Enclosure Design of Electronics Equipment
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Lecture – 27
Video in ID Lab

Hello we are back, say the last when I left you I took it to your fabrication shop and I was trying to explain to you how we work with sheet metal.

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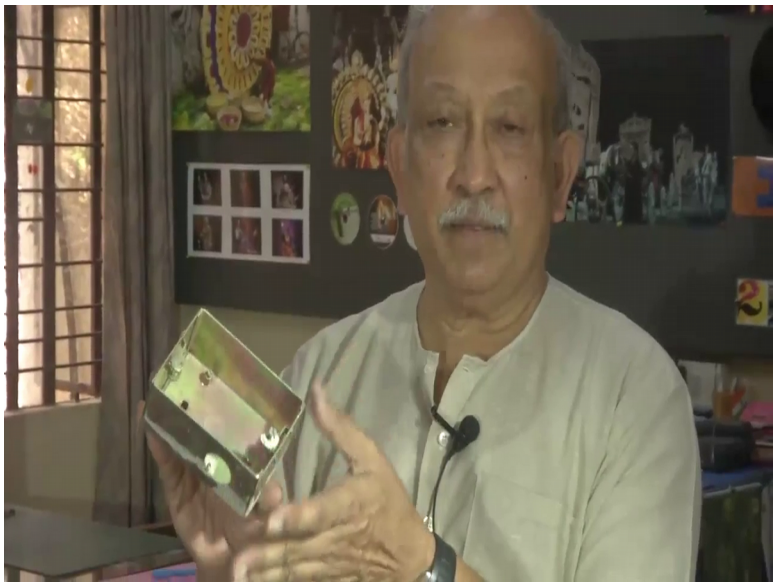

So, sheet metal has the advantage that in a given thickness it is very rigid and then it can take a lot of use a word called beating meaning, a tremendous amount of stress and it will not get dented, but you will notice it that fabricating things using a general purpose machine in a fabrication shop is not so elegant and then in larger quantities it leads to a problem.

So, you see here that we have a box which is still made using normal bending tools and all that and then in the end this corners have been resistance welded, such a conduit bugs in low quantities that probably makes sense then whenever the design changes we end up with problem of how to make these things and then it is not economical. First of all its heavy and then the chances are because of this conductivity problem even if were to put a phasy plate I am sorry phasor plate and then mount modular switches chances are there in short circuit.

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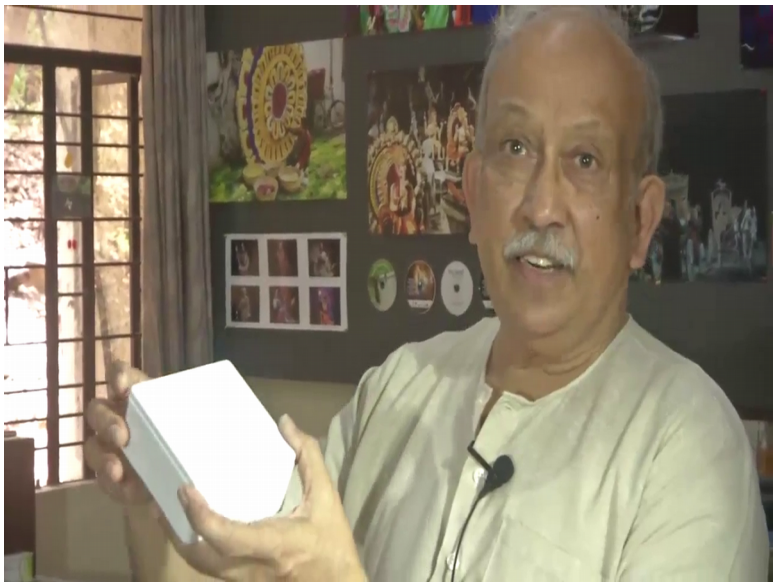

In the course of our fabrication slowly things are being replaced by insulated materials and the moment we talk about insulated materials we talk about various types of plastics. So, in case it is supposed to be meant for high heat and arcing and all that they use thermo setting plastics, but in the case of these, these are all thermoplastics which can be injection moulded easily.

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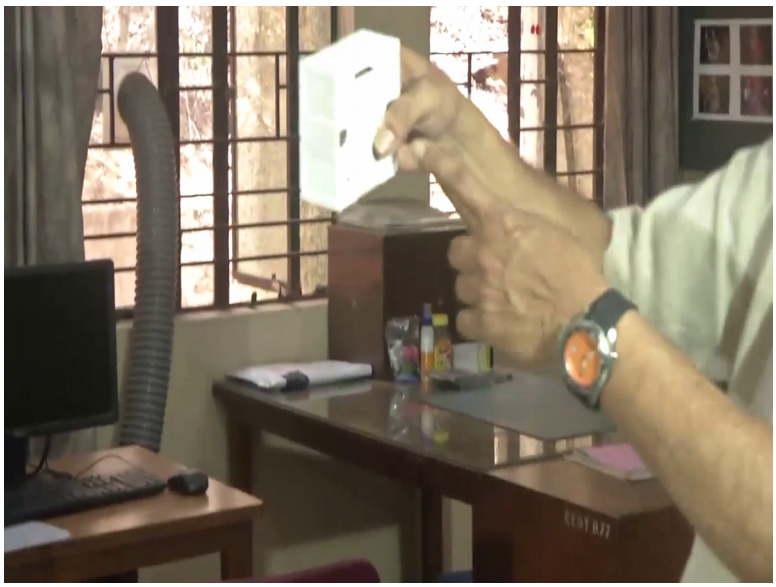

Here is an actual conduit bugs which is a direct replacement for this, one of the things you will notice is this has been made for the old circular electrical conduits.

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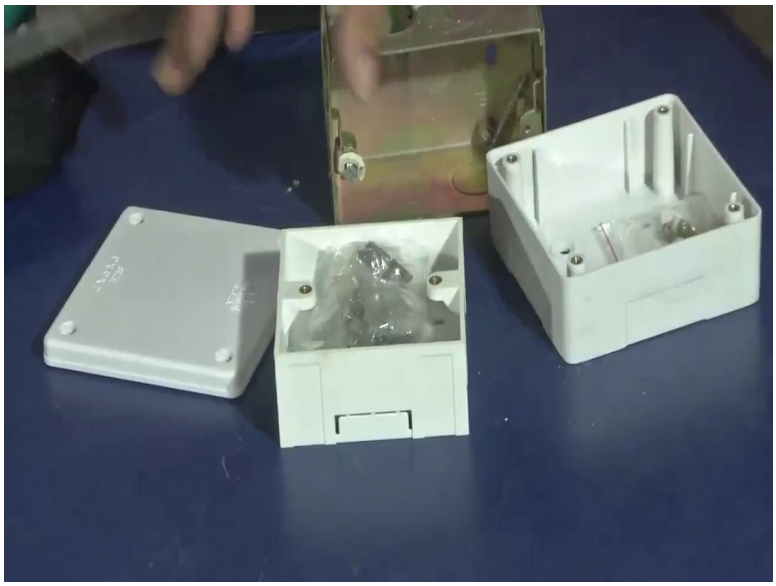

You see here, this is a conventional conduit bugs it comes with the face plate and the face plate has a provision for 3 modules that is either you mount 3 switches or you can put a one single switch and a 2 module plate and so on. Well, this is this seems to make sense when we talk about whenever we talk about new modern wiring and electrical conduits the circular hardware is become a little unmanageable and then added to that you see here what we call knockouts are provided here. So, that we punch them out where they push them with a special tool or often it is just enough if you give it a general tap and it will come off, it is all been replaced now with a new range of these devices you will see here, there is a simple knockout and these are all been made with the flat cap and care system and its somewhat universal to the extent that if you take a 1 inch or a 1 and a quarter inch cap think it terminate here and then the wiring can be taken.

This directly fits a phaser plate which have I was talking to about which carries this switches alternately you have general purpose boxes here which again we have the same mechanism here and then we have a cover. Now, this can have multiple applications we can open this here to fit any other hardware we like or we can also use it to use this modular plates switches on this that is we have a phaser plate which sits on top of it and so on.

While this is for a general purpose thing, now I come to very interesting things here.

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You see. here we have a an equipment which was made once upon a time using sheet metal, the reality is you do have a cover and then if you remember I was talking to you about this operation and the fabrication shop off setting something by one thickness is called joggling. So, a joggling tool has been used and then very, how do you say innovatively something has been done that if you see only at close range you can see the how the corner has been formed. So, something has to go down here and so on and finally, if you know look carefully most likely the whole thing has been formed out of a single sheet.

Positive advantage there is no mechanical damage in the unlikely case something falls down, but you still have radiuses and so on. Now, this whole thing when it is come to commercial application has been replaced by full moulded plastic.

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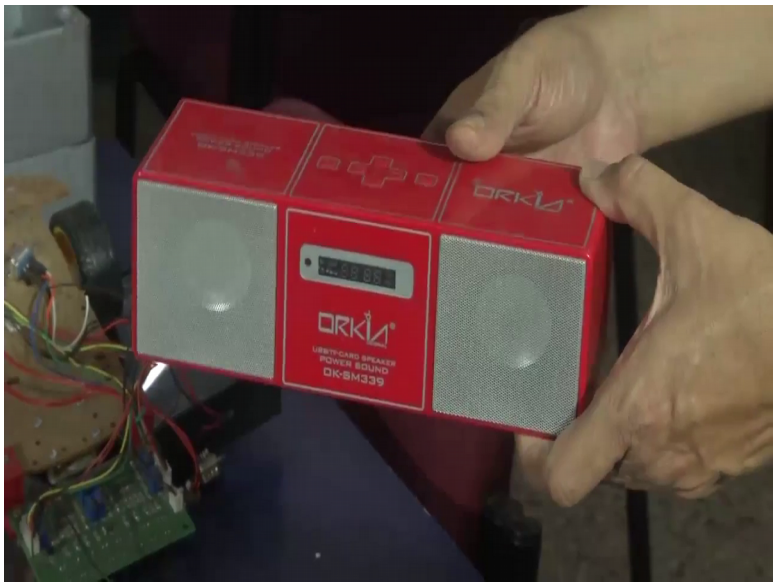

This is not a very elegant design it seems to a when something which made to be a little retro flat sheets and then a little bit of displays and so on.

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So, as things have progressed things have now being replaced with this steno types of accessories, this one is an accessory which is required for the has a mobile has an external speaker you see here again once again, it does have things which are just part of a normal thing we have plastic items here they have something in this looks like it is just only a protective cover. So, by playing around a little with all these various items its

possible for us to come with really interesting and novel combinations of materials, even today this speaker will continues to be a metal anything else has tendency to drattle.

Then insides are made with a thermoplastic can be easily mould this outside is just a soft cover, it has a dual purpose one of them is that it should not when it falls it should not shatter the corners plus it gives a soft feeling and then all that you know things have been they have been playing around with this, such that it gets assembled in one particular way and then we have things very much in control.

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Absolute full control of our design has progress from mere flat geometry to other geometric primitives you have something here which probably looks a little like an older speaker, there are small visual cues some which makes it look like a round speaker and then you have something with which you can hang here I mean hang it from then you have; obviously, various types of controls and so on.

This whole thing is easy for us to fabricate it can be in metal or in plastic and if you have to make one of samples most likely the for the prototype purses the fabricator will probably, for the prototype purses the fabricator will probably choose materials which are easily available the outside enclosure this enclosure can be made with a circular PVC round and then there is grill can continue to be a metal grill and all this detailing can be done with various other types of plastics and part of the novelty will be sometimes there

also made with acrylics. So, that you can see what is inside and once in a while they will become very very popular.

Only when you start making a prototype you will notice that small detailing like the same, where you will make this stowage for the cable can all be worked out while later design stage it is possible to still make them, if you make the first prototype you can now include all this into the design and see if there is any potential places it will get damaged.

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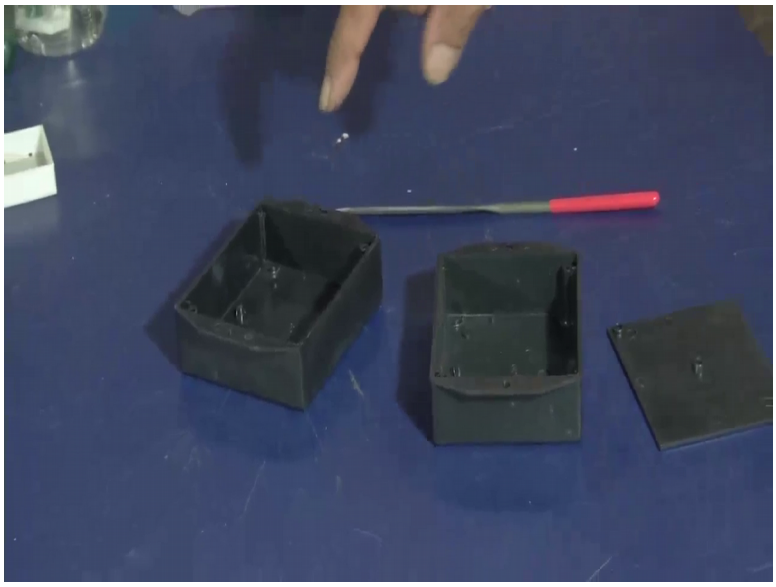

I will now take you over to some other items this is a general purpose box for making small items. So, in this box you will notice that there already it comes with some drilled holes and then you have to have flames with mounting holes and then in other side it is covered. When I open it there are enough details which are available here for us to play around with its main advantage being that, this being made with a modified version of ABS, but the other components have been reduced in this is probably made with a very low cost polystyrene.

So, I am not very familiar with the whether they have use the technique generally is somewhere you know they will include what is the type of material for recycling purposes, you will notice though it is basically a flat object made with flat planes still be moulded and probably suits several type of our prototype applications.

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Now, I will progress on from here to see, then somebody you see here this is a typical sheet metal aluminium enclosure that has been made and people have tried to duplicate whatever it is in the sheet metal using plastic materials. So, you have here a plastic material this was made, in fact as a backup what you call device for a calculator. So, that the calculator base is not damaged while in a small this thing this seems to work.

Now, we move over to this new concept called rapid prototyping, we have this from here onwards I will try to see show you how instead of working on this saying you know cut and stick type of materials how we can move on to more advanced technology.

I will point out where the use of this plastics is a must even in routine things like automobile, contractive intuitive reasoning you cannot go ahead and say analyse.

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You cannot analyse an auto rickshaw there is nothing like you there are no equations to start a design of an auto rickshaw. So, somebody have to conceive an auto rickshaw here and then if you see these whole conception has been done in the mind of course, and then a little bit of, I will say sketching hand sketching which I covered in the third or fourth lecture and eventually a prototype from the design point of view has been made.

So, traditionally all this is as I said styrene sheets, there is something with 2 wheels at the back then there is something with you know 2 wheels in the front with 1 wheel at the back and so on. After coming out with an outside structure you end up with the actual load bearing structure, this load bearing structure for the first time now reflects what can be analysed without this no analysis is possible. So, we have the external top down approach withstand there and then we come here and then of course, this is old, this is old as old as some 30 years, I think this we first started in 90 and then I will point you out to the original cad drawings that have been made here.

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This cad drawing will show you that wider front seat make sense and then these are all the electrical things and then you see here finally, this is the fabricated prototype. So, I am very happy that I know some well known people are here and the all my colleagues are here including me and my other items.

Now, I will stop here I will get back to the plastics demonstration. When we, when we replace any of the sheet metal parts first thing that occurs to us is let us make it flat and then the corners and all which normally take on a joint will initially be replaced with, if you have a piece like this how do we make it strong we depend on adherence to the adjoining part, same here. So, in this case this particular piece as support, here supports here and support at the bottom.

Sometimes this is not sufficient for us. So, what is done is a piece like this is used for rein forcing the corners, sometimes it will be a tape part piece sometimes otherwise this is be a same material and then you cut it to the correct length after fabrication and then try to use engineering it is use and then make it adhere to this. After that when you turn it over right now it is just made as a simple rectangle eventually you can reproduce if the inside is already acquired properly you can smooth the net outside. So, the same thickness here and same thickness here and the same thickness here will be maintained and eventually you will have a part which if this sample part is handed over to the

fabricator, the part designer will optimize it such that injection moulded tools can be easily made.

From here now I will move on to some very very interesting concepts.

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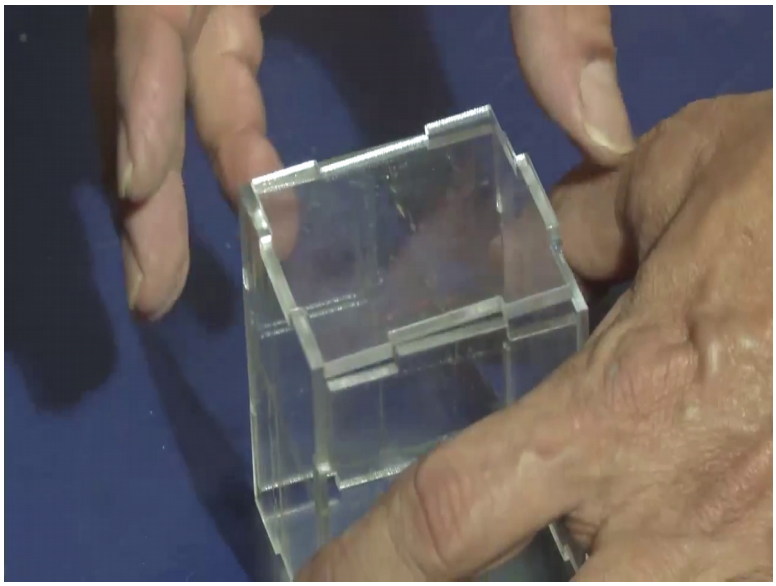

See here the whole thing has been laid out using a single sheet of acrylic and then classical doubt I will if it has been given, it looks a little like the jigsaw puzzles which as children we enjoyed doing it, except that in this case it has been made such that this is pieces are practically identical . So, if you just fold them over and try to make them you have a beautiful cube, right now unless I constrain it using what you call in elastic band it does not stay there. While as a novelty it works out well and it works extremely well when these pieces are actually constrain, my pack of cads has collapsed, if you carefully use an adhesive and join them together they can hold their shape.

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But in reality what happens is, if you have to make some equipment using such a technique it does not work well because we end up with losing that intergrades structural integrity of the whole part.

So, over the years by a little bit of trial and error and a little bit of following the various things on the available resources, some of our designers have come out with our designers have come out with that this unusual concepts saying there are no necessity for us, there are no necessity for us to have the external flush joint it is may be much more logical if you have one of them going and sitting in to the other one like this.

So, building on that whole concept near replacements of metallic objects have been made here, you seen here this side the still the side still looks a little like this joints that have been made that is you a plop put things here and then try to fix it, this is actually probably a broken piece the original piece was intended like this in then the top and bottom have this instead of having a dactyl they have actual what you call places where things it and in the end, we have a beautiful enclosure which is made out of coloured acrylic, this whole thing has been made of black coloured acrylic.

So, we have a beautiful motor here and then you will also notice it is not the first time or anything.

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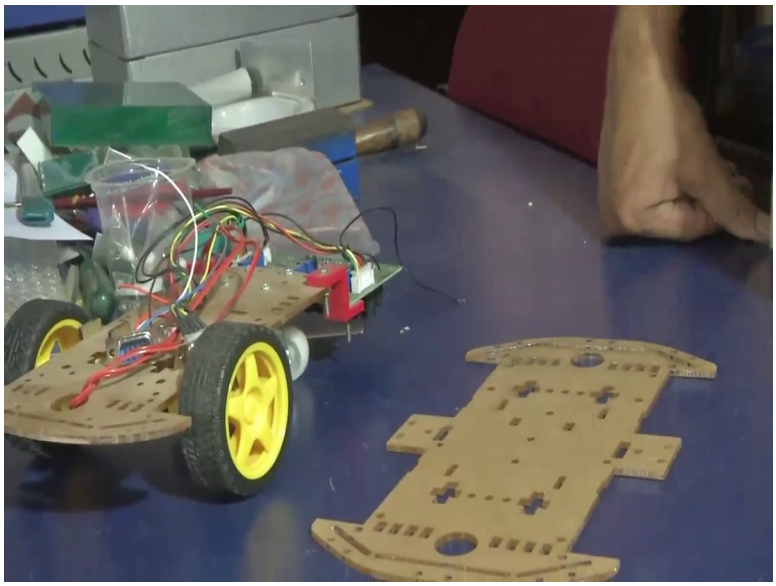

If you go to the hobby network seen this this is part of a line follower car. So, this line follower car there are various types of sensors and we have a things here and then it is supposed to work here and you see we have seen the base, this base has been cut out of an acrylic sheet this whole things is an acrylic sheet some corners you can find the material of the acrylic sheet

So, plastic continues to be very versatile material for making these things, next level is how do we go about fabricating things in elastic.

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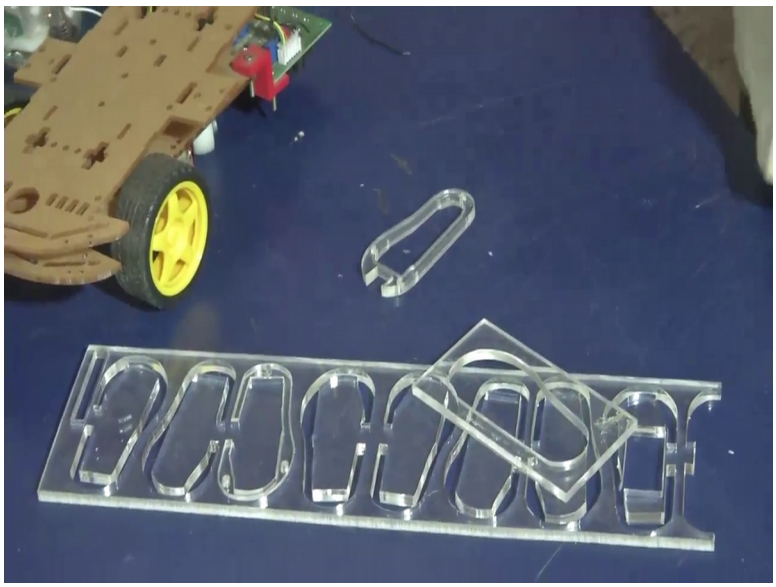

It is possible for us to actually release this materials out of actual acrylic using a laser cutting technique, you need not despair if you do not have a laser cutter all it needs is you must start with the rectangle and then use all your skills and maybe you can even remove the material, only in this case after I remove this material inside and then a factor are make a thing I still continue it can make the piece like this.

So, this can also be made by hand, but you want it in the medium large number like it will say if you want a few 100 pieces it is very uneconomical either to use a injection moulding machine or to start doing it by hand even if you have a template. In such cases we move on to the laser cutting machine. So, in the background I have this laser cutting machine which is slowly getting popular.

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So, we have this laser cutter, so it is magic. So, in the magic inside this magic you will notice that we have the actual device which focuses a laser point here and then there is lot of other things which are there then you see there is a beautiful rollers here. So, you keep your raw material, the raw material can be slided, it can keep here and then after that after the cutting is over that is it close and start cutting operation you have, you can very easily get any of these materials here. You see here it is start here it will be datum line and in the end you can have multiple pieces which are practically identical and if you can do things directly at the drawing board stage, so possible for us to reproduce this material. Next round I will request my colleague engineer who can load this machine and

then show you the actual cutting, except that it is a little action oriented you will not mind, you will not see much about it.

Let me start from where I left off with the issue about this laser cutting we use laser cutting essentially on planar materials and the machine we have here is only a plastic cutting machine, meaning the peak temperature and the energy involved in the laser can cut plastic and polycarbonate up to maybe around 6 millimetres and the dimensions and all you can easily calculate depending on size of the bid, though it looks as if it is a very ancient and old technology it is now stabilized enough for us to use with feature sizes which are down to few microns.

So, even in our new senses this thing that is in Nano senses we continue to use this things. Today I will try to show you a job which is being run here.

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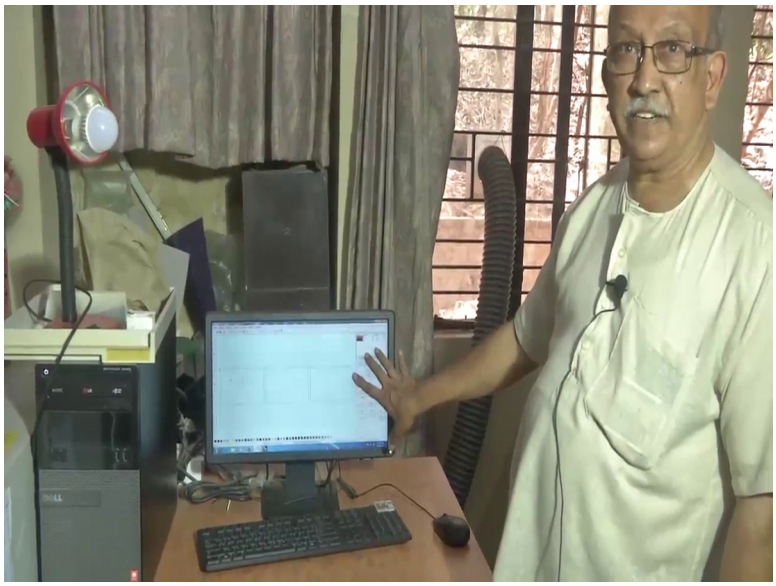

If you now look at the monitor you will see that we are looking for a job which has a particular profile that has to be removed out of a material and then we have 4 holes we try to match with this and then there is a cover also with it.

Most important in this point is how to sequence operation, imagine in a conventional fabrication shop what we have to do? You will probably cut this and then go about trying to drill holes in it such a thing is not possible in this case because the cut piece will fall off into the machine. So, what is done here is we a particular sequence and hierarchy of

operations are listed here. So, what is done here is first this profile is taken and since already this machine is in that same thing because it is in a planer shape we next open these, for openings 2 or 3 things will happen here 1 of the first thing that will happen here is nothing outside this gone it will be a still a sheet with the profile cut on it and this 4 holes which are made and then an empty cover on top of it.

Now, once these operations are over this around forty mm by, I am sorry the 30 mm by 40 mm piece will now be cut off, after these when you now open these and have a look it you will notice that they are perfectly matched and you have the jobs which are we just need to be released from the raw material. So, we will now take you to the laser machine.

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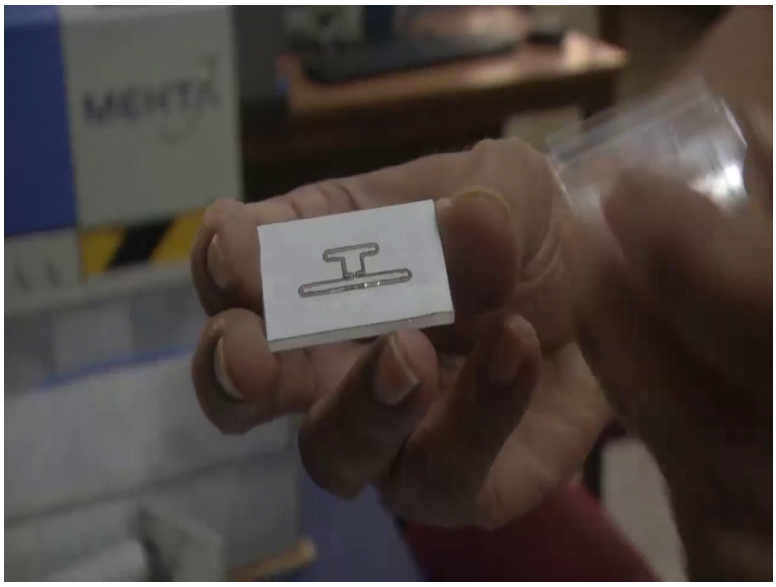

I will just cross over to the other side we need to stack those objects, there is no other method by which this perfect alignment is done.

So, you see here the he has place the job here about the machine if you see carefully anything which is it produce in the cutting all that has been shielded from us. So, even if you open the cover and use it we can continue to use, unlike high powered lasers which are used for sheet metal cutting here it is safe and if you can if you are safe with all the gases that emit during the cutting operation you can once and while open it and see it, but normally once we close this this is a cover, once we close this cover it is not to be touched until the job is open. Now, I will open this and explain to you how the machine works the actual power laser is mounted at the back we have a series of lenses and

prisms here which is direct that this one is a silver mirror which you direct all that, then we have a small lens here and then it points it to a correct operation and top of the sheet.

Part of this machine is that it has to attached to that pc in which the original profile has been drown out and then a zeroing has to be done. So, using the inching facility here we bring the point to an available space where the cutting can be done. So, in this case there is a raw material is you know specially they have selected the raw material which was the correct refractive index and then this is already been used and then this white tape is quite for their processing. So, the laser head is now positioned somewhere here. So, that the cutting operation can be done here, moment it cuts here whatever that small dimension of some around 30 mm by 40 mm you will get the 3 pieces here depending on where the material is you can have it here or here, but generally I expect that they will start these things here and important thing is this is a tape which is used for stacking and main specific advantage of this under all conditions dimensions are maintained and usually a test piece is run to make sure about the linearity and the in case there is a thickness loss during the cutting process.

Now, after or engineers starts a machine we will see these things and these are all meant for other raw materials where the load is taken and then you see here this is nothing, but a stackable removable bed and then at the bottom we have a shelf in which all the excess materials will come. If you remember the old first thing sequence I told you whatever is cut off will fall of inside we do not need it anymore. So, you will have four dots and that profile will follow of and the outside line is cut, then afterward they remove the sheet and then you have this and then the check whether the alignment is correct or not, once the alignment is correct our job is done.

So, we will wait until the machine starts, I will now get you back on to the good hold drawing board.

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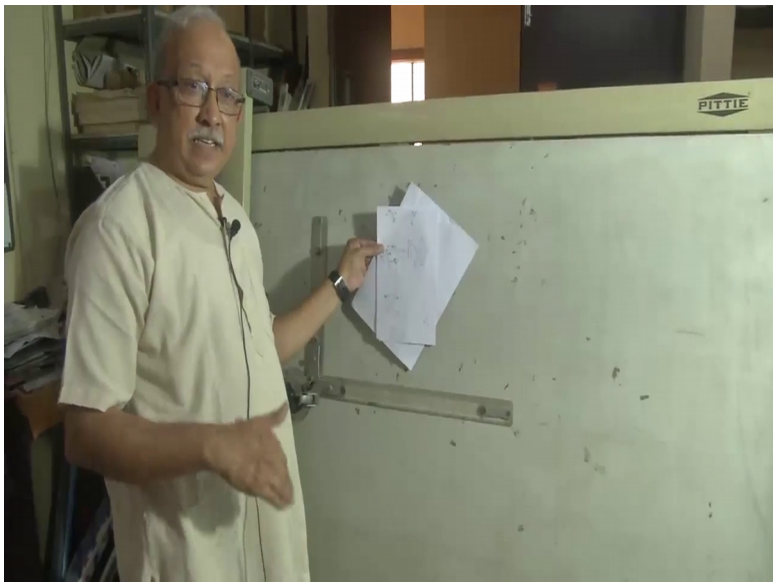

Drawing board has almost become an allegory for design board, if you see several textbooks in this area these days you known they do not talk about computer aided drafting, drafting is still little legalized compared to actual design it is all about computer aided design.

So, things like this continue to be made on a flat 2 dimensional plane and in fact all the cad programs and all what you come about we will all probably start with this. you still have an x and y and then a local aid item and things like that and this is right now absolute because we continue to use more practical digitization techniques, but I could locate the drawing with which that other parts were made this is the old drawing. To see here occasionally at the back or engineers continue to draw things by hand including title making all these things and all only as a last and final thing, they actually move it on to the computer screen.

So, I will stop here and then I get the, that laser machine fired up and we will see next one it is ready.