Enclosure Design of Electronics Equipment

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Lecture - 02
Aspects and features that are non electrical and are essential to Electronic Product Realisation

I want to continue to talk about the theme of how to make enclosures for electronics products, as I have explained to you earlier the simplest thing is something we should like to probably make in the in your lab and then after having tried the circuit you want to put it in an enclosure such that it can be presented to the public. This I will say is a little better than hobby or what you say lab exercise type of thing, there your idea is you have a concept and then you want to say if it works and then minimum amount of protection you would like to see a few lose wires also is not an issue other extreme we have extremely complicated and what you call potentially life threatening situations for which products are designed.

One of the thing is imagine weaponry that is used in a war. So, there is nothing like it is all right if it fails we will leave it in orbit, it is even more dangerous than a aerospace application or imagine something which goes inside the brain here and inside or inside the heart here, some new pumps or something you know which will have to inject things through the screen and all that that is really something you cannot afford to have a failure there a failure is the end of the world for everybody.

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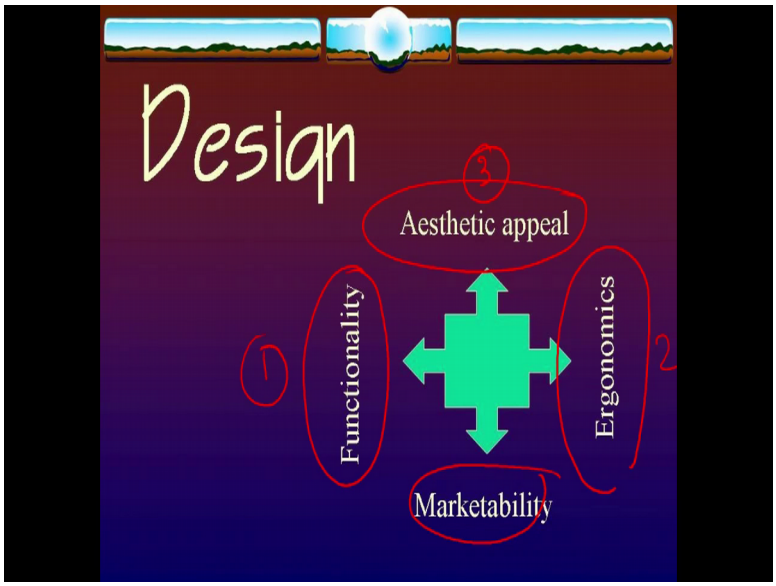

Now, let me go back to yesterday's thing and then I will start with the PPT. See I will show you a few examples from mechanical enclosures just over a roundup of what we did yesterday at one point here we have very important thing about the main function of the product is it is functionality we have seen it know very very important is number one thing is about functionality it is something does not work; obviously, nobody will buy it is not like an arc piece where appearance or the reactions it evokes in the user are the important thing in this case functionality is how it works it has to work a light has to give light and then if it is a watch a watch is to show time I have no choice and show a correct time we can have added attractions like that know watch this thus does so, many other things

Basic functionality for an amplifier is obviously, amplification with certain specifications, and then something which is equally important know is probably the ergonomic aspects of it ok.

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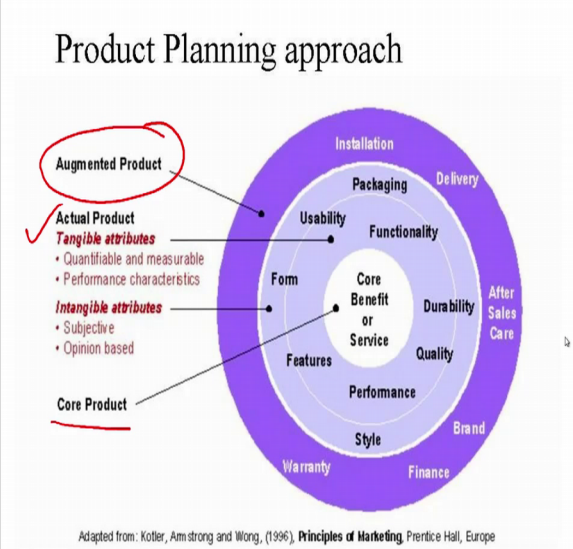

The ergonomic aspects of it is that it should be convenient to use easy to use and it should not deter the person from a trying to touch the object if something looks threatening it is unlikely that you will touch it, it should be user friendly. Once upon a time they used to take products and hide them behind on a glass shelf, but the things have changed now they do not hide anything behind a glass shelf. If you go to a any shop including something which sells very costly DSLR cameras they want you to experience it they will give you a camera in your hand, and part of the success of all the new retail is that it is almost a word called retail therapy has been coined you need to go there if you are a DSLR fan you go to a shop which sells cameras, handle all the cameras maybe try what you call the zoom and then maybe try everything and see how it feels and so on.

Same way if you were to go to a specs shop I think I give with this example already, you will probably try try all the frame have a look at yourself in the mirror the moment you look at it the person will know; obviously, the ergonomics is right. Here you will notice you will notice that the ease of use how well you use it is very important and various things know especially something which is related to the anthropometric data that is what does the population normally use it is very very very important. So, we have this ergonomics where anthropometry also is not included and then quite an important thing know is this that a couple of the product, unless the product appeals to the person nobody will buy it that is reason why even if you are to take an apple computer you will see the

apple logo at the back of it all lighted up if you close it, it looks upside down, but obviously, everybody wants it that way.

You will be surprised to seen that we often select even monitors computers everything know based on how inviting they are if they are more inviting they are more what you call useful and something which is beautiful is probably know is already you have a positive attitude to it you will work carefully about it, and then something which we should never forget is this marketability. Again marketing is not selling all these four items have not in any way related saying you cannot have over the wall approach that is somebody makes a functional product and then after that know he says kindly attach ergonomics to it, and later on know sort of spruce it up make it better and make it there and finally, you know dump it in the market thing.

Any of the sequential appeals or what is called a over the wall approach may or may not work in all the times, marketing is probably a good starting point, but then it does not mean here the only people who can define what the product is other extreme is they can probably go somewhere else now we know you know they we have the dragon, they can go to the what you call birthplace of the dragon and then buy it and try to sell it to us then you will notice it is not easy. Now I will go on to the next slide which if you remember we started about what is the core product the functionality and all comes here core benefit or services like that then; obviously, tangible attributes that is the usability functionality durability, quality, performance, features form and then next level comes to the intangible saying opinion based saying it is a good product we buy it and then something which is augmented emergence installation delivery after sales branding finance and warranty.

A lot of products are sold these days not just because they are good they are because they are affordable we have a financing option which will make it sure because of this financing. Now you can buy things always on installments and you can buy things which you can afford you can decide and then of course, branding gives you an image which says yes this is quality absolutely, otherwise you wont to had it had branded bags branded jeans and now even branded commodities like we have branded salt the sugar is not branded yet. So, I can just imagine it then something related to how well it you know is installed and so on.

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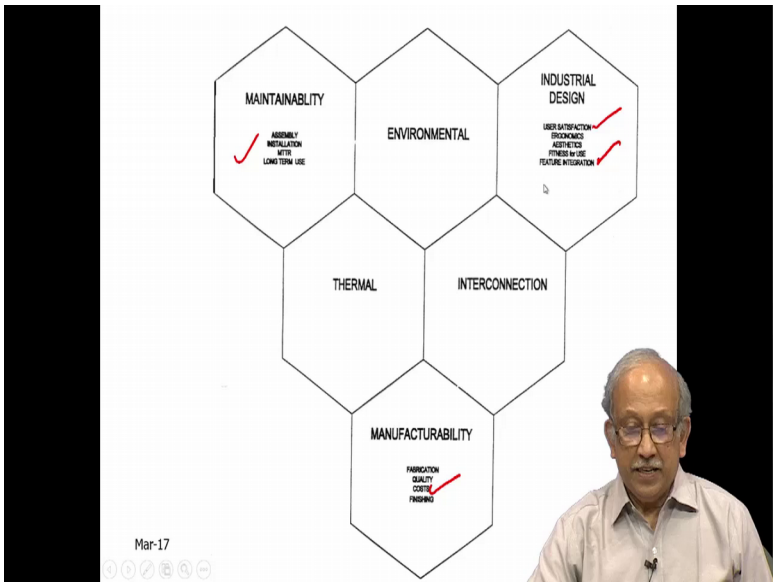

Now, coming back if you remember we have the four things we have talked about, saying maintainability id and manufacturability.

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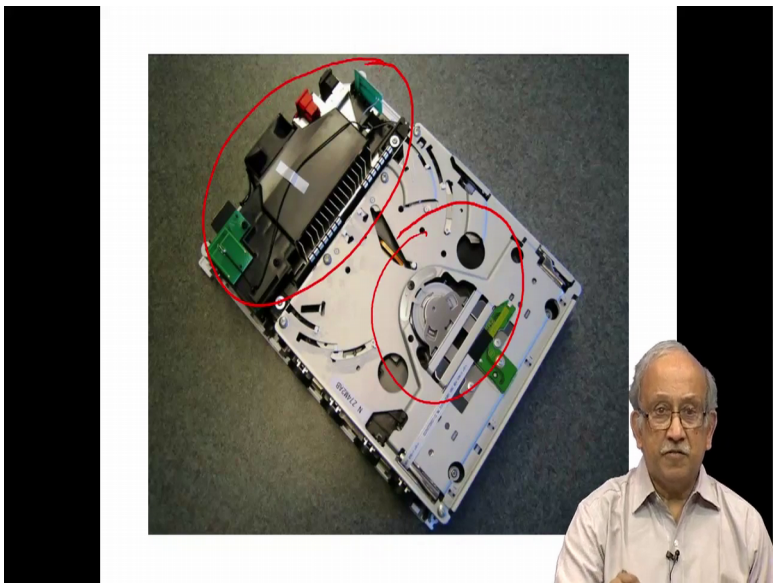

Then we wanted environmental thermal and interconnection this is the actually the core of my course now I will get back to typically something you are likely to find in your house this is a nintendo wii nothing. If you see carefully there is nintendo wii is nothing, but it is a drive it is a disk drive in which you put a cd inside, and then it supposed to

work, but then how does it work so well you see here if you see carefully there are so many items here.

So, this is the core part of it which you know this point of it is a drive point and then you have at the background a tremendous amount of work which goes on at the back we come to one corner connections.

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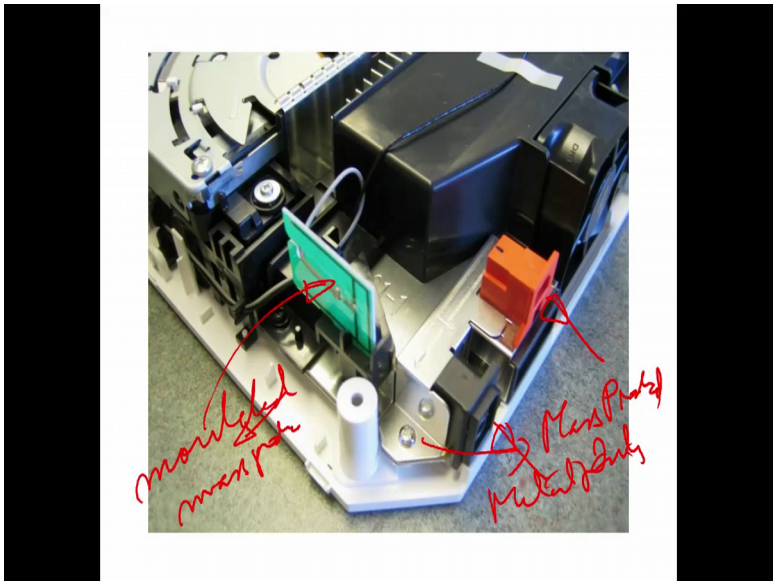

You have an interconnection here you have one more here, and then there is something here very very funny it is probably an antenna which will connect it from the external world and very very important part of it is you have all these you see this point of it is made in a molded mass produced item, some more in a very magical way it is married to same mass produced metal parts.

So, you have here products which the load bearing part as of now cannot be replaced with plastic, plastic is good up to certain point. Especially in very thin sections if you have to take a mobile phone or if you have to take a digital DSLR camera, one of the first things you will notice is the core part of it now it is probably made from a special alloy usually a magnesium silicon aluminum alloy. Magnesium silicon aluminum alloy can be made into small portions and then special injection techniques are there by which can make something strong.

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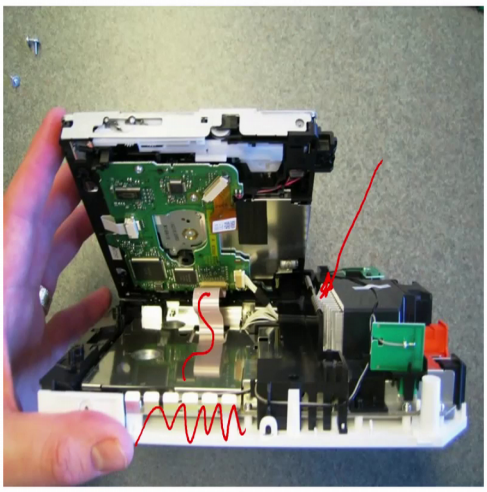

Now, going back to my slide a little closer thing you will notice that it has several very interesting things like that you know you can open it you have seen that this part opens up nicely and then you have here some contacts to which make sure that Rf isolation is done, and then you have see you see very very nice beautiful way of interconnection from one layer to the other is there and then this one now we got it know it is an antenna it what you call (Refer Time: 10:43) communicates without any of these cables directly like that then you have seen, this we have a nice beautiful aluminum dabble here otherwise known as the heat sink.

A heat sink is actually a misnomer strictly speaking it is not just a heat sink as such, it is not just a heat sink I will just go back a little and see if I can just locate it is I do not have a close up view about it. The idea of a heat sink is it just a heat spreader the beauty of it is it is a this is a heat spreader and then on the other end know you have a small what you call fan there what this heat spreader does is it will take heat from any of the hot points and then it will try to take it into another place, and then one interesting thing you will notice is it is not black color, heat sinks need not be black. In fact, they have found out know that heat sinks probably should not be black because black is a very good radiator as well as it will even absorb heat, it depends on the temperature difference normally ambient temperature inside an equipment maximum may be 9080 and so on and the devices and all that know may or may not be about that, but just next to this imagine if

you have a really hot component let us say there is a resistor which goes above 110 degrees that will be passing on heat to the black heat sink and not the other way.

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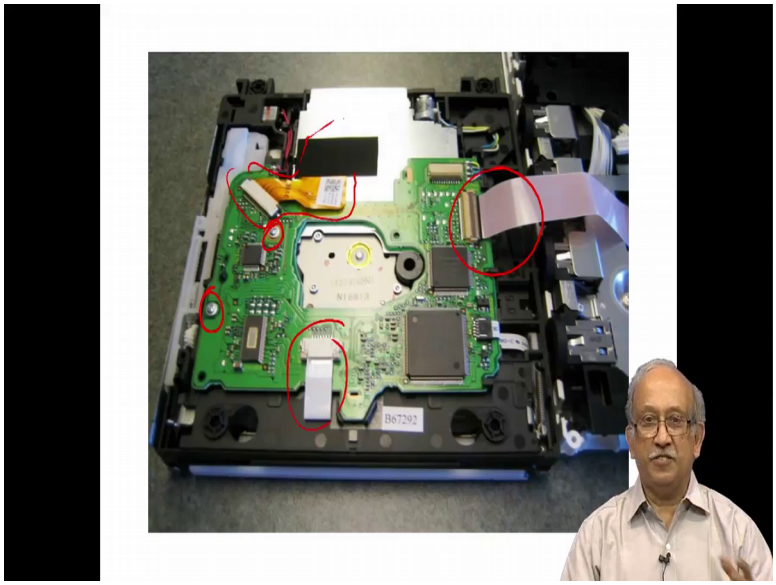

And most of the time heat sinks the mode of heat transfer is convection, because of the convection convection does not need an color. So, you will notice that a heat sink is one of the unavoidable portions of this and now further if you go inside you see here we have a printed wiring board. So, this printed wiring board contrary to normal have the exercises is rarely a rectangular shape, I am not being what you call I have no criticism about it as a lab exercise it is worth trying to layout a PCB it taking the four corners of the screen because you can do things and you can learn how to do how to layout a PCB how to make a schematic capture, how to make a rat nest and outer the routing, and then how to also what you call space all the components properly that is you make sure that things fit naturally in all the places, and then you can oven locate to see in one edge here know in the one edge here they have made the connector here, and then you see here it is at an angle like this because it the connector is folded and taken off there somewhere and then you have something, and then you have most important know you have the fastening screws you see here.

So, two or three things you will notice about it is fasteners need not be located at the 4 corners, and very rarely in a professional equipment the printed wiring board is a rectangular thing. It generally it has all these fancy shapes, but for you are in case you

are a serious hobbies or in case you are a learner for the first time you know Hamid making in because next round know every any of these product designs request two rounds the first round where you prove your circuitry and your technology and all that, at the second round you need to now make sure that the whole thing can be enclosed properly and then once you run thing know maybe and the third iteration you have a professional product which you can now try to see how best you can do with it.

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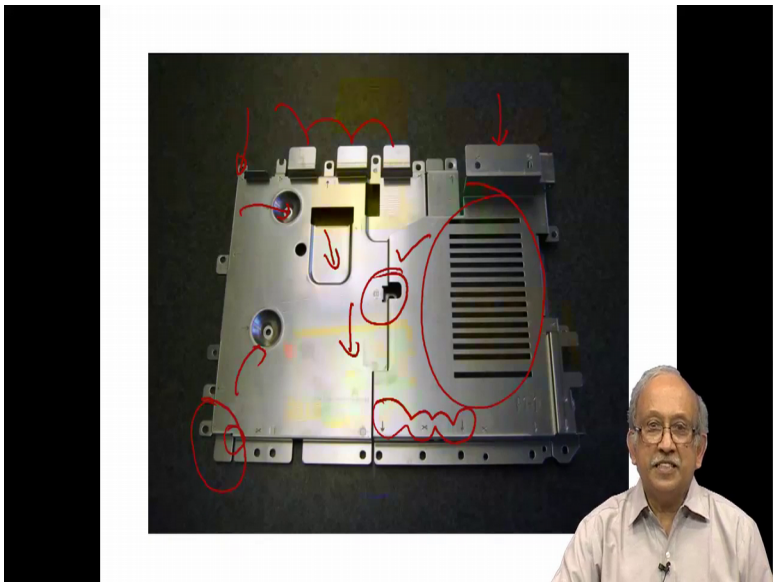

I will move on to the next slide very interesting thing and even this so called sheet metal know is no longer in a sheet form on a level flat ship it is embossed everywhere. Embossing has two advantages one of the advantages is you can maintain the level you can make something at a higher level, lower level, you see here this portion of it know is at a higher level this portion of it is at a lower level then there is a small thing here probably it is part of the where you push some other thing and then all these various fastening devices know even this things have been kept nicely depressed. So, that they have their proper function and then if you see here even depending on the method of manufacture and depending on the quantity of manufacture it is possible for us to make very very complicated specific to the product enclosure.

So, that typically what is just not very different from a cd drive as used in a wii or anything which is based on a cd this thing, they have spent such a lot of effort it; obviously, does not come the first time it is in fact, probably know it is second or third

attempt like this know. So, you have here a beautiful perforations here to make sure that whatever function they want know probably it needs a little bit of external cooling.

So, I will just allow you to take a look at these things I will just point out various features you have a look at it. You noticed everything seems to have a special thing including a few things there when either marked at directly stamped orientations have thing and then you have fastening devices and then you have a small step here they have made a small notch and one thickness they have taken it inside I do not know unless you see the whole thing we cannot make out at this stage what is it.

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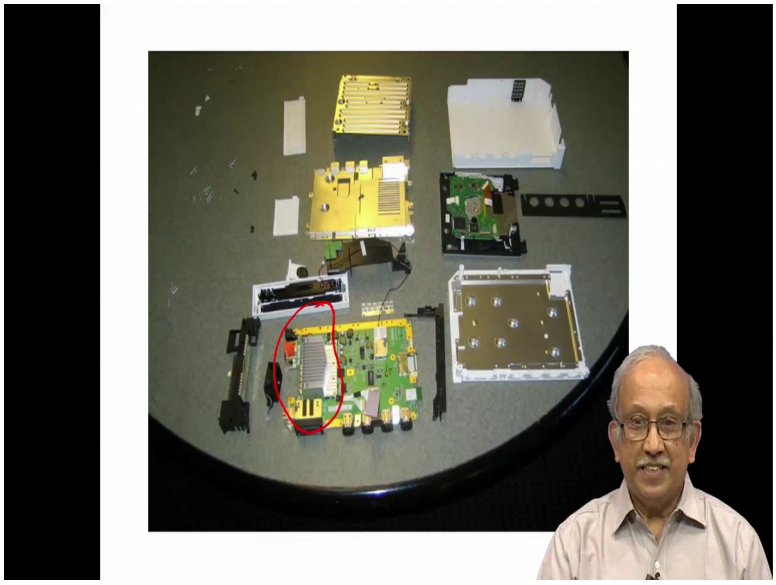

Now, if you spread all the parts and keep it here I will notice that it is good it is beyond belief you have that beautiful cover in a one place and then you have the main PCB and then you have here that heat sink business which I was talking about or a heat spreader and then you have the cover which you have seen and then it also seems to have a slightly different color it is not a lighting they do something to make sure, that this thing does not get corroded that is where as part of that environmental thing if you remember the first slide I draw a circle around and then on the circle I have also showed you that how well it you know puts up with all the harsh environment is all included the moment you put a fan in the moment you send air into it, you are exposing all the circuitry to the ambient.

So, one of them is that it is corrosive; corrosive are not in as an acid corrosive not as it in you know very harsh environment even in a routine normal indoor environment, there is a tendency for any metal especially mild steel which continues to be the cheapest sheet metal to corrode. So, to prevent corrosion what they do is they try to plate it with some metal earlier it used to be cadmium, but in due course a last everything 25 years cadmium has been restricted, right now most of them are made coated with tin either it is a pre galvanized tined sheet or anything and then this yellow color is probably what is called bichromate passivation and top of it, that is they take it and dip it in a this thing.

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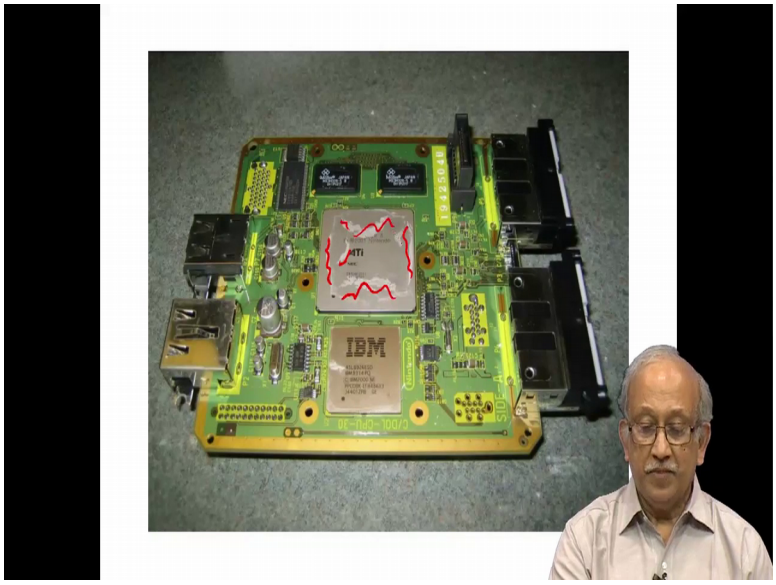

So, it will prevent another level of patch up and so on and something which is very this thing is it will make all the finishers compatible they look good and there is no electro motive potential between the finishers which will cause degradation of this. So, next slide show a little closer of some other product I hope it all belongs to this only you have come in several type of processors here and then you have seen here the top this all thus this is all; obviously,

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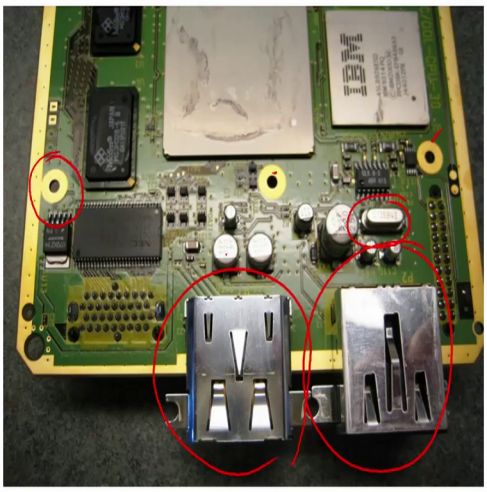

Some heat sinking compound like thing this heat seeking compound like this what it does is it you can attach a heat spreader on top of it and then do everything and then you see here this is the most beautiful part, all of us know we love to heat it this is the connector which is know the ubiquitous USB.

Sometimes we associate USB with the pen drive the pen drive is not the USB actually it is a interface specs which are the USB. So, yes we have type a b and then we also have you know mini and micro and what else will come to the extent that most mobiles this is the USB this also USB connection only this is come here, you see here next time take your mobile have a look at it I cannot show it here properly you see that there is a beautiful USB I do not know it is called a probably it is a micro.

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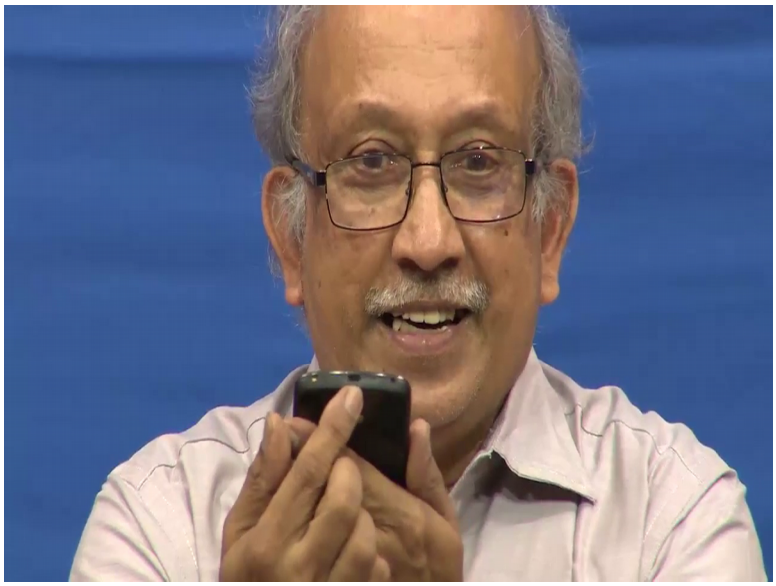

So, we have this and unexpectedly even most of your cameras these days come with this is a different type of connectors like that.

So, coming back to my slide here again you will notice that I have the USB connectors here and then you see here some very very critical thing this is it is a clock crystal luckily after the advent of the new electronics you need not keep it in a very what you say controlled environment for it, and then you see when the fasteners know you have here a beautiful earthing thing. So, there is a earthing plane somewhere hidden inside you have all these things with the fasteners are fixed and more important you have they are seen that even small a dots and you know the way somebody has spent a lot of time to make that this is EMI and probably ESD proof once you properly make the whole thing, if you take it around a stray magnetic field it is not like to make a difference not all the time it does, sometime next time you will listen to a TV show or anything know you will hear some very funny noises that is very peculiarly they transmitter antenna which is trying to locate from the cell tower saying I am here sends very strong signals and these are invariably picked up by this small what you call microphones which we carry whether it is electromagnetic or piezo or anything know invariably it will give that pit pit pit pit noise all the time trying to connect to the tower.

So, life is not easy and then a very simple I will you know I am a dumb fellow with a smart phone this has 5 to 6 antennas inside I it is a surprise to me how they were packed.

So, many of the antennas to me we all know the basic GSM GPRS system that is there then we have got a three g and four g then we got a near field communication then I have a Bluetooth with it oh then I do not know what all things are all fitted with this even the hearing aid I have this hearing aid is left hearing aid and the right hearing aid are interconnected with the Bluetooth communication, to make sure the phase it is in phase while you especially young people who can easily hear things, it is naturally you would not have think about it if you were to wear if I were to wear a hearing aid, I have a part of bone conduction part of air conduction like this.

So, there is a small phase difference when the hearing aid processes it. So, all those things are built inside, that is why it is a little expensive hearing aid which incidentally is the cheapest and the thing it costs only 50,000 cheaper than lot of jewelry.

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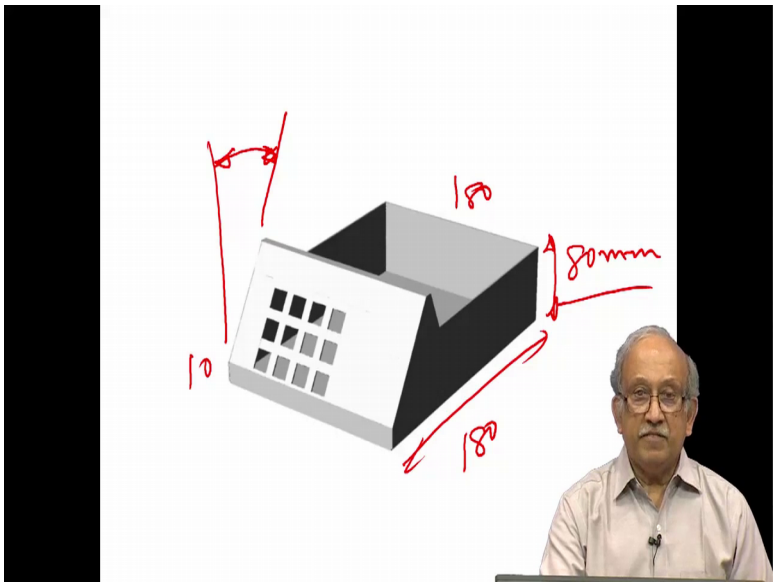

Now, I will get back to the first very simple thing which probably you can do in a workshop, this is nothing I just cannot say this is probably a box was made. So, that they can put any microprocessor based small pcb inside it was part of a exercise meant for people who come to the workshop first time. The moment you have a concept one of the things you will notice if you have to just take this box as it is this height is limited this is probably I will do in millimeters you can convert it probably 80 millimeters not more than that and similarly if you remove for various effects I remove 10 millimeters here and then this length is probably around 180 millimeters width is probably again one

more say 180 millimeters you will notice that if I remove all this there is not enough place for the front panel with which you play things. For easy purposes of easy layout here a three by 4 matrix type of keyboard has been made meaning it has 12 keys.

So, normally zero to nine is sufficient for you and another extra two keys are there which would like to make. So, the obvious thing is that coupled with having to look at it when it is on a table it has been made to be at an angle as you said is there a ergonomics or there is an anthropometric data for it not so much it is a little about just look around see other things which is have done and all that because it is not as critical as an aircraft or a spacecraft where you know humans are to operate or in the case of a submarine which is very critical it is in case you do a mistake it is finished. This is generally more to accommodate the amount of space and then if you keep it on a table and if you are sitting like me you can reasonably say these things without glare.

So, this is a starting point saying I have a raised small step here in which I have a front panel and then I have a box in which an enclosure in which I can keep things huh.

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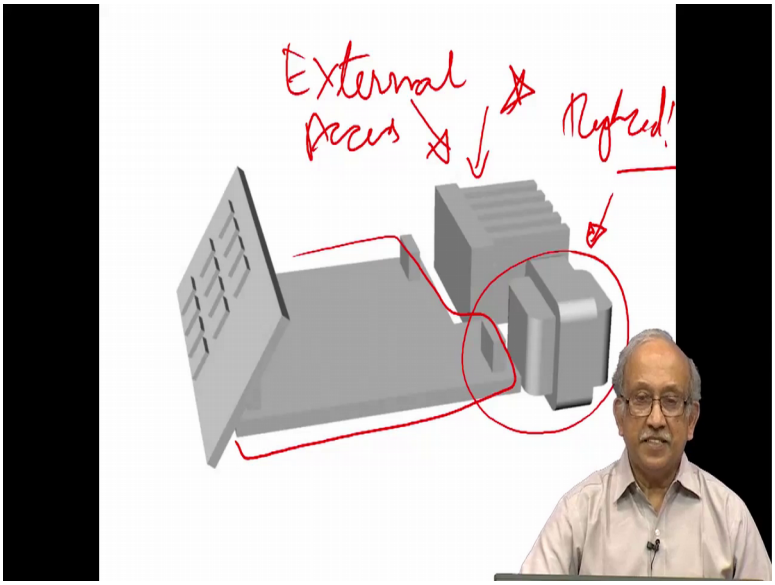

Now, slowly we are getting into details this being a very standard that this thing and then you would like to probably make it stand alone I have tried to put the power supply here. So, invariably the power supply has a transformer most things inside even if you take a big monitor or if you take a computer or anything the voltages they work with are very

small now with the new power thing we have 1.8 volts chips similarly earlier we used to have 5 volts.

So, if you take a power supply of a ups what you call computer system unit, you will probably discover there only a few of them out of which 5 volts, 6 volts and 12 volts you know take a lot of current and these days know even little lower voltage also is available, but for purposes of illustrations this certain course material was developed when a transformer and a series pass element a regulator was required for maintaining the voltages inside.

Now, these hardware items this will continue to stay it still is there this will continue we cannot get rid of it. These now is replaced by other thing it is replaced by equally sophisticated heat producing and add it to the something which is EMI inducing meaning you have conducted and then you have also radiated or picked up from the ambient EMI and all that, just for us for the purpose of understanding. So, this part of it know is a printed circuit board you need to put everything and then we have a front panel and then you see here this is where we come to the important thing this this needs external exposure access stand.

Now, we have a what you call a heat sink and then heat sink as I have explained to in the earlier example it needs a conviction. So, there are fins here just for rough aspect know I will just put some fins here.

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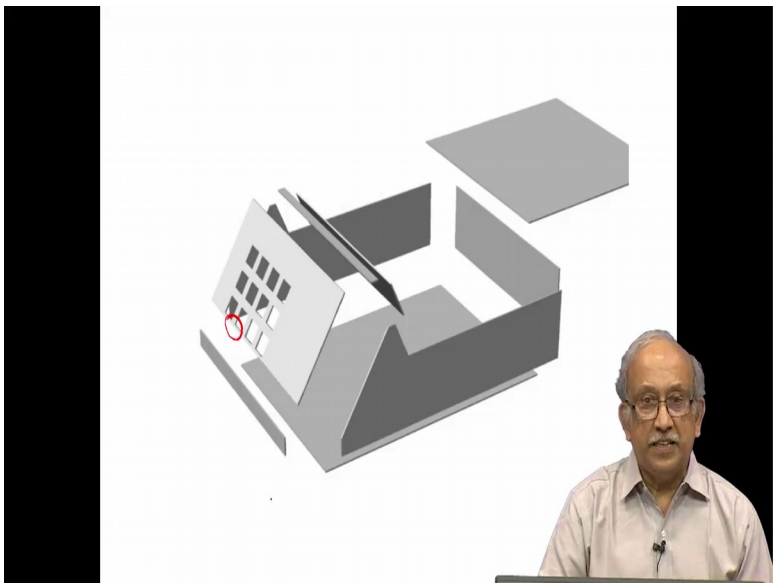

And then it is a natural convection heat sink. So, in the case of a natural convection heat sink you need to put things here. Now if you want to fabricate the same thing in a in a sheet metal one of the first things you need to do is to find out know how well you can spread all the parts inside is there some way of making an optimization of the layout. At a first level it makes a lot of sense to break it up into parts which are flat because by definition heat sink sheet metal things are flat.

Once they are flat, but you see here now we have a little problem here is it very nice I mean very much come to the close thing very close to the edge not easy to fabricate such things.

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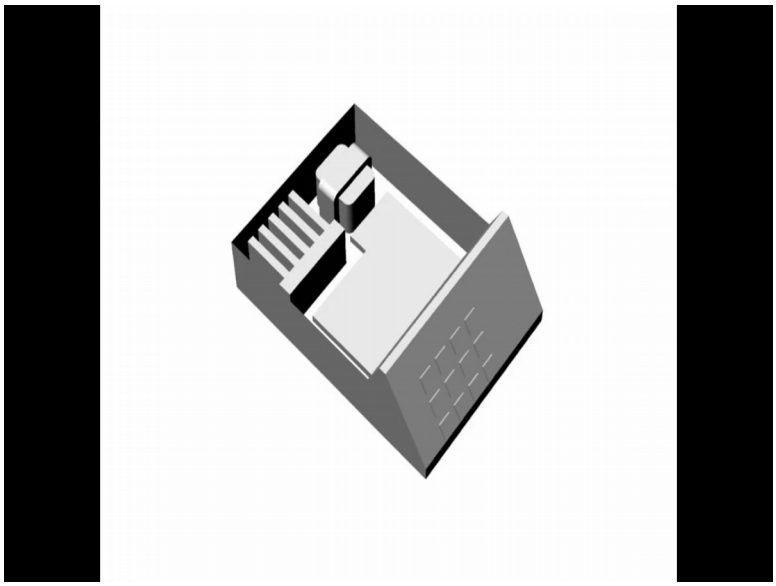

So, you can combine all these things together and then try to make see here I have combined the front panel with a little projection on the top.

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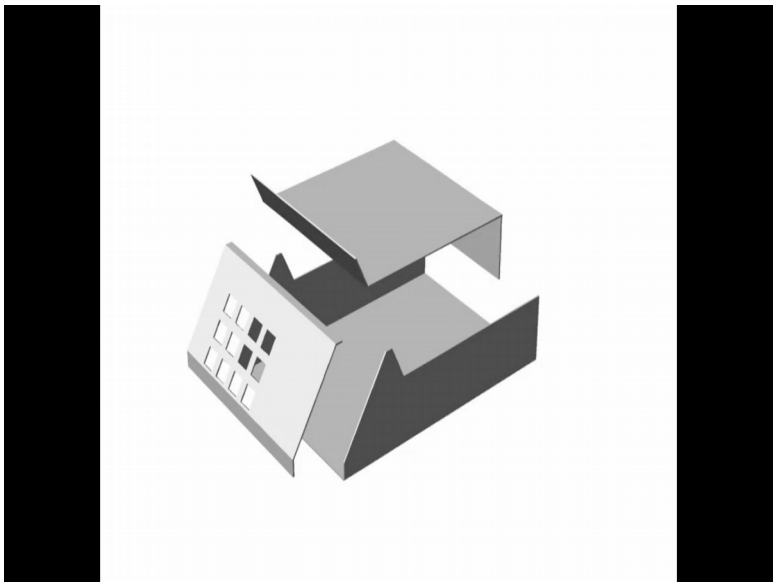

And the little projection at the bottom then that left and right sides have been combined with the bottom and then in the top I have a what you call top cover, and then I can do proper perforations and all that and make sure that all these things fit inside.

So, it is possible for me in one corner I can make perforations here and then I can do something with the front panel, and then in due course it is not impossible for me to achieve a product know which looks like this, but remember the starting point was I have a concept in the product saying first of all this is required. So, when we talk about marketability well engineering ensures that we can what you call optimize a design, as such there is no simple formula saying what sells not easy. I think first time when what you call a thing like a digitizer and this pen came people who are not very happy about it saying it is not easy we cannot make it, but in due course.

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Now, we accept things so, from a marketable product we come to something and then eventually you know we make a product like this as I said this is about 20 years old this one is a power meter.