Enclosure Design of Electronics Equipment
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Lecture – 21
Video of Fabrication

So, good morning. Today I will say if I can take you to work shop, and say practically how we can make a small unit which will be similar to what I was trying to show you last time

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I hope you recollect this bugs. Now these are all existing products that I have shown, instead right now I like to go back.

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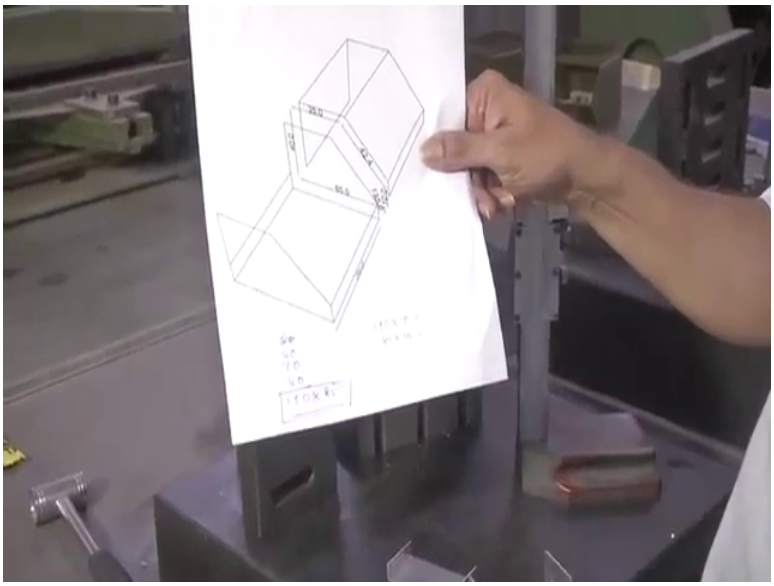

And see if one particular unit like this can be fabricated. You will notice here the details similar to the other process which I was talking about. Except I will just for the our convenience I will try to copy and say, I have all the 3 videos are fit. Do not get worried about is it first angle, is it third angle, is it as perding or is it as per the American system or anything, you just for beginning so that we can understand the perfusions of this particular product. If you remember earlier is spoke to you about saying this could probably be a front panel. Then this could be probably be a top, then this the back, then this is the bottom. Have you set all these things I would like to have some dimensions associated with it, saying in proper proportion.

So, if you remember earlier now I will remove this by hand, I want a box which is above 65 mm and then typically the height could be above 40 mm and then top portion could be around 35 then I have small step which is 10 mm here. And then something which is I wide as 70 mm there intentionally I have not put I was I have not talked about is it an external dimension or is it an internal dimension.

Now, we come to the important aspect of how do we split this box. Do you have a top and bottom which slim belongs to wear. So, I have had a talk with the work shop people, and then told me while this is all right if you can follow the same.

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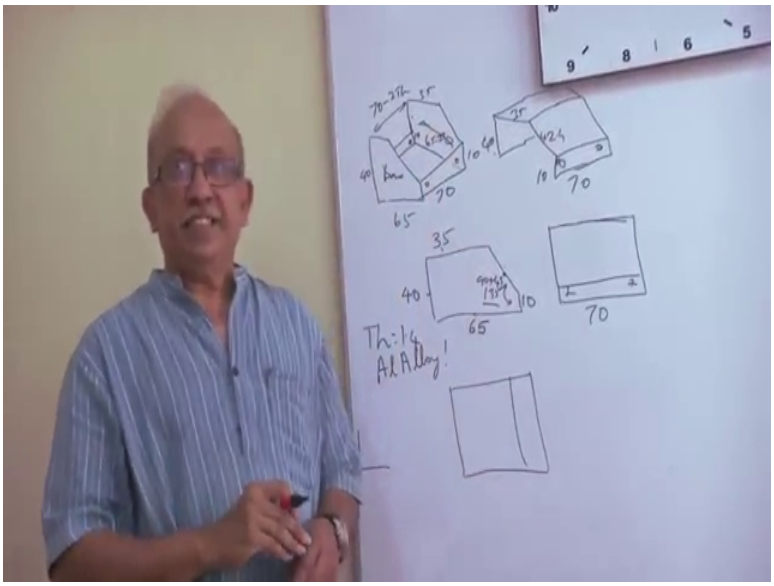

It probably make sense if I make a top which is the approximately like this. The same 10 mm water ampere gets can I here 10 mm that same 35 mm gets can it here the mac there is a 40 mm plus the fabrication person has suggested that I have also take a small unit here and then as before this continence to be 70 mm this continence to be 65 mm. It is a little throat. Because over the years I have ask the capacity to draw a straight lines on a board, but if you have a proper draft and all that is possible luckily, for us these days I can very easily use a computer and get all these pictures on that.

Now, compare to come back to here this here this forms what I was call the base. Now falling in the same thing on the other side I have a cover which stores the follows this like this. Seen here approximately follows they have also the same dimensions are represented here, 10 mm then there is 35 mm, then there is a 40 mm here. In one dimension which I have intentionally left out here is this is particular dimension. When we are lying out the sheet; obviously, it is easy we just need to mark this and then you mark this after mark this 10 mm by joint these 2, 35 and 10 and then it comes automatically

However when I want to spread the sheet here, using some usual geometric calculations I need to calculate, it at this point I would like to add here from various what you call practical purposes. This experiment to 135 that is 90 plus 45 degrees. This is one which I have talking to about how inclined planes are made and so on.

So, we have 2 unit is here and then depending on the what you call the our strength and I means the amount of quantity. We would like to mean probably, I need to make to small openings which I can use for closing the cover. I need to make the small openings to make the cover in a very simple what you call unit like what I have been showing around, these it is conventionally to use a simple self tapping screw we just take screw and then you just tap it. And then usually self tapping screws that looks too small invalid kept one in the work shop I will show you advantage of self tapping screw is just need to make 2 holes put everything together, and make a small pilot hole and afterwards you can just use this and then the whole thing it is covered without any problem. I will stop here.

After going to the workshop and looking for material we have found out that probably 1.4 mm they material will be suitable 1.4 mm aluminium alloy. This you will best understand if I take you to the work shop, and show you their how we end up with saying what are the wanted dimensions. So, in this way the external constraint of the box I have want you wanted the internal. And the moment we have this 1.4 mm whichever while you rotate it. If under the fix is a 70 this internal dimension will be now 70 minus 2 thicknesses.

Similarly, if you have could 65 here. Once again this internal dimension will end up with 65 minus 2 thicknesses, which is still an issue. So In fact, to make our things easier, I have asked our my colleague to help me with make one sheet, this is sample sheet I will consider and that is what you call drawings are there. What the sample sheet will do is he will take across section across this.

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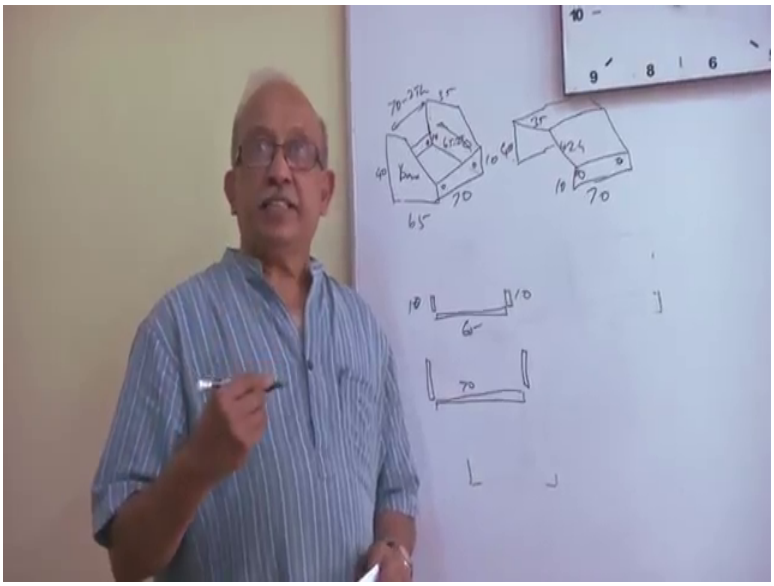

So, I have 10, 10 I am sorry, 65, 10, 10 oh we have ended up with this problem. Say now is this external or is internal. This 65 the external dimension we want or the internal dimension same way the other direction I have a 40 mm in one direction and length of 70 mm in this direction and here 40 mm in this direction.

The physical properties of the metrical and the physical conditions in which the fabrication is carried out, has precedence over a simple equation, even if you go to the best professional says one of the thing they says, blank calculations are only indicative along depends on the direction of the grain how will the material flows what they what is the property of the grain flow of the material, and then we take about the minus small t r and all the calculations are there which is anywhere they are available on the let us just notes what we have. So, from here I want to stop and we move over to the work shop.

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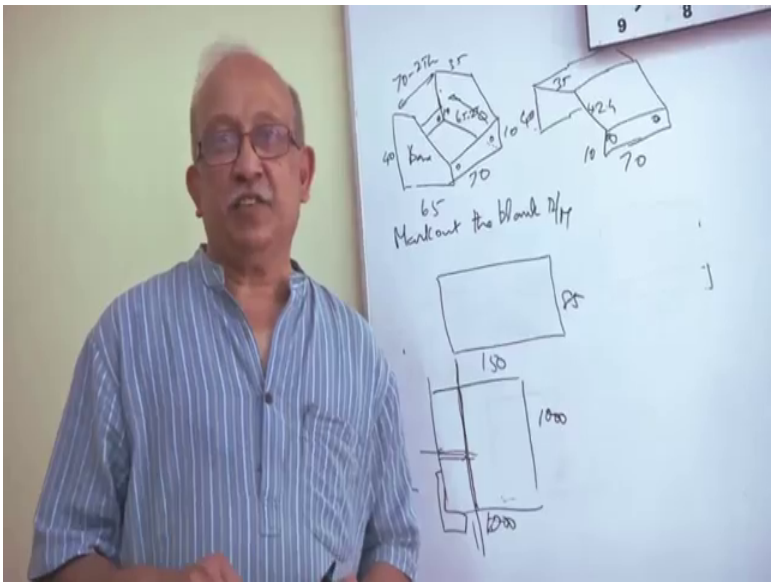

So, in these in the sequence of operations one of the very, very exhausted materials mark out the blank a raw material. So, after lot of calculations we have come out with saying we need a sheet approximately which is 150 into 85, only for the bottom piece now we have the top piece. Now we have in this case we have a 10 plus 42 that is 52 ah plus 80, 92 plus 31, 33. So, we end up with something which is 70 mm wide and all these various dimensions are there.

So, what this they are people will do is they will do not near what is card and huge shearing machine. They do not cut them anymore you have do not take what you call, tin cutter which you want to be in case of hobbies instead. We have a shearing machine only to mark out this, you need to mark out this on a large sheet. So, what they do is they take it to what is got a height gage. We got our proper what you call, a surface the different surface I will show you what it is the one we have is an orgentical and it marking plate. So, on while marking plate they keep a huge that a basic raw material and then if this is one to be the basic raw material usually raw material come and the size of probably around 1 meter by 1 meter 1000 millimetres. And they need to square per corner even square per corner then after that it start marking depending on how you want to like to me a first mark here and one more mark here.

Now, we need to take it to the shearing machine cut along the slide cut along the slide. So, in the end we will have the beautiful raw material to start hum. So, we will now move on to the work shop from here.

So, you see here this is oiled granite small surface plate. Then we have angle plates are this one is a large shrink.

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And this is the height gage. Height gage is nothing except that you know here we have a nice reference surface. Then there is a knife edge here it is small step and it is a dry 0 here and then this is possible for us to adjust it, and as before we have an vernier, then we have a vernier screw set up.

So, what he does is, he is trying to make the small trial thing which is around 50 mm or 10 or 20 mm wide and as per the total lengths. So, he has set them marking here, he first locks this then after that he operates this screw and ensures whatever the dimension you want is make here.

Now, he was marked it 10 mm, now you see here he will keep that plate across it, and he has cut it then you see those 2 marks. This is the blank which he was cut from a larger thing. We can see that there is a mark here it 10 mm there is a mark here it 10 mm. This totally say 85 mm we have an 80 mm 5 mm sheet then it suppose 25 or 30 mm wide now

it will it will like to say it depending on how it bend it. What are the total dimensions we get? What is internally you get it, and what is externally get it.

Now, he trying the next sheet see once again he will sets the desired dimension. Use this that small screw so that in steps of 0.05 millimeters he will be able to locate the, he has made one mark there he has made one more mark here, and we have a sheet seen here the 30 this is only a test sampled to see how well all the dimensions we have marked here. We will come out in that stop.

This is a typically a folding machine with figures. So, see here the one part of the joggles are can be or modular are split.

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Then this will starting from around 10 mm all the way up to 180 mm, we have fingers which you can adjust, advantage being in case all ready a sheet is bent like this you can keep it here and put it there theory. Later on I will explain what do we need to do is, this radius would be, there is a small radius here, any peak to a bend and all the radius will be following this automatically. See what he will do is now, he will try to as per the marking he will try to locate it there. You will notice here in this case we mark the clamping line and not the bending line. There is edge of the clamping line.

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Thought he does it by practice. Normally in that a case square to make sure that this is perfectly at 90 degrees. You have seen here very little air ways there.

Now, it will ensure that we get a proper take all when. We have something which clamps it here. So, we have there is marking of the what you call clamps. Now he will trying to, now he will trying to move it up like. This in the cases small job shop and the normal materials; obviously, precision is wide and then you see after bending is completed. We will check whether it is 90 degrees or not. And we will compensate for any spring back or short limb has come. So, it look like around point 3 mm error is there and open length and then he has now adjusted it and you will know one more time he will check to see if it is perfect. See it is reasonably perfect now. Now he will try the other side. In now I will go little faster.

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Now, comes the critical portion of checking, what is this external dimension what is the width that has made what is this which was come. We are interested in the external now I need to worry about what is the thing he will explain to you. In the cases soft material is like this, but you see here some of you may have seen such items.

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It is a taken from an exercise cycle which is used for tensioning the band that is there the break band tensional; obviously, this is very thick this is something like you know 3

point 2 mm steel sheet. And then all these things are designed for power. So, in these cases you need a regular power press you can do it with a hand press.

So, you have hydraulic bending presses you also have very complicated forming of the thing, and if you see carefully this piece is one piece, but this outside there is almost have 180 degree bend to economized on the material there. This 180 degree bend will make sure that overall things are very convenient. And then you see here there is something in this direction there is something here the something here this is all done by special purpose machine with heavy loading of the things. And if you are to attend something like this it may not work easily on a simple folding machine.

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But this is a thing which is to cut us (Refer Time 18:16).

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See I have a few samples which I have been lying around here, while these 2 are easy to manage. You see here we have a clamp which is precariously in the shape of is it while in a symmetrical section like this we can talk only about the internal or we can talk about the external. We come in to a certain thing here where external is here external is here we have a combination of internal. And then it is not easy for us to determine what is the internal here. So, I had one point these internal this point is an external point. And this is an internal point. This is an external point. So, this is a reason why we need to work about and learn how these things are made. We have seen this very easy to talk about an internal, internal, internal or we are talk about on external.

But in this case part of it is external and we take this dimension full thing is external. Now how do we get the internal dimension. While this is easier to manage now we are come to a very critical thing, this is part of the door lock which use everywhere. Not very, not very easy to fabricate such a unit, because you see here this one is long and this dimensions are separate and then there are some special openings here and as if that was not enough is also a embossing here. And there is a fold over here. Now we need proper strength.

So, in this case they have selected the limbs and the thickness such that it overlaps here. I am still interested in the internal there is a small thickness overlap here. In the case of mild steel welding is possible, but when we want to work with these materials with

aluminium which not as easy as it things. It is a very 2 thin sheets like this there have joint together to very thin sheets here. You see here this weld has been made little deeper. So, it as come on to the other side and you see if you do not want any build up on the inside you can probably just weld it on the outside. This is done with a loosely we call it arc and arc welding. So, we have a shielded gas shielded arc welding. So, in this case to prevent oxidation we have a arc which is filled. And again both types are there one is you have a wire feed inside, which has the plucks has the less the raw material or it can be a just a tungsten shielded arc.

So, in this case, 3I am not sure you say these 2 welds have been intentionally made such that they thing does not come outside, but we have a beautiful fill it in here. This comes on both sides which is probably stronger in that case again outside, outside. So, it is for us to decide which way we can do. Simple shapes can always be even this fairly complicated shapes we can always make out of a single sheet. These are the way are they have been laid out and then there is no relief given here there is no notch given here. So, you see that it is shear form, it is sheared and the same operation has been formed. While it is easy for us to talk about we can even make this formation, how does it close without spring back.

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Even today life is a little not that easy, say you see here something which has been fabricated as a one of sample in our work shop. See here there is oh very nice t shaped

thing here. Made out of a single shape use it so thin sheet. So, it has been spot welded here and then after that this thing has been done by folding over. It is a little like a sample which I have showed you here sheet thickness has been done. And because of the various things it stiff quite stiff you can attach things together and after that all the fabrication has been over they have taken a lot of interest and finished it by giving it what is called a non reflective black colour. So, it has multiple functions you also have small mounting plug here which has to small limbs here which will make it stiff.

You will need it an all 4 directions, no, because most of the force comes here and then we have a reasonable good enclosure with reasonably good joint phases here. After bending it over probably they have put some better welding they have carried out. Now you see something which goes matching with this, seen here, we have a device which is I do not know there it sucks an air or it transmit is something or it to the heat sink or something here. So, we have perforated sheets and instead of directly fixing a perforated sheet they have used washer shear to make sure that they locate properly. And then out of various constraints and in the earlier thing I was talking to you about how do you attach 2 thing do uses self tapping screw, and use a different type of a screw you see here. And this is called a riveted nut.

So, this nut is kept inside and then we do a switching or ah different type of an operation. And then the main attraction being once you assemble both of these together to start with that is what a close fit. And it becomes flush on the surface. How do you ensure it is flush? If it is a professional you know multi made thing, we can make a stuff we can make what is called a joggling stuff. But in this case they have founded convenient just to make simple formation and add another thickness. To make things easier and then also ensure that there is a no gap here. We have technique over after making the 4 bends have left a gap here.

The attraction of this is overall this will now become a generally splash proof equipment.

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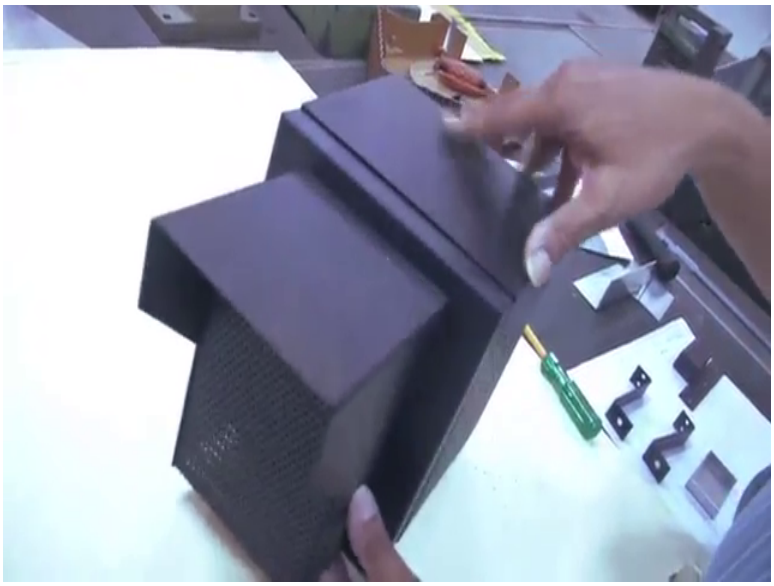

So that in the unlikely case of some liquid flowing in that something still it does not trickle and through this gap this gap here that is not matter. And then you see here they have made a cubed also a small hood it shows that depending on your IP protection, if you are in this IP 55 and such things it up to 45 degrees inclination and normal water will not affect, that thing hence the small hood has been kept here.

Now, you mass wanted go through this yes this every chance of it, contra rate our popular thing not all of them are air and water type has we expect them to be.

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So, I will now stop here and take you to another place what you call a low volume a flexible manufacturing thing. This one is called a horizontal machining centre. While the inside and all is complicated, I will like you point out the several of the features here and all use this same techniques as we use here. You see here this is simple sheet metal, this is sheet metal and then you see here even here.

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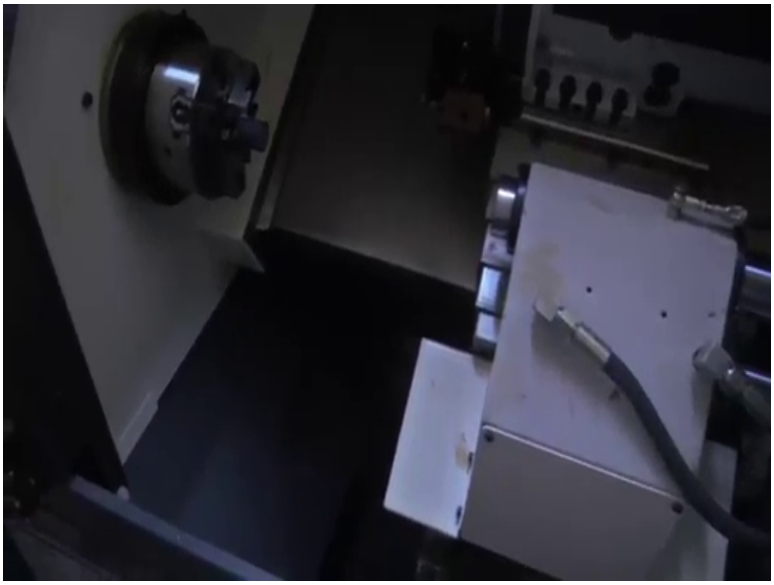

There was small gaps and it is a vary for practical purposes even if you or if you have shake it you cannot bent it. When internally also internal machine also you will notice the parts of it still made out the same sheet metal what we are talking about.

You will notice here inside I have several mounting details I have cover here. I have all this this continue to be the same mould sheet metal which we have shown there. Now this is a simple very beautiful sliding if you notice here you see this corner how this is made out of similar flat sheets only thing is the raw material the finishing and the things are different. You see at the bottom this one is our hydraulic circuit. It has a cover in this case precurely does not matter whether it shapes a little.

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So, what we done is they have made it in a simple way (Refer Time: 30:08) while this have the machinery circle.

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We have a brought it an machinery circle. We have a v and sheet here this v and sheet several of the thing these are all sheet metal work. But here you see that this is rounded using special tooling they make the things rounded. This is a normal control panel it is a mixed up both them when we see this very effective simple things that kept here.

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Then now I get back to you for the various types of hydraulic and control devices here. This continue to be sheet metal and then you see here we have a perforated sheet here. Which say probably has a fan of some sort which will take things and take it out. And then you have box there and top of it which again has it power input module.

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And so, sheet metal whenever go out of fashion. And that 2 flat sheet metal is unlikely to your problem and it continues to make use of it.

So, I will stop here. I wanted to rewind this video clip and work it carefully again and see as much as you can observe. This is not about how to use a machining centre. See all the sheet metal that print out and all what I have done I showed you has been started here. Once upon a time we were using ah regular what you call drafting machines, now these days instead we try to make build build these things using some sort of it tool.

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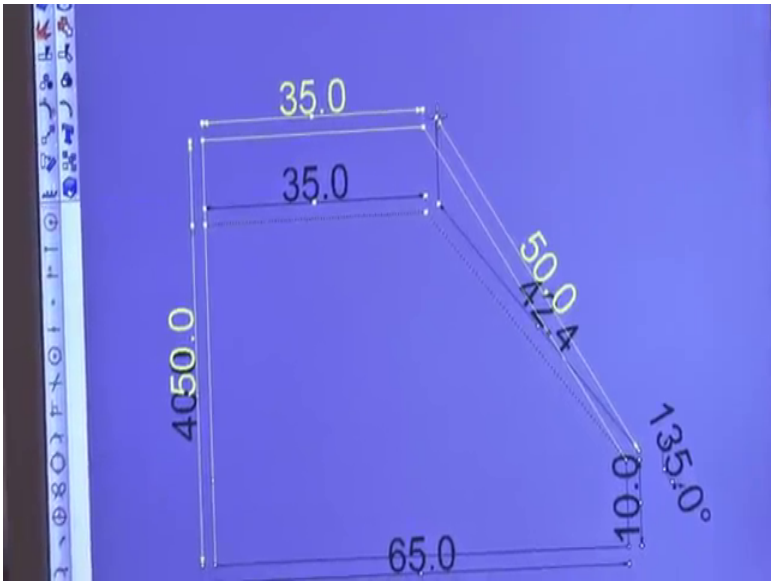

Right Now, it is still in the usual 3 dimensional line drawing. So, it will permit me to move materials that around and then adjust something and then depending on the type of assembling technique this possible for me to make a full 3 dimensional module. And in case of any problem with the dimension you will see what is 42.4 and then you see this 35 and I will go to the side beau. These side beaus while see if there is let us say something happens. And I am not able to accommodate all the materials inside. If I just want to increase the height it is just enough for me to pick one of these things and then take it up. You see here instead of 40 I have now made it 50. Conveniently this is become 35 this is become 50 this is become 10 both the parts track each other.

Now, this top portion will fit there. If I undo it you will notice watch again watch this 50, watch this 50 if I undo it see here this is 40 and this is 42.4. I can keep reduing and then play around with it let us say the height has become an ensure forming. When he see forming and after go back.

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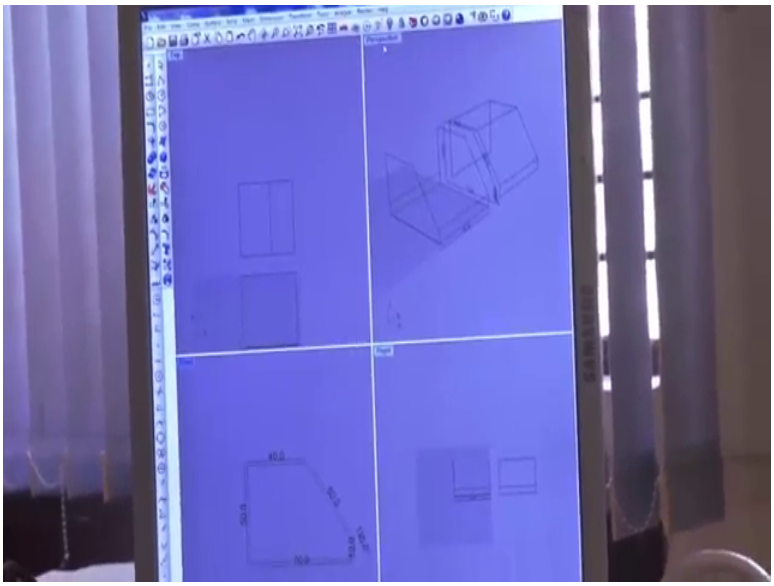

Let us say the bit has been the issue I know make this, you have seen this, conveniently this is all become in to rounded numbers I have a 40 I have 50, 70. And at the movement there is still continue to be lines when easy for me to convert these things and to surfaces I can make it into a surface using edge comes. So, if I use this, this, this, this I am sorry, pardon me, I have not practice this. See I have the surface the first surface that has been bit here. Seen this is last point I need to just build this next to surface.

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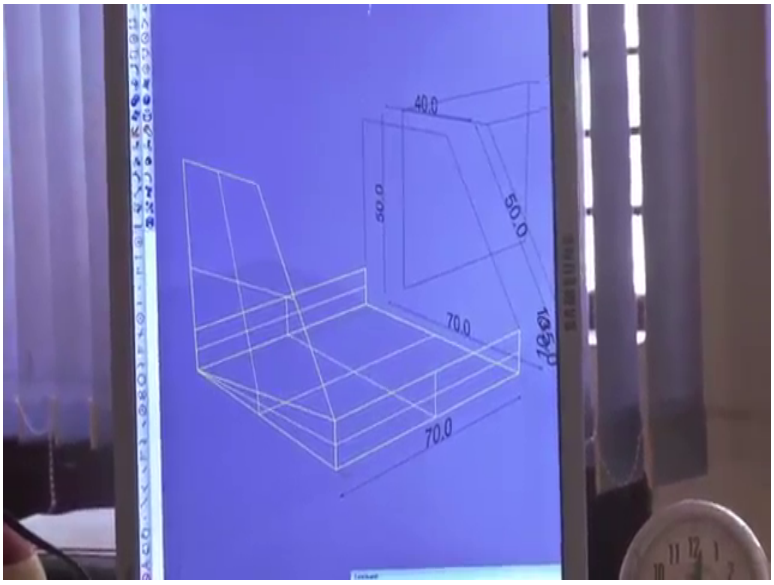

So, here so, part of my, but unit is getting ready. Only thing what you have does noticed it it still has a 0 thickness 0 thickness will lead to all our bending problems. So, I will just say what best I can do I can make this things, see part of my enclosure is getting ready now if I just hide all these you see here, I am always ready. This is format now joint these 2 things by in various options are you need to discuss for convenience on just group it, I will make a copy something from here to here. I have a reasonably fitting bottom part of the unit.

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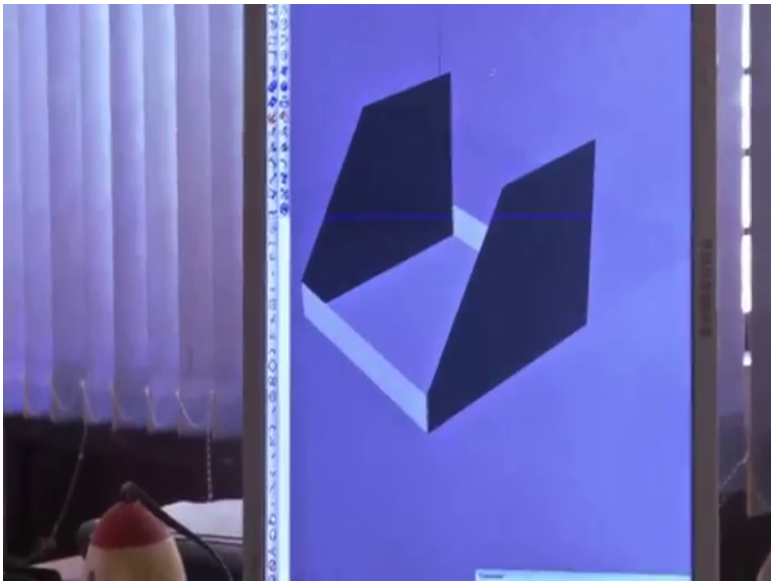

Now I will one more pan I will go back to the other portion, I will see they can.

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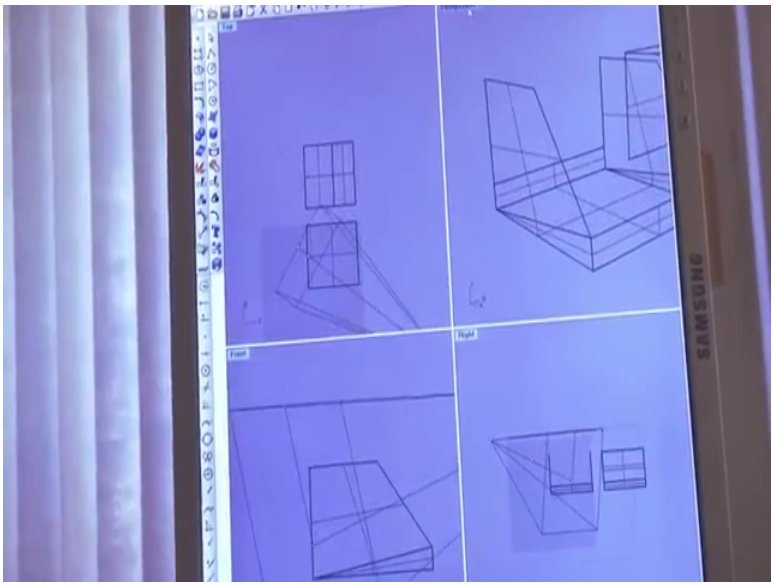

Solve the bottom form, I have beautiful bottom and then at top portion of these things. So, I can just it is joint them weld them together or it depending on the type of in I would like to have.

My enclosure is about getting ready. Advantage here is I have not actually fabricated anything and made a mistake. I will get back to you again after that measurement point of it. So, I have the top cover just to be at the same side I will just see whether the top cover fit is or not to well.

Now see I have beautiful small enclosure the they actually the issue why ensuring you all these items is that from a drawing like this it is easy for me to now make or development right. So, what we do is for the moment I will hide this. I will start with this bottom start this and you see, I think there is a small error, it is depending on the sequence of bends. I can now make it life flat in the other direction. So, it is a almost still lot more is say last one is there almost over yeah.

Now, if we come back and see this, you seen this? I have got a beautiful sheet which is labelled. It is possible for me now trying to optimize how these things can be made out of a sheet metal press. If you remember the last thing was this workshop practice where I started you with this conceptual box, I have a bottom piece which has an inclined front panel. And then I have a top cover which goes in front of it overlapping it, at overlaps here, overlaps here, overlaps at the back and then there should be 2 openings here. But in

keeping in the best traditions of blank design we need to start with the actual bending elevens which you need to give contrite to popularly thus no equation for the bending elevens. What we have is physically we need to check what is the bend that we take.

So, our operator here after calculating this 40 plus 40 plus 70, he has come to 150 mm. So, this is typically the 150 mm blank that he has taken. Similarly the other one is after taking this small length of 10 mm, 10 mm and 65 he has come to this 85 mm. Having then this we now need to carry out the bending operation after carrying out the bendy operation and taking measurements using this height gauge. Height gauge is nothing but a basically it is a vernier accept that, it is a lot more precise and how it is mounted and so on. We have this angel blocks then we have the surface plate. In these case for the (Refer Time: 41:19) of it they have cleaned of this surface plate normally it will be a granite which is oiled specially. These a little spoiled, but it is ok. Having done this after measurements what we started with this marking how 150 mm by around 20 mm and 85 they 20 mm.

If you measure the limbs, we now come to very peculiar thing is 40 mm has become 42 millimetres. And I am sorry, 40 mm does become 42 millimetres 70 mm as become 72 millimetres, suddenly you notice that in spite of marking the internal thing something what looks like an Unix plain able, extra 6 mm has come out from somewhere. This is what is part of the behaviour of the metal. So, today my colleague will continue with a more real life example of a unit which will be quite useful. Compare to what you did yesterday which was a simple you this is only to find out the bending allowance, that is there the 2 types of there one is, if we take the external dimensions we do subtract a material which is call the bending deduction allowance. Otherwise we take the internal and then after that you add an allowance.

Now will come to a real life object, in this case this is called a height section. It appears slightly more complicated, the reason being what appears you know outside, inside and all that those dimensions internal external and all that out of practice ah.

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This people will know how to take the outside dimension, remove to thicknesses. Similarly in this case, same take one of these things remove one more thickness and come out with all these things. This is a generic product. Loosely we call it a hat because a cross section looks like a hat. In today's second real life example my colleague is drawing to try to make a small mounting arrangement which is probably used for an antenna.

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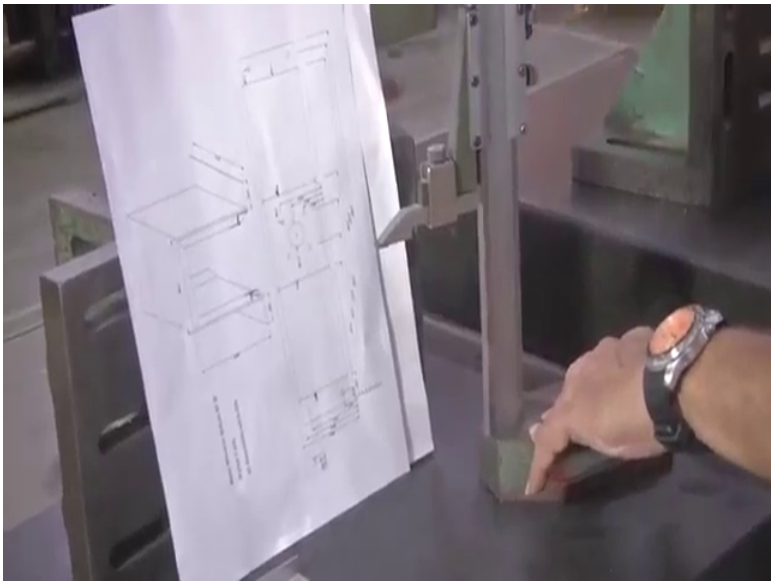

See that important issue here is, all the details set are required here in the final part are already marked out here. And compare to yesterdays system by which we mark 10 millimetre from both side which have little problem when you work with a height gauge like this, what we need to do is we need to mark out dimensions as they come here from the bottom to top. So, as before he will release these things start reading out this and marking it one by one here. So, the advantage being it is all they have standard datum line. And if you follow a cad or even otherwise hand run things making references from the datum line is very convenient for us. Mainly because in the flat conditions we also need to make all the perforations, in this case are large hole has to be blanked out. Any hole which is more than around 2 to 3 time the thickness are best punched. Small holes can be drilled otherwise the best operation for it is if it is a let us a 2 mm sheets anything above around 8 or 10 mm cannot be drilled if you drill it leads to lot of problems.

So, now, I will stop talking we will start concentrating on the marking out. So, in initial stage what he has already done is he has cut the sheet he has prepared the sheet to the necessary thing 88 mm then towards a length and then here also know it is a 326 mm. How did these dimensions come about? As before they have taken all the necessary dimensions, and then added and subtracted the various types of elevenses. And then we have a sheet which is already cut and prepared here. And the sheet has been cut from a large material on the shearing machine we have there.

So, keeping all the safety things and mind and all that, in this case this being a very ordinary I mean I would not say ordinary demonstration piece and meant for students you will notice that is a few bit is of screeches and all here on this.

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So, our engineer has started he has put the first mark, which represents in our case a line which is the clamping line. The clamping line using our finger type of break is the line along which you actually clamp the object. This line make sure that any material which is inside the finger does not move. So, after that we have an internal bending radius after that we have the sheet thickness and all that to get the external thing.

Now you see here one more time he is now marking all the dimensions based on the datum line. So, the slide difference is expect for the symmetrical items which he finds it convenient all others have been marked with respect to one of the edges, it is very, very convenient. Main advantage also being that in case you have a coordinate drilling or a coordinate type of machine, it is easy to program or read all the dials and check these dimensions easily; so, these standard operation in the industries it least the first few pieces after the vernier marking is done it is sent for inspection, to see whether there is been a mistake in either that drawing or the fabrication. Why this is required is we want reputation. If you make even say 10 pieces at so earth while having the drawing checked again say first marking and completing one sample piece. There in case there any inadvertent errors mostly caused by not interpreting the modification list are modification request that have been made. Now you see one after the other fitting else being mark there.

You will notice that some of the essential features especially relating to bending, instead of following the datum line or engineer is marking from both the sides. Why he does it is this through depth which is available on our machine is limited. And the various features are based on in a sequence of operations, such that you see what he is going next is he is doing the notching of the corners. And you see the what you call good thing about a work man is he depends on his tools. Nothing is done just by eyes looking at the are ok but still you see here, he is trying to use a square to ensure that the notching is perfect. You may notices small error that does not matter because even if the can noter didn't follow the whole things it gets compensated on the other side as such there will not be a problem it all. How are in the case of production generally what is called a front or a back stopper used to ensure that it always runs parallel.

Now he has come to the notch of the second symmetrical bend on the same side. Over all we end up with appropriate number of notches, is an experience gentleman, but in spite of it he stilled depends on it. You will notice that for each bend wherever we have we have one of these notches here.

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If you look back on our drawing for the head section that top to require this notching, because you have 2 webs which both need to meet that is where this 90 degree notches required. But then you will also notice the other 2 bends which form the basis of it, they do not have it because the bending is being taken in the other direction. It is done in the

90 degree direction; as such even making a bend is not required. Instead he will probably remove the material which is not needed at all.

So, we have flinch, the total length of the flinch the corner is being notched off. While this say general purpose 90 degree notching device, you can have it for other things including may be circular including other angels and so on. So, I will call it the limb one corner notch he has removed. Now he is coming to the limb 4 corner notch. So that part which is between one and 2 has been removed now between 4 and 5 he is trying to remove the material. Now looking at it you will slowly notice that this starts looking a little like the drawing that is been present at was, your seen here?

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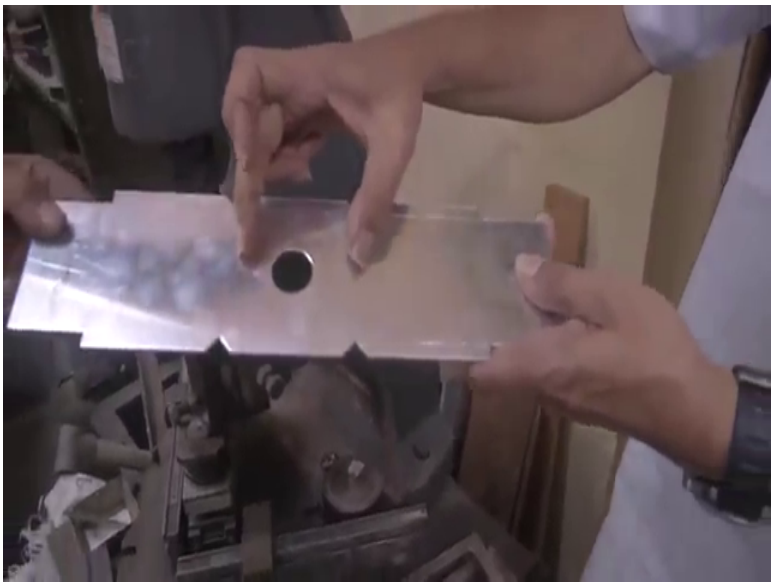

Now comes the next operation of is having to make a big opening. So, once again are engineer is now adjusting critical stoppers. In the previous operation both the operation we could see where the work is being done. In this case it is not easy for us to find out where the punches now sitting on the actual sheet. A we need to depend on we need to depend on the stops to ensure the total dimension is maintain. So, if you observe this machine carefully and the top where I will which gives a tremendous amount of kinetic energy. And then this just a stopper to see that it does not go down and in their things. And then in this case we have this is called a stiffer, stiffer ensure see he has done a sample you has to make sure that the opening and the location is perfected. You see here

he has started from one edge put both the stoppers and as for the original centre mark he is able to now locate the particular feature where we want it.

That impact is the one that will give a clear opening, it follows the marking that he has done. And generally if you see in the real life more than the location from here to here well to location between the 4 mounting holes and this opening is critical. Usually this is done by a template, though in this case will mark and drill it is done by templates so that even if there were a small point when are point say 0.5 mm error, it will not accumulate and cause a problem in the final product.

Now what the engineer is doing is, because there is a small change in the thickness and this is the if you remember I was talking to about the finger. You see here we have a finger here you need to adjust exactly where we wants to mount the fingers. So, he has just marked one line here and then after that the internal bending elevens and after that the radius this 2 are included a need and then he has mark the clamping line. And that the rule being that whatever is held inside this will not change. And this machine it has the lower to movable gels which ensures that are things moves up.

So, you see here use trying to align it has best as you can. Generally for are purses are demonstration he is just trying to hersnit up a little bit. In reality they all always be stoppers at the back. So, if you see here at the back you see this stopper, you can move it up to that point. Now because of the thickness involved he is now a compensating for the thickness of the sheet. In the amount of force does required to clamp the sheet. Now will operate the both the gels lift of the portion and you will notice that is also checking for the spring back action is there will little spring back yes all materials will invariably end up with a spring back.

Now do we have to do it as a trial and error not necessarily? First time when need to make an empirical thing, at the back of it here see it is clean. And both these lims there is a stopper there you can see there is a drilled holes there he can adjust the stopper to make sure that would stays within the angel we need. Most of the times it is right angel occasionally we have other angels for the and because of the design of the clamping fingers we have reasonable control on, how well the thing how well it bends here one small detail you down notice this.

Now, if you see you see here the material has try to form and share also in the corner.

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In professional practice, they also provide a small notch usually to equivalent to other thickness depending on if you want this lims to overlap this or if you want this lime to go of inside this will be little smaller and the notches can done in the other directions so that it goes inside. So, I will see what is application. So, you see here this fingers come for different lengths.

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We see here they all come in discreet dimensions, 10 is marked here, 20 is marked here, 25 is marked here. So, making combinations of this it is possible for us to see this is a

really wide piece. So, what it does is he can remove this depending on whatever we have marked yeah this is a one 65. Show me the samples. Sir show me the sample.

So, you see here see it fit is reasonably well. So, depending on are since here to among the accuracy that is required, it is possible for us to spread them uniformly like this to make sure that both that strains fit properly. But in this case since material is not very, since a material is not very, what you call dependent on local deformation he is taking as a small risk of making a just can notered and then I expect that up to one or 2 thicknesses it is safe. So, I think in this case around 2 thicknesses worth gap is there and then with this little bit of skill he is now forcing it back in to the 90 degree. See where quite close to what we have done.

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It is nearly perfect. While I do the talking he does the working, which is the actual perfect part of any work. Bending the internal bending between the 2 and 3 are over now there and 4 is doing here.

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This is where a small edges meant as been done without telling you, see that this features of this depth here the depth inside have all been taken in to account and In fact, he has provided a small matching to make sure that it does not hit there in the whole thing you see, sequence of bends and such things are very, very critical here, they will try their best instead of fully closing it now he will do the next operation and see well how far we can take it inside and continue the operation.

So, in this case this as opened out a little, but it is a harmless thing, we can always dressed back to shop. So, whenever use this general purpose tools we have this little bit of compensation we need to do having done this an one side, now the since total length is little less you see here it is since to miraclessly sit inside without any problems.

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So, if it were a batch production probably they will do it in one or 2 extra operations, and then we have something this is practically reading, you see here now probably there you can manually dress it are in this case little clamping it is even probably possible and we have a nearly perfect operation accept that it operates you know little more unit. But in our case this because of the spring in use of the material it is possible for us to dress it back in to the original condition, you see it is a little spring in this case.

So, such for are type of work it generally easy now in the original drawing will notice that we have 2 more openings here as holes. And 4 more mountings holes for this centre feature. He has in this case sometimes, these holes are probably need to be drilled and transferred to another mounting base. And then inside there may be other features of it. So, these 4 holes these 4 he will now attempt to make it on this by taking it to the drilling machine. You see here this has been part of the operation which they required.

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So, I will now take you back before we said see we have 3 drilling machines here. This one is a little fairly big one this is a tapping machine. That is your standard work house and then we also have a portable drilling machine for longer operations. Drilling and tapping machines then we have a thing here if you notice is does not have a check it is directly large things are mounted directly using a more stepper. And then this case you have a tapping attachment. So, this tapping attachment when move it up and down it will reverses. And then makes the holes are this is the conventional drill there ok.

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You see here this is a actual bending machine with a we punch here. Even this we punch in this specific case we have made this long one notch piece, but you can have them segmented same thing this can be segmented all other angels less than 90 little more in cooperating spring back everything is there.

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This as 2 operation there is a large lever there. And then we have a toggling mechanism here which insures due to the toggling it goes down bends back and we have a nice what you call long length which we can do. And we can progress some along So, if you have a sheet which is let us a 2 meters this whole thing is only 600 millimetres sorry 500 you can just moving it along and we can make it.

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Something matching with that is another low non impact normal what you call punch. In this case have normal punch, if you have small small openings like this and then there need to be a little precise we can mount this and the die holder, we can mount this punch on the punch holder. And then after words carryout this operations directly by aligning it and then we can make the small operation. So, what is required in a small workshop is probably a few of these machines. So, you have a small precision so on. And then you can carry out most of the operations at are required for a electronics thing. I know bring your attention to things.

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Which are all made you see here this is the sample we made yesterday. Comparative this what we think know is little hard this thing, this is made from a steel flat and this is part of a bigger machine which we for the accuracy is very, very critical.

So, while in engineers needs to familiarize himself with all these various operations so that the design comes out properly. There are job shop people who continue with the various types of operations for you, but the why we have other I have push put you through all these steps is that you should know the amount of various types of limitations of the process. So, while a drawings looks good when you make it finally, you need to compensate for the short comments of the press. So, thank you for today, we will meet again next time.

Thank you.