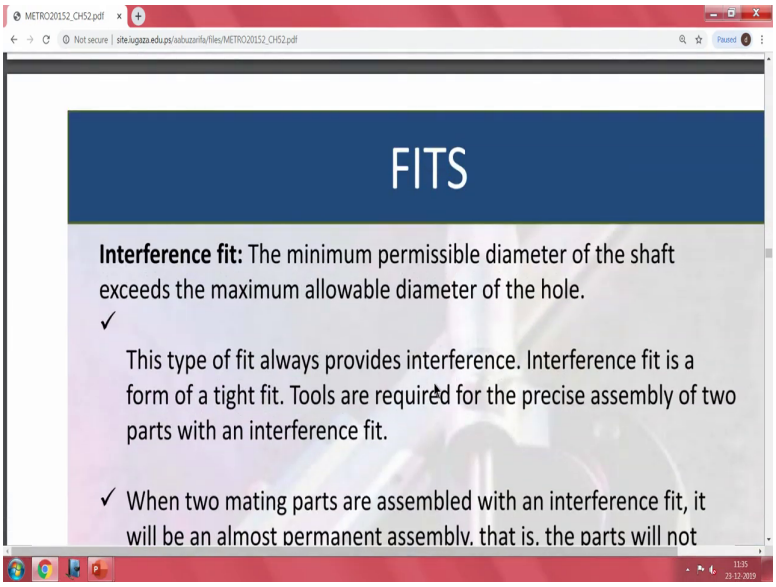

Then we have the, this is, I mean it is a standard; anything you take, it is just I found out something which is useful, it is called i u g a z a at edu, ok. So, we have a beautiful website which shows anything which you need to mention about it.

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So, at this point, I will try to stop here and I will just try to show you a small example of something which I have shown in the case of your 3 D printing. This has been made on a precision 3 D printing machine; in this precision 3 D machine I have a printed circuit board, which has all beautiful all things mounted. And then when I keep it here, there is also a small opening here which is used for turning the trimmer, then there are places here to take out connections. And most important is, this one is through hole metalized wire which is used as a thermal wire; that thermal wire touches this plate and there is further insulating coating.

And after that when I assemble it like this finally, and even if I part it, I have a beautiful perfectly working unit, which is a I think it is a buck converter meant for the for taking any like a standard input. And then this particular one was made to connect to a battery which while charging is 14 and half volts, and the output typically it is 12 volts and very rarely it

falls below that. And in the unlikely case, if it falling below 12; this looses about 1 volt and still it pass, it is passable.

So, in this case if you see, the clearances everything have been made very very carefully. This printed circuit board is routed, so there is no issue about it. This is done in a 3 D printing machine, which typically gives us without too much of a problem of plus 0.2 mm tolerances. So, but why I am saying this, the same model which was used for making this by hand has also been used by running it through the 3 D printer and having this job ready. I will continue with this saying where there is some improvements we could do with this.

I will stop here.

Thank you, we will meet again.