Enclosure Design of Electronics Equipment
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Lecture - 12
Sheet metal in small equipment (PSU)

Good morning. I will now continue with my theme of how to make a simple mechanical enclosure for your electronics product.

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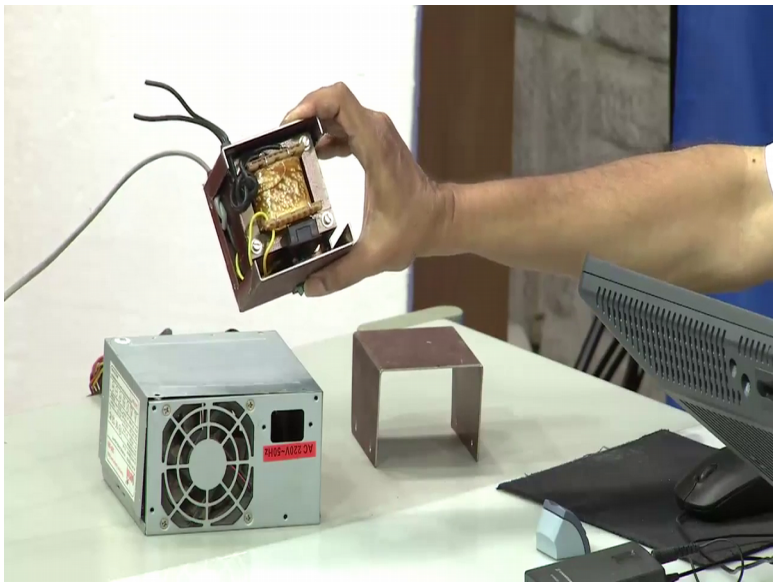

So, if I see here I will show you to products here if you see this is very ubiquitous power supply, you are all familiar with this because we need power. So, if you see inside a power supply first of all it is a cover and very unavoidable thing is this heavy transformer. The move in to we have all this parts are natural selection is probably about why do not we use a metal because it has to take the weight.

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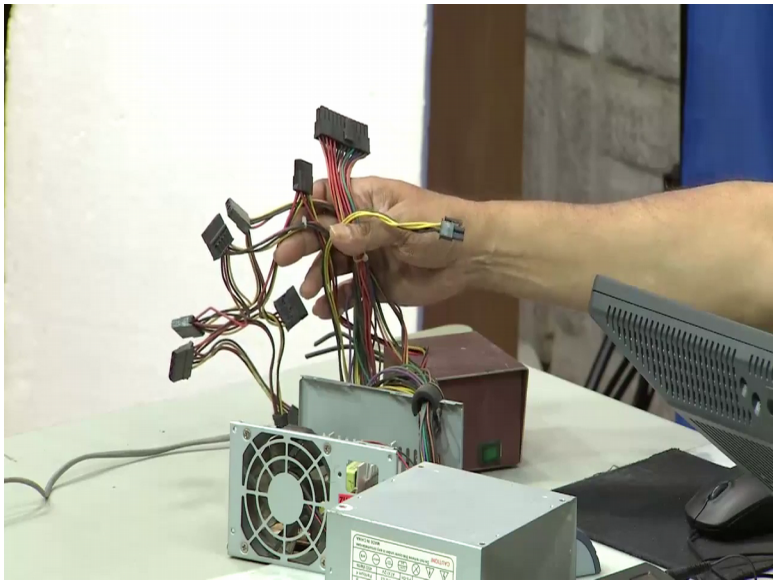

Now, if you go out and look at another power supply this is taken from a computer, there not many heavy components here, there are lot of components anyway. You can see that there is a big PCB, then there is an inductor there are some parallel disputing devices and something we come to like and hate there is bunches of connectors, there both bad and good if you use it in unwanted place it will create problems.

If you use it in a correctly applied place there a convenience you can always disconnect and connect and so on and then this also incidentally is made out of sheet metal and excepted thin extremely thin and its made an every complicated way, lot of embossings are there lot of openings are there and it does all its functions.

Now, I will start with they call my power point.

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Why should we have sheet metal at all for an enclosure? So, the first point why is it usefully it is easy and available. Now we keep talking about various things like why cars should not be made of light materials and all that if you see the main body of the car is still made out of a specially treated steel sheet, occasionally you have aluminium things, but the main panels and all are all sheet steel, but then if you are notice the bumper in the front and back, they have all been now replace with engineering plastics, because over the course of years they have found out probably it is much more a heavy dented fender is not very good first of all it cannot absorbed all the energy, it will transfer the energy and probably get us into a different situation.

Instead everything has been now replaced with variants of probably nylon or some new high impact polyester material with various type of filling inside. So, down if you give here main important thing is if you have to make a prototype, most small workshops are able to make something 300 mm is equivalent to about a fut this much of a enclosure, you can enclose anything you want into that and a very important is it can be painted and graphics can be added. Very easy to take a plate sheet metal and then maybe you can spray paint it or you can print graphics on to it like as an if front panel, like as an your air panel in which you know we give clear indications of what each of the items are doing. And main problem is not I mean the advantage of is in the unlikely case there is some damage or some other additional work has to be done, it can always be redone.

Coming back to my this thing here say let us say in the beginning when we started with the simple power supply.

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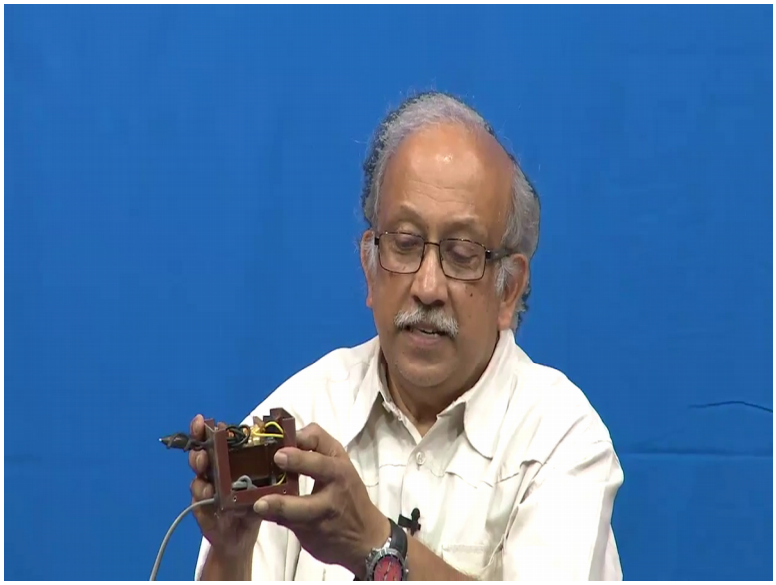

And the core of it is we have a transformer, why it is been made this way it is probably part of some rac equipment or something, where this directly gives an ac output and this ac output is treated to do various way. So, this is basically a very simple 230 volts to some wanted ac input thing.

Let us say you wanted change something, you just wanted to add an indicator to save the mains is on similarly we would like to see if the current is being exceeded. If you have a series element and then in case the current is there we can even more monitor the output, saying if the light is on that mean some current is flowing if it is very bright probably it is about to trip.

In contrast while that is a single what you call use single parting you see these this stuff is see everywhere you have seen this you know to many connectors, to many voltages everything fortunately you know we have a bunch of wires here, this bunch of wires takes us to all the outputs. So, you want so many outputs everywhere voltage current floating independent.

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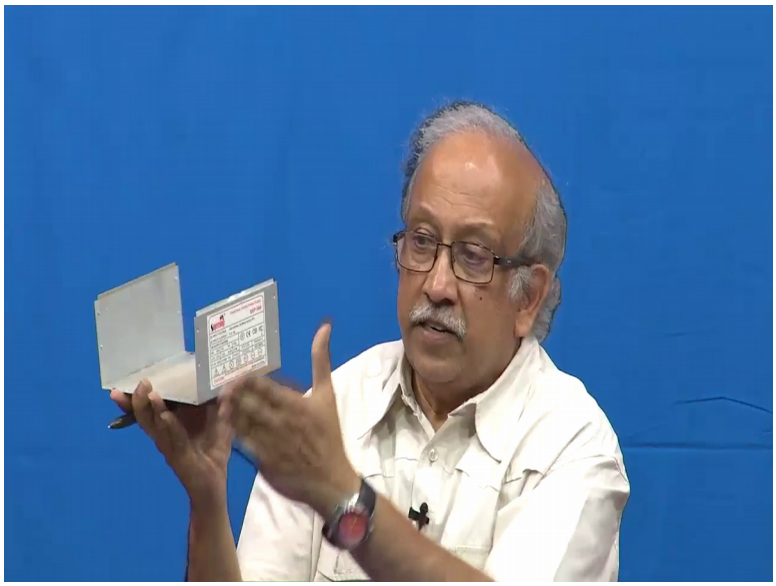

So, if you were to look at the outside we will get tremendous amount of thing. This is where I wanted to tell you it being flat, you can always add this decolour a sticker on top of it. It shows in this case you know that it gives you 5 volts to 20 nms and then there is a 3.3 volt 50 nms that you cannot achieve easily, we using that big linear power supply. Why I am saying this is if you see the way the whole thing has been made, does not add much to the weight and you can repair it.

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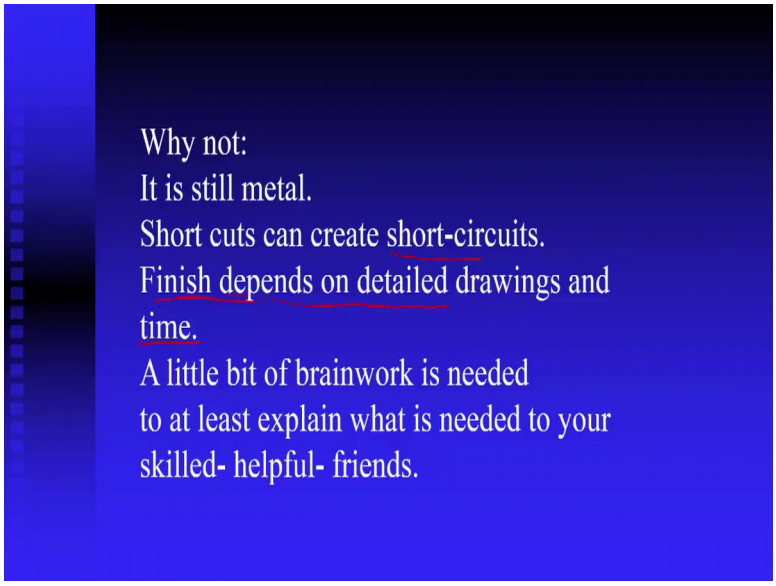

You can add voltages demo voltages make it as big as possible.

Next slide we will take us to why we will not be able to use this in all conditions first is it is still metal. So, metal has one thing is that its conductivity is a little high. Shortcuts can create short circuits hum I thought it is a fantastic funnonic, but the idea being in case you do not use things like a proper grommet see here we have a grommet here. In case you do not use that grommet we end up with it creating short circuits.

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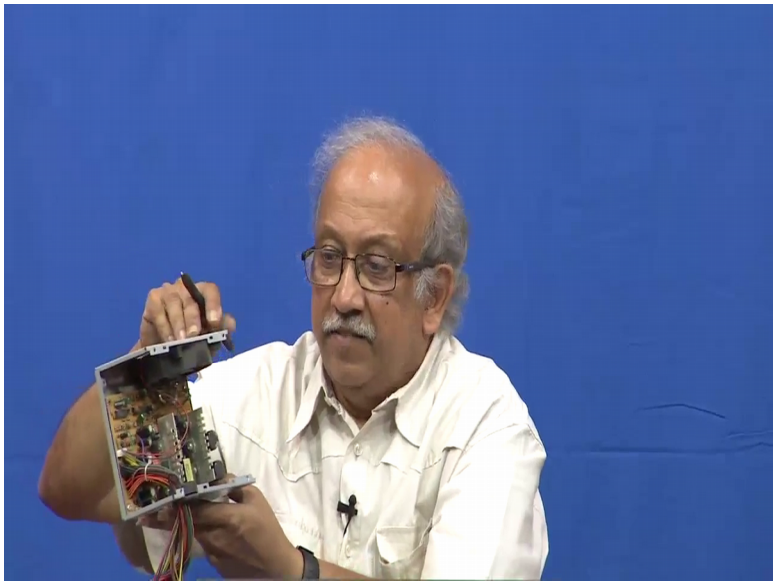

Similarly, if the inside electronic is not properly placed on a standoff, if you do not have proper insulated standoffs where these where these items are standing there if you do not have them properly chances of it short circuit can be done see how they have managed it to avoid it, what they have done is they have made a small embossing here they have made an embossing here they have used a tool to press the material inside.

And then they have put a screw here and then underneath that there is even a washer; which ensures that the strength is not compromised and show is the electrically in session property both are not compromised. Because the one that is holding still the strong metal fastener they one that needs isolation is a smaller washer or that is required thickness is less

Now, if you go further

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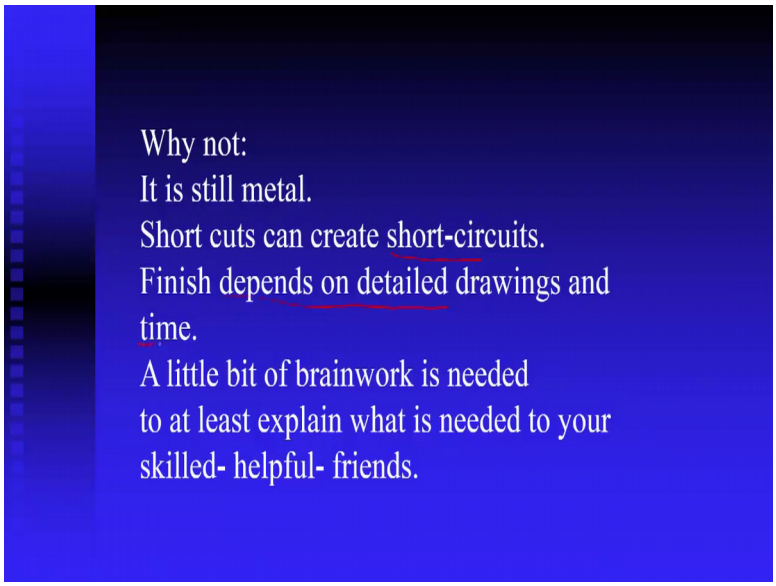

Finish depends on detailed drawings and time. In this case finishing is about making a corrosion resistant quoting on the other thing, and another thing is the type of how well it looks; it looks well because you see we have a fan here the fan has four mounting holes for mounting holes of the fan and then there is an opening here the way everything has been calculated in the way everything has been punched if you have sufficient detail we have a neat presentable product, which does not crumble in your hands it is what you call still fragile in some parts, still there is a way you can hold it and you can mount it inside.

Coming back to my this thing a little bit of brainwork is needed to at least explain what is needed to your skilled helpful fradm friends. Here there is a targeted at engineering what you call a graduate students were very good in their basic focus of electronics, but then there are not expected make all these drawings and so on. Just like I am sure some of you are following it.

So, you should know a little bit about mechanical saying how do you term a particular I mean thing that is something which is lugging which is called I mean there is something blanking and then you also have drill and tap and so on. If you can convey all these in a drawing eventually it can be fabricated

So, I start with a very horrible cushion mount here.

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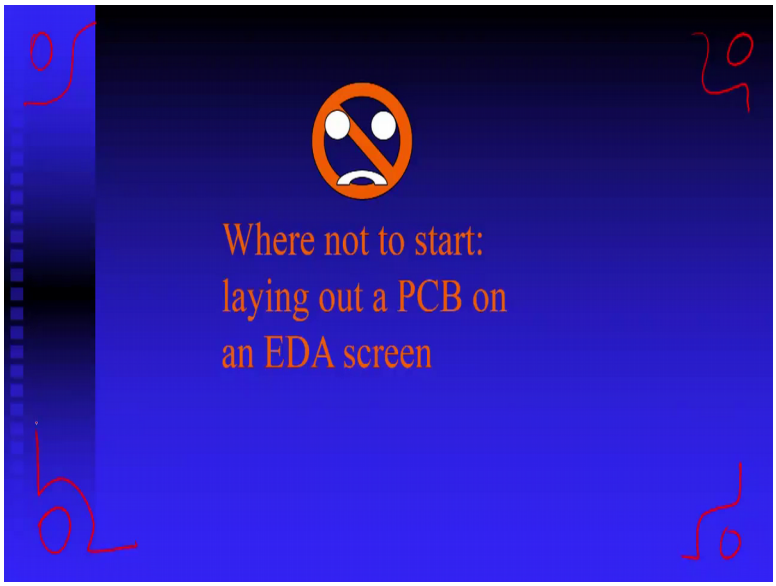

And not so great way it start with a rectangular PCB, because we have a PCB layout electronic tool which is sitting design automation tool which is sitting in our computer. So, what the design automation tool does is, it will make you saying make hole here that is you could point to start make one more hole here, make four holes in the corners good know this you design in Ireland saying

Now, make sure that they you know thing does not come here and all that. While for making a PCB for checking outside is not a very great weight to start because soon I will find out that there is no place and you end up with making things which are likely to cause problems.

So, the next slide we will explain to me.

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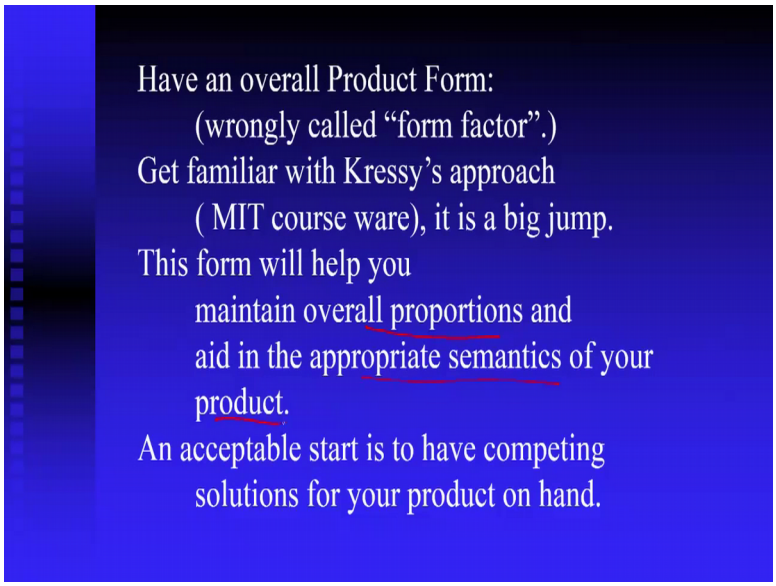

Saying overall thing come out how here product is it has a form. Sometimes you know the word form factor is used to which actually main something else what we understand get familiar with in MIT course ware Rhode island school of Dian design mister kerseys has given a beautiful presentation saying how to start. So, familiar with the approach, this will help you maintain overall proportions aided and the appropriate semantics of your product.

So, if you are to make something it will convey some ideas just like your words have certain ideas some of them are attractive what you call pleasant to hear some of them are very harsh. So, somebody will what you call you a rascal or an idiot, it has a different meaning. Same thing it is a product some products have this feeling of being threatening if you have the sharp adjacent so on.

So, the product semiotics what the meanings the products contain we will also make a lot of sense , if you have some models which are made with it an acceptable start is to have competing solutions for your product on hand.

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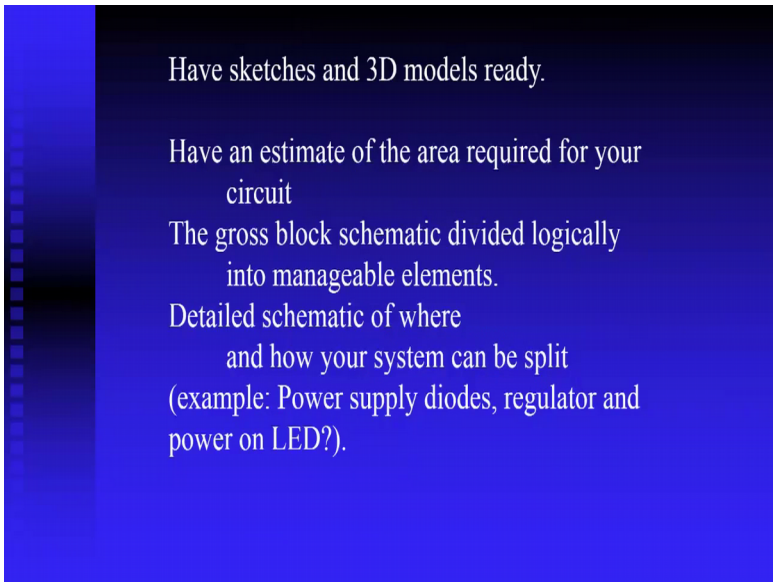

Sketches and three d models ready; most importance seems to be I kept on insisting on that. In fact, all designers you know they seem work on with sketches, sketches, sketches and sketches. And now that they we work in 3 D; obviously, you need to make 3d representations of your ideas what you have in hand. So, we have here I told you I have shown you a phone, and then we have this beautiful mouse seen.

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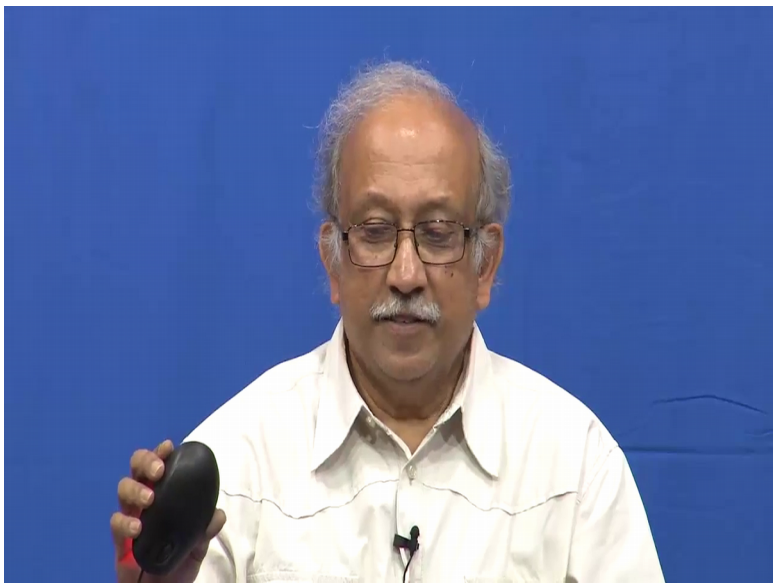

You know a mouse by looking at itself you have a little bit of confidence. So, first time you would have I mean wondered know should be tail be pointing away from you are not.

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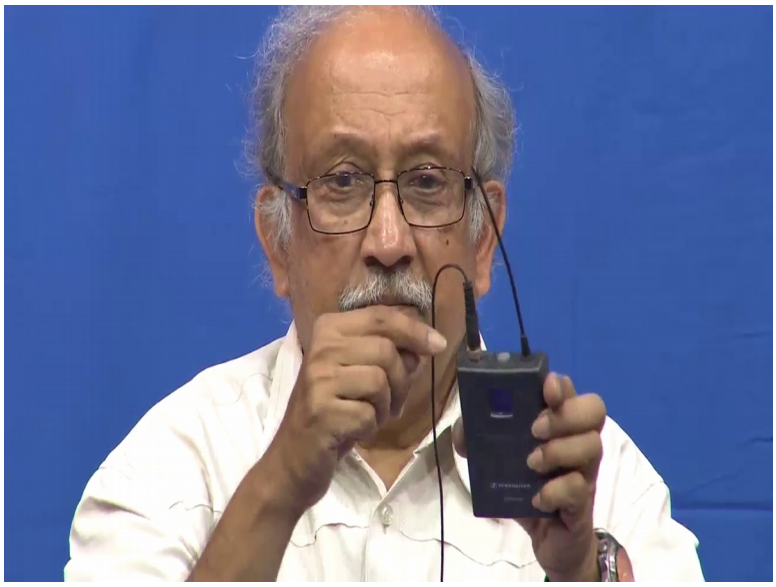

And then we have this beautiful wireless device. If you have a concept how it is expected to look we can make a neat compact thing. One thing have you notice the antenna comes out on the top. So, it is that this connection to the collar mic and then one thing which should do not you know of an you do not come across is that is a beautiful device, which holds the thing there is a null thread there and then you can couple things and then something related a little too it is the a display here which shows you various features.

So, we have a display, we have a connector we have something to do with the rfid I am sorry rf antenna and then we have other things which in the normal course one should not touch this is a power on off button by some bad luck the power on off and reset button and of front panel of ubiquitous personal computer. Say no see person like me whether out of ignorance or out (Refer Time: 14:00) I go and press reset button on my friends computer and remember that friend does not have the watch dog timer which I have thought about at the I have shown you in the earlier thing now all the work is lost.

So, here if you see the where they have made it know they have made it flush. So, that accidentally nothing it is pressed when I have trying to wear it in all it does not get pressed. I contrast the other thing there is big mute button here the mute button has

something which is outside. So, even if I am without looking at it I just go and press it I can mute it and then we also have some other buttons here so; obviously, this is a well thought out product.

So, it is a 6 sided patella of a pit the back portion contains a clip. So, that I can wear it either in a pocket or in my hip, and then one phase of it has some volume gain control instead of making it rotary they have made switch one side has the on off switch, and all that this switch is the front side gives a display of various parameters switch is probably programmable and at the top we have this relatively very simple product and it has a form which is uncluttered and simple, but still lot of thought has gone into it.

So, where we start have an estimate of the area required for your circuit; in the case this is it is the referring to the printed wiring board or printed circuit board. Must have some idea what it is then a blocks schematic is divided logically into manageable elements. So, let us say your printed wiring board has some digital section, then there is a analog and analog you may have low level high gain sections then you have a RF section. Similarly case a power supply you may have an input high voltage section and an output section and then some interconnection section.

So, the blocks schematic typically allows you into logically cut your thing into manageable sections; then we have a detail schematic of where and how your system can be split. Example power supply diodes regulator and power on led. So, it is possible for you now to take a chance of it.

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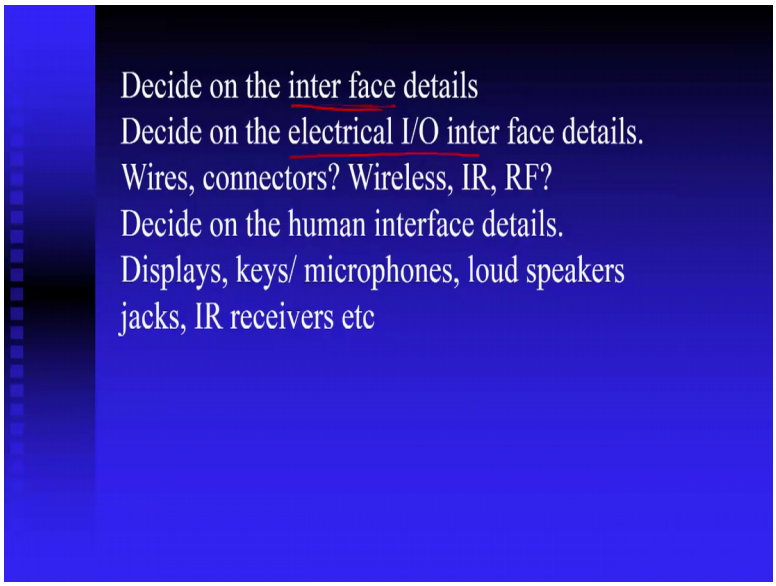

Slowly we are coming into relatively complicated thing; we have this interface details decide on the electrical IO interface details. Some of them are a say if it is a cushion of a control panel, some of them are displays some of them are where we have to take action that is the controls about it.

Then how do you decide on the wires on the type of connectors, and then if it is a wireless you end up with antennas. So, if you take our modern phone it is getting what you say threateningly complicated. It is 6 antennas of one size or the other this ordinary phone.

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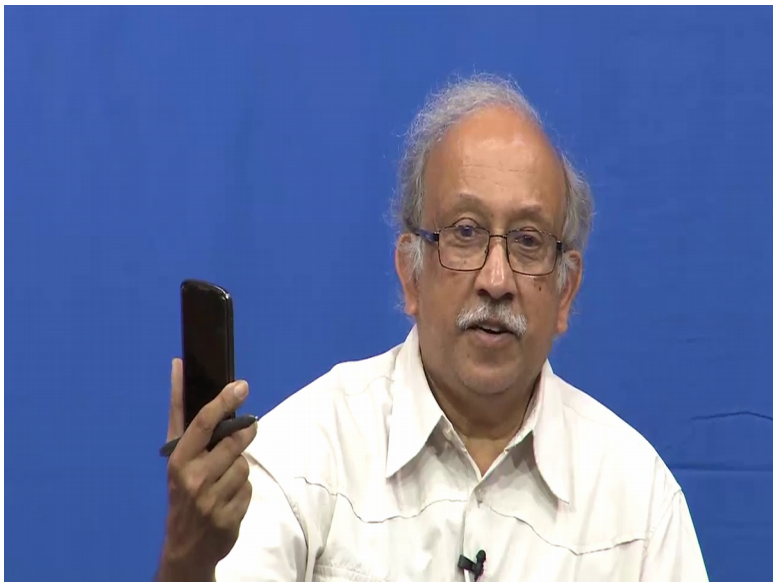

It has a very large number of antenna is are all the time there adding something to it originally it just to had a 900, 800, 900 1800 megahertz simple GSM antenna then we have added up anything more we have now NFC we have Bluetooth ,we have various other types of wireless suddenly power charging has come. So, there is a doc you place it on that and then without by eliminating there is a power connector life can be extended, but all of it is still not easy.

Something a little related to this is the machine human interface details; what does the machine tell you and what you tell the machine. So, we have displays, we have keys we have microphones, we have speakers, we have jacks IR receivers etcetera. So, what is the very simple remote control for a TV or any of these things still has tremendous amount of thought behind it.

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Very important thing is get the details of each of these items we just cannot randomly say connector will come here. So, we will now I wanted to have a look at this.

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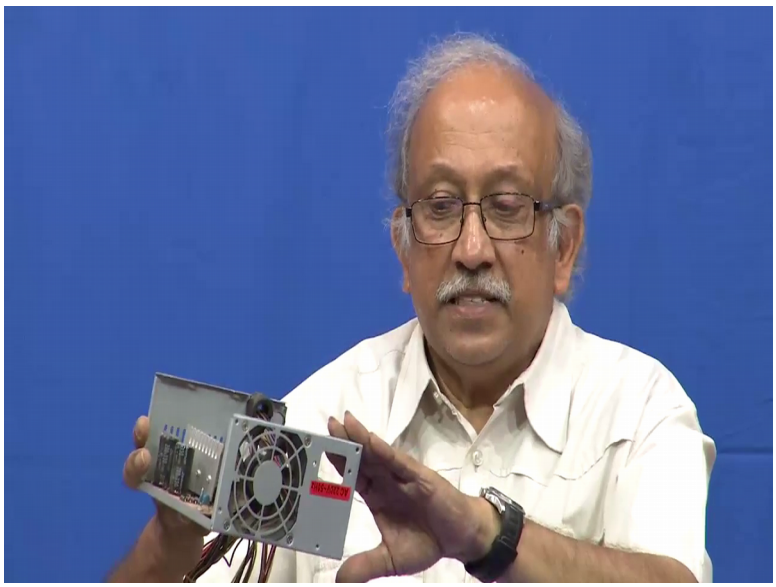

I think all of you remember with this cutout it is very simple it looks like obliviously there some rectangular object, with two screws several ways of mounting it. One of them is you can hound that you have mount the what you call I think the main part of it know the pin assembly goes here and in the back you continue with this holstering input and output it try to do there are two wires which have been cutoff here. Looks is it not

because replacing from the outside is easy all you have to do is a remove this screws and pull it out.

But then electrical side it is not that simple because when we want to assemble this PCB you are any way assembling all these wiring harness on to the PCB. When you are assembling all the wiring harness it is logical that you have a connector which sits from behind instead of sitting from the front.

Now, if you go back to your pc your and see this power supply is know that is all the provision if you want you can mount it from here alternatively you can put it from behind. At the movement you put it be from behind we end up with this detail saying we have a tap screw here, we cannot use tap screw anymore this threaded portion should go in to the connector or at the back of the connector we need to have this thread. So, that you can put a screw here

But then if you put it in the front we have the advantage that we need to this is called a plangent tap, it is very easy for us to just you know make a funnel like thing and tap it very simple somebody has to take distortion.

Now, how to we get over that problem which is better this is where I see it depending on do we actually do a repair on this it is unlikely you will do a repair. So, in case something fails we take a higher rating thing and just push it inside. So, it is not a big issue its all it its logical that we keep it from outside. So, easy for us to put it and continue with all the work alternatively we put it from the inside because of the total manufacturing cost is assembly cost of this device is small.

So, somebody needs to gather all these details before we end up in a problem no detail no product for every little small item you need to gathering detail about it. Something very much related to again or part of it is the large volume items starting from PSU component displays connectors all the way to the small wire every detail its better you have it with you.

So, most engineering successful engineering products a successful because of the product detailing; and then again in detailing both the issues are there one is the mechanical detailing and how to fabricate it, another is the detailing about the design the

appearance of the thing from outside how neat does it look at then is a manageable is it use and all that.

So, we have all this stuff you know wire harnesses cable stays, grommets we have all these stuff just now I showed it you.

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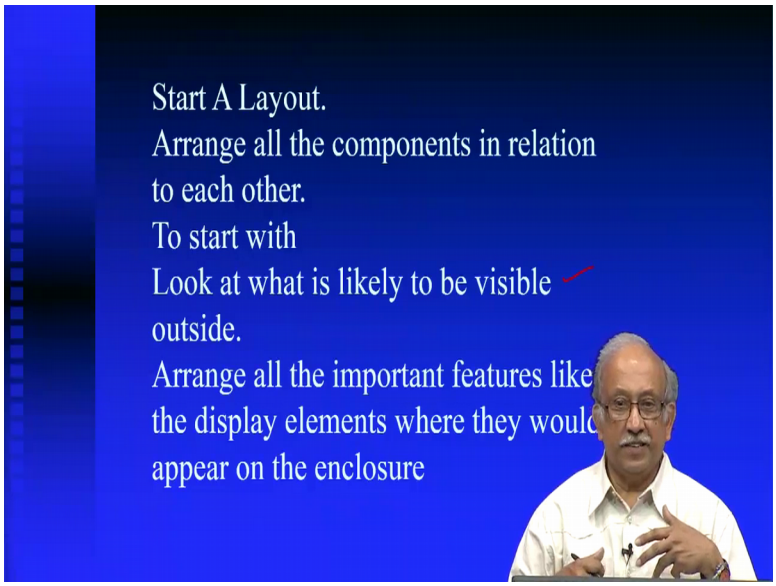

Not an easy life for all of them start a layout arrange all the components in relation to each other to start with look at what is likely to be visible outside, this is what I showed you a sample of the transmitter which goes with the wireless mic here. Arrange all the important features like the display elements where they would appear on the enclosure.

Now, going back about three lectures back I asks you to imagine one any hand held device which is likely to you have to probs, likely you have a display, and then how will you keep it on the table is it an angle and then in case you want to hang it around your neck can we still use it, and are their small things that are required.

Good a very good start.

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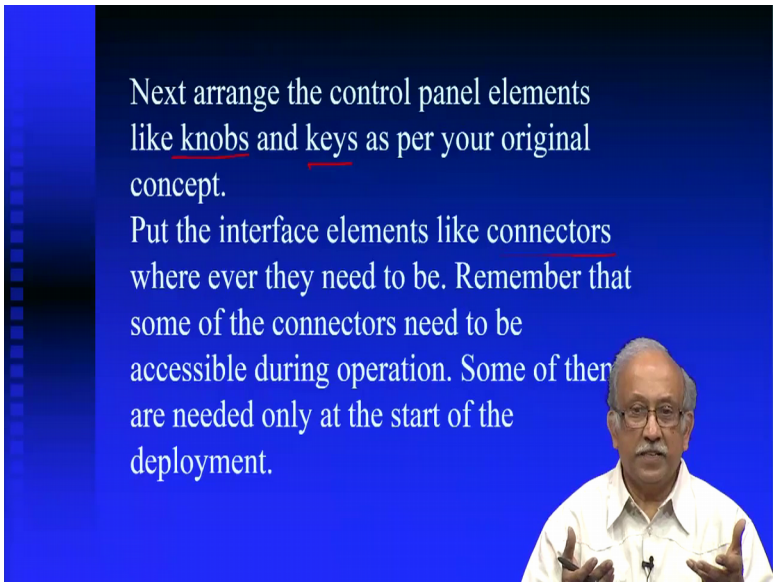

Arrange the control panel elements like knobs and keys as per your original concept. This has been made few years back these days luckily for us you can configure things on a mass produced product, but how are still individual products are not that easy to have them reliable and make it work. So, if you are to have a power switch, if you are to have a some sort of you know high voltage or high current connections, you still need to have the keys knobs all these has reality and it should also look presentable and make sure that the operator does not do an error. If you remove the all old components and new ones now you have a provision of making them very very presentable, and if you take a place like a even a control panel for a cnc machine.

One part of it is small section of it still has that old what you looks like a jogging knob and a shuttle, and the remaining display part is there and several other things are all programmable keys. So, we have this connectors you know there a blessing and a nuisance. Blessing is you can detach anything into other parts and replace things I have shown you about the power supply in case the power supply feel, fails we just need to replace another power supply which occupies about the same area.

In case you need other voltages or things have changed you can continue to the to use the old PSU cabinet, and get power supply is which can give you lower and lower voltages we have a 3.3 volts supply which is very good. And then if you see some of the connectors need to be accessible during operation, but some of them are only need

needed at the start of the deployment that is when you install the equipment you can adjust the various levels of maximum and minimum and one of the well-known thing is the voltages. So, would you like to monitor the voltage and then once it is done you shield it you do not need to do it only in the case of when a failure occurs you can go and attend to that?

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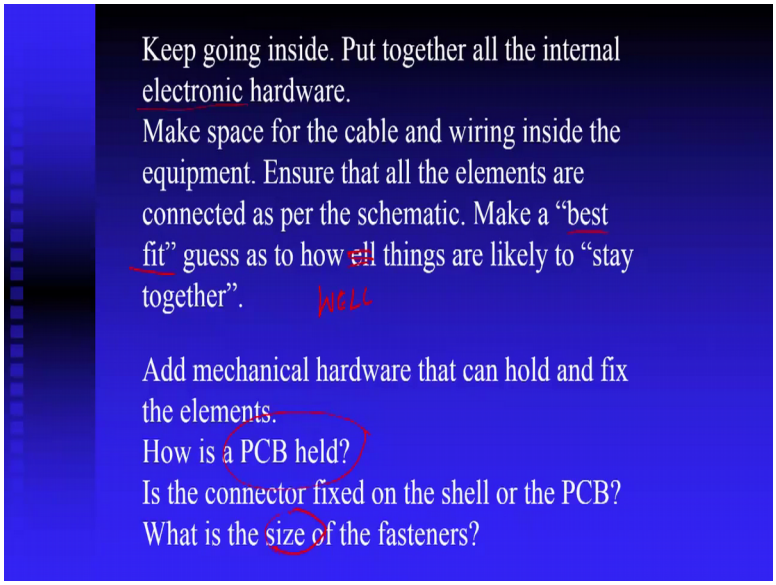

Having started from the outside is slowly go into the internal hardware make space for the cable and wiring inside the equipment, ensure that all the elements are connected as per the schematic make a best fit guess as to how see I found a at the well here how well things are likely to stay together. I mean just again a little small pun if there something that should be replaceable it should be probably isolated a replaceable object can be isolated or something called test field components are there. You try things in the field and then try to keep things optimize it for that particular set up after that you stop.

Let Us say you have a video projector which is being fitted in your classroom or at home. You do not need to keep on fiddling with all the various things like the focus and then you need not at to fiddle with you know that why fit the height, or the why fit the width or is an aspect ratio may be a little about the ambient illumination is all that is required. All these can be done and things will move on smoothly when the two things can fail in that one of this that electronics which drives a display actually it is a shuttle like thing and the other one is the main power supply with a lamp is that a way I can

replace these things as I expect you know things slowly come better and better for a given voltage, you can get more lumens are for a given lumens has technology progresses probably less voltages are required to drive that, that is related to current and so on.

So, if you have a schematic its always for us to a best fit guess, nobody can optimize everything in the what you call first time I thing we do not now I am still that debating how long it is taken us to evolve to this condition its second time. Mechanical hardware that can hold and fix the elements, so this is where I was talking to about do you required screw, do you require a standoff and do you require a grommet and then do you need a screw thread screw, or what you need a counter sunk screw.

And then in case screw thread is a must how do you height the top portion and all that and then something equally important is how is the interconnecting device held in place. If it is very much possible for us you keep everything such that you know proper snaps are available, pushed it into the snaps and then close the lid and then there will be a single screw holding both the parts together.

So, we have all those things you know what are the sizes of the fasteners, after if you do not decide know if you do not have information with you upfront we will try to do firefighting search, this screw head is looking big can, I get a smaller screw head I mean that occurs that what is student would does or what a designer would do is now we will try to search around for it. If we have a library of all these components have priori we can always work with these things and make things better and better together.