Enclosure Design of Electronics Equipment
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Lecture - 15
Materials choice

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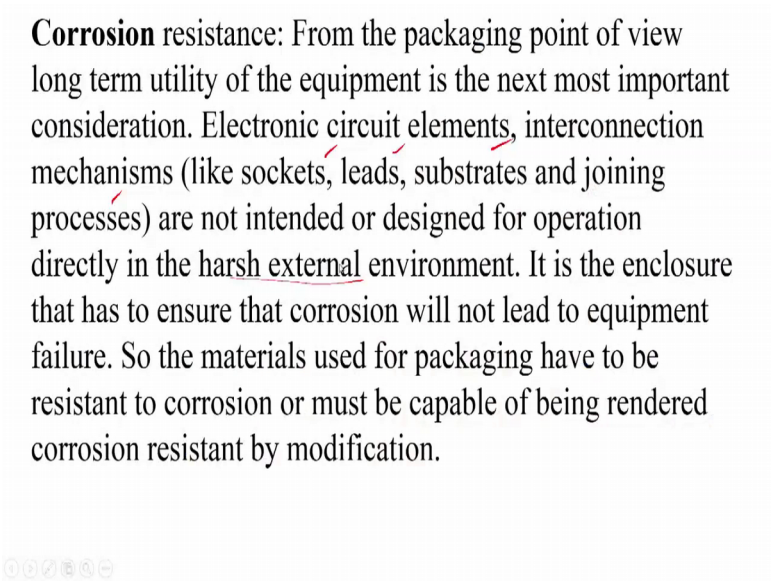

So, coming back here you will notice that it is enclosure that is ensure that corrosion will not, lead to equipment failure materials used for packaging have to be resistant themselves not to corrosion or must be capable of being rendered corrosion resistances by some surface modification.

So, this is where we have a little issue with common materials like mild steel, now trying to be replaced by lighter materials like a aluminum and magnesium silicon alloys, and then we have plastics mould it. Something has to be done such that no all these requirements have to be met. Have you still even today it is good has is no issue with you know still heavy and then corrosion, by itself you cannot do anything with raw steel.

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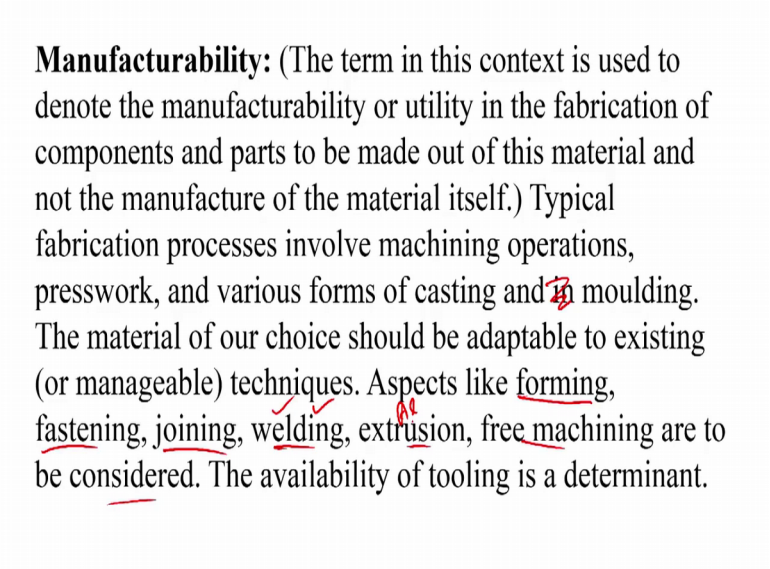

So, my subsequent slides I will show you about those things, you need to do some covering with it. Something we cannot we have to consider after all these things. So, manufacturability term in this context is used to denote the manufacturability or utility in the fabrication of components and parts made out of this material, and not the manufacture of the material itself.

So, if you want to stamp a few parts that is manufacturability; meaning you have process and then you keep all the process and you do something and you have all those beautiful parts. I am surely you had a chance to watch TV probably on a national geographic or BBC or any other special programs, or in your case if you are one of the curious people you can always go to you tube and look for how car parts and all are stamped that is something absolutely. Show is a monsters procession and you have a transfer line, one some heat comes and gets embossed and it trimmed and it moves on like that. So, that is something manufacturability of parts out of that material is very very critical. Something a little ahead of it is the how you make the sheet itself that will come in a subsequent lecture; it is not easy to make a thin sheet.

Now typical fabrication process involves machining is where you can put a lather milling machine or make wholes and all that presswork, presswork means using a power press various forms of casting and moulding. Material of choice should be adoptable to existing or manageable techniques; one of the reasons why plastics could not be you

know suddenly used for replacing everything is that if you have to take a car bumper and just try to make a copy of it, in plastic it will never work. It will never work because bumpers use to be big monsters thing known like this. And then there were all welded to the h frame, made since at once upon a time, but now right now if you see any car the bumper is a huge moulded thing if it is a small car it is about may be 400 mm, it is a big car it may be some 400 to 450 mm such a big thing the whole thing is moulded, and then it is assembled to the remaining part of it. In the chance of a crash this whole thing crumble and you are safe inside.

But it is not a one is to one replacement for an existing metal presswork line, you need to make new moulding and new techniques or how to even fastenate to the body.

And other fastening techniques as used by other plastic uses like simple snap you put something and extend it and all that, they are at the time when they leave the factory. But subsequently not subsequently there are problems and then you can even make a car, look at a car which has taken a couple of beatings. First thing that gives is all these non metallic parts lose their shape and then it does not go and hook itself properly.

Aspects like forming, fastening, joining, welding, extrusion free machining are to be considered mild steel can easily be welded resistance welding is possible, but you cannot extrude steel. In contrast aluminum can be easily excluded; hence I told you in the case of professional cracks and all that aluminum has practically replaced all these strong members, completely it is replaced and then we need to do various operations. So, some places like if you need to tap a particular in that is a form as crew thread; obviously, mild steel is still king. I showed you the power supply cover yesterday and I said something called a plangent tapistron imagine there is a flat sheet flat sheet.

So, they make a plunge like this and then they tap it all around like that (Refer Time: 06:03) make a plangent tap, what is initially a small thickness can be made in to three times that thickness up to three time the thickness. That whole plunge to one conical portion can be made, we can either tap it or even use it for sheet metal. I am sorry self tapping crews in the unlikely clayers that you cannot use this there is always a clip, they attach a clip and then that clip as formation of a single thread and it uses all the fastness.

So, availability of tooling for a given application also is very very critical, saying can we make it section thicknesses change all the time. So, you cannot just like that replace a

mild steel tool with the I am sorry the job with still is still, may not be able to punch same thing it is various materials. So, something called fine blanking and all has to be done. There is a tool clearances those things a determines specifically for one type of material in one heat treated conditions, the moment anything change there will be mild variations and long term.

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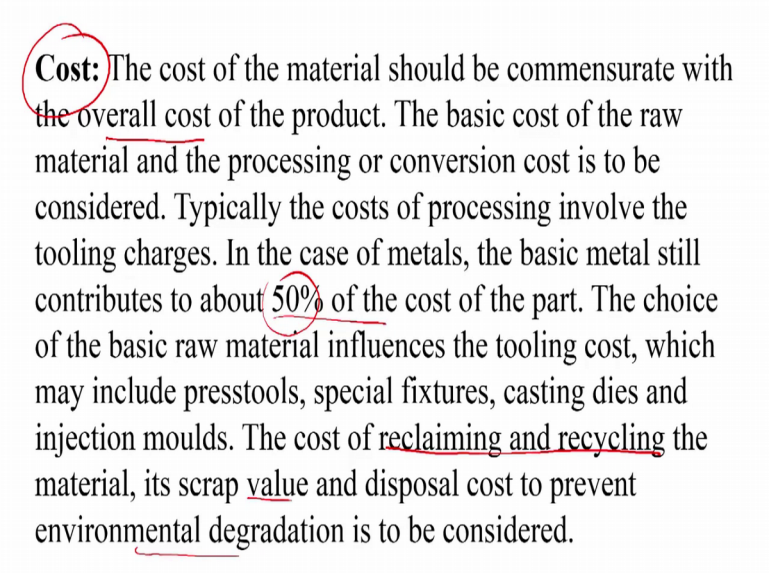

There will be a loss after having covered the basic strength and the manufacturability we come to the cost, Cost of the material it should be commensurate with the cost of the product.

So, it is a reality, will we have a psychological or something you are ready to pay for a given product, it is rear there is a target cost for every product. Now somebody has to you know apportion all the target cost and say I am ready to spend so much time in the electronics surrounding the inter thing and then the basic materials. So, it still a compromise; sometimes it works we are able to meet the targets cost, otherwise you add features and then try to observe the cost with the some of the other features.

So obviously, cost is the one of the very important thing first thing stated as the strength part of it. Second thing about the manufacturability; related to manufacturability and all that is the corrosion and things. Thirdly we have the cost which is really really critical, probably these three things determine or choice for the product and then we come to

what you call availability and then lots sizes and then how easy a test to procreant all that.

In the case of metals; so basic metals still contributes 50 percent of the cost of the product. Modification is a 50 percent the basic row material cost is there. Slowly things are trending towards even if they keep on reducing the cost of fabrication, the metal cost continues to increase unlike plastic. In plastic it looks like the value addition by way of design and all is costlier then the row material itself and now the correct thing is you and I know that you should use recyclable materials. Recycling is a expensive how do we get all the plastics how do we segregate it is not like segregating dry and wet waste.

.So, if you have to look at any plastic part the class of plastic also is mention in that your seen in that know ps, pps, pc and then there is a symbol and number 2 3 4 and all that. These all comes in to the cost well you can recycle the materials, right now you are able to get way with some matter of time before legislation or our own up liftment or enlightenment will make sure that the cost of recycling, the cost of what you call getting irreplaceable things from nature needs to be considered that time. Now we know probably slowly it has come now see the latest packing materials.

While expanded polyester in EPS form is still common, lot of them were being replaced by things we choose cardboard. You do not use just the EPS or expanded polyesterine form as much as frequently only, really high value things and where the cost. Is really seriously this thing they tried to packet with the thermocol box, otherwise slowly things are being replaced. So, we comeback coming back to the cost that element of reclaiming and recycling scrap value and disposal cost to prevent environmental degradation all these are to be considered. It is not a matter of just writing here it is at internaisa I am sure you are do it all the time.

If now somebody were to give you something in a you have a choice hot coffee. You can take it in a thermocol cup probably the worst or you can take it in a fully what you say thermo formed probably I do not know what the material is, could be some type of a what you call thin sheet and then you have a card board and then finally, carry around cup, I know what you will prepare. There no doubt about it I am sure all of you given a choice you would like to carry your own cup, next choice will be to have a card board cup, last choice will be to have a polystyrene cup. Polystyrene it hold things better

everything is there, but still non recyclable nothing you can do with the polyst that what you call a foam moulded any foam cannot be recycle, that there is no way of heating hit and all there because it all the condenses to fraction of original volume and it cannot be reformed, I do not know what happens to them that is why you push it in to the ground doubt.

So, we have this issue about looking it disposable cost to prevent environmental degradation, and then something the choice of the basic raw material influences the tooling cost, which may include press tools, fixtures, costing dies, injection moulds, not easy know casting dies and injection moulds. So, it is very easy to say oh use a plastic injection moulded part, no now we can three d print it not true. A few pieces three d printing is under some conditions it is and you want make a mass produce product you have no choice, but to go back for the old good old injection process.

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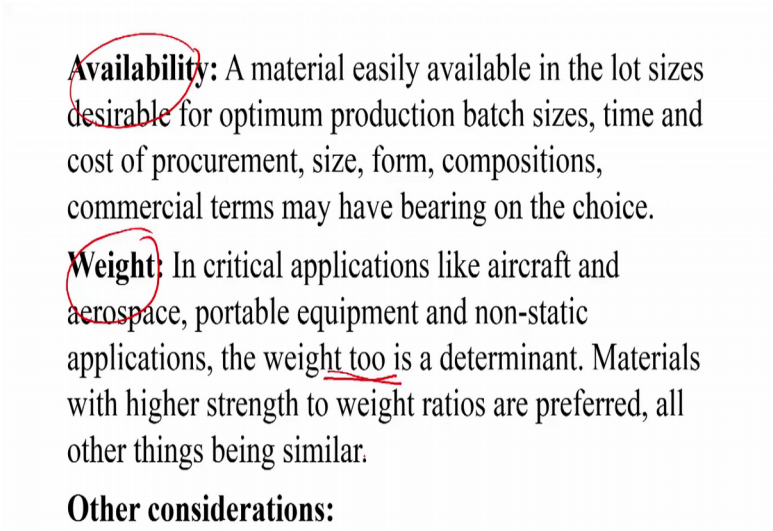

So, next 2 or 3 slides I will you know scroll 3 quickly, material should be available easily. A lot sizes desirable for optimum production batch size time and cost of procurement size form composition commercial terms, have bearing on the choice. I can make a beautiful aluminum exclusion, but here at list here know a minimum of 100 kilo kgs of where a dies available we are expected to order 100 kgs. It still a lot of kilo grams not easy, but then if it is a non what you call intellectual properties not part of it, I can even buy the exclusion and try to make things what I like.

So; obviously, the while so for what have talked about are look like very simple technical things and then it is possible for us to make an analysis, and how flat it is use the theory of plates, use the theory of shells, and come to I am optimum thickness, you cannot make it where we have started not easy to make things which cannot be made in small contest.

So, coming back to the next reasonable thing is the weight; in critical applications aircraft and aerospace portable equipment and non static applications, weight too is a determined determinant yes heavy. Sometime somethings are heavy, somethings are not heavy materials with higher strength weight ratios are preferred all other things being similar. That is the reason why various alloys of aluminum all the way up to I think some of you may be heard about this 6000 series 60 70 and then you must have heard of this 7000 series, and if you are biking enthusiast there is in fact, big discussion saying or the merchants taking you for a ride or you can have a safe ride on a cycle, which is uses know a 6000 series aluminum with a 7000 serial aluminum.

In reality if you actually look it strength mild steel is probably still looking. So, you cannot really automatically replaced a good old what you call thin tube chassi, and then expect the whole cycle to weigh anything lower. A light weight cycle probably is a little lighter weight then the other one, but then there some advantages to it use it. So, we come back to a few of the other considerations appearance.

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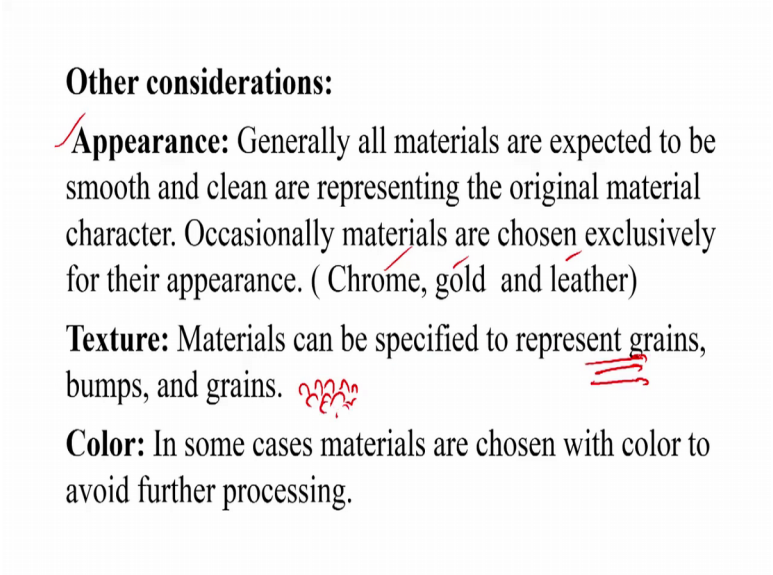

All materials are expected to smooth and clean are representing the original material character occasionally, materials are chosen exclusively for their appearance, chrome, gold, leather.

Texture: materials can be specified to represent grains bumps oh I thing it is a repetitions. One of them represents the linear grain how it is other represents the surface granularity these are. So, you would have seen often that talked about talk about brushed chrome finish. So, chrome and as if know somebody is taken a steel brush and try to make the scratches on it has it own use full appearance, I think the more you actually work with it you enjoy it more than some of the other things have smooth variations granularity about. It is important granularity is really really you know some of them make a very good texture.

So, people go all the way about making something which looks leathery, good point is pvc and all can be done, back point is growing crocodiles for making a bag that is bad. So, I suggest you know I mean this is not about a other things.

So, if you want to make crocodile leather I think artificial crocodile is better, instead of growing crocodiles and then trying to make thing out of it.

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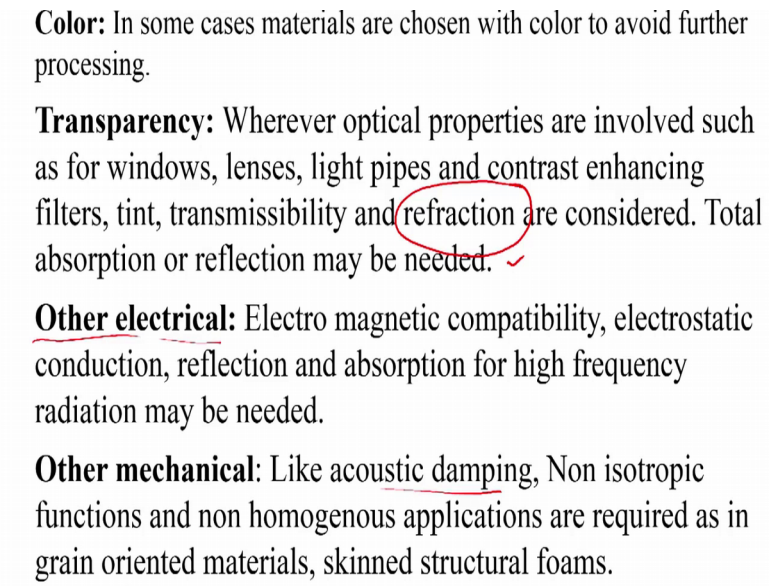

Something other then the surface texture and the grain layerity color in some cases materials are chosen with color to avoid further processing. Transparency wherever

optical properties are color optical properties are involved such as for windows, lenses, light, pipes and contrast enhancing filters tint transmissibility and refraction are considered. Total absorption or reflection may be needed. So, typically you remember these old thing know refract index of material. So, if you have a display which is deep deep set, for various consideration you have a Basel and so on displays deep side, if you just try to tilt to one side you cannot see it properly because it is a narrow angle like that

So, in the front they put an optical what you call I will call should call it a filter, made of high reflective index glass. So, it can be very thick to the extent of may be 20 mm; 20 mm I think it is 3 quarter inch for you movement you have a thick high optical index thing even if you tilted, it looks as a if the back surfaces is coming out. It looks like a little like in your school probably in your fifth or sixth standard; you talked about how a pool will look shallow if you look at it from a shallow angle. It look shallow it looks as if the bottom is higher only if you look straight up at one particular thing only they particular angle of incidence it true depth will be perceived by your eyes.

So, that material which has that property of higher reflective index, it chosen in some application typical in filters, another application I am showed all of you know about is the good old read led filter. All red led is they light which is given is an particular spectrum. So, if you have a filter which allows light only to pass in that spectrum, the remaining things can be hidden. So, you do not need a special mask only you know showing the led frame outside, just put this led filter and the everything becomes dark and you can see the glow automatically outside.

Well known obvious application; other electric then something related to this is absorption or reflection may be needed your have seen this you know glass coating and all other electrical, electromagnetic compatibility electrostatic conduction reflection and absorption for high frequency radiation may be needed. This is a special subject unlike all the other what you call design elements which I have shown, this still continues to be over the wall. So, unless you make a prototype and you test and then you take a input for all your persons who do it, only after the equipment is fairly in a very last stage of integration, they put it over the wall check it for the other electro static and electromagnetic compatibility issues, and then try to incorporate it. Conductive is still electronic, radiative is still mechanical. Anything involve radiation and picking up and all that you know it still considered a issue with the enclosure design.

What comes through all the contactors and others things know it is considered as a electrical issue. Then we have other mechanical like acoustic damping oh technical word; I saw something homogeneous something, isotropic refers to the physical properties in all directions. Best non isotropic is probably a bamboo and replacements are carbon fiber something something. So, if you have a badminton racket carbon fiber, fishing reel carbon fiber, everything even thing about in your glass frames because there we are interested in one direction how well it does and then we have full control about the flexibility.

So, but should I sheet be having that issue yes and you make a transformer it is a expected that the grains in silicon steel are all oriented in one direction, the direction which the electromagnetic flex passes. So, there what is called grain oriented steel is used while it make sense in the case of a transformer, in the case of electrical rotating machinery, it is counter what you call functional if you have it oriented; there we must have a non oriented non grain oriented material. We need silicon steel to have a higher goose, but non grain oriented. So, you have a non NGO non grain oriented and you know grain oriented steels for it.

So what looks relatively easy about this grain orientation and then isotropic is critical suddenly very very critical and such things. And then we have this nice beautiful thing new thing coming skinned structural foams; we have structural foams called assumes compound sheet metal sheet molded compound, where one side of the thickness you can have it soft, if you see the our wheel I mean our chairs used for our hand rest, it is actually a foam inside, but outside you have a beautiful cover which it is made to look the little bit of embossing and all that made look originally it was made to look like leather, right now it has it so on various functions and now one of my colleague has worked on what you call how to get energy out of this things.

So, they have embedded these materials with something which can generate energy harvested. So, in this new materials like we must able to incorporate one inside the other; can you have a heat sink, can something be wearable, can then something you know when you sit or when you press can something happen when you tilt can you generator electricity, or in case of our lectures know they should give us enough electricity to put as in the lime light enough par it suppose to be joke. Probably I will take a small break

here I will continue with this from the next lecture, and then at this point allow me to show you a few of the things which has started last time.

So, it is it possible for you to connect this. You remember this old hard disk all eventually replaced with this new pocket hard disk. It looks a little similar is it not (Refer Time: 25:50) look carefully by the mould itself that right to created a texture in it.

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So, very peculiar texture, it looks random, I do not know and then to me it looks a little like that metrics screen saver views to have in that know some following all the numbers and all. But it the back that is not there something else is here, you seen that know small rubber things are there and then this is where I wanted to tell you we have visual queues to make things looks smaller and they are actually it quit a thick fat thing, but the way they mad small cantor here and the way they made a small cantor here. The whole thing the edge what you see is only about may be about 80 percent of the total. So, it look thin though in reality is really thick it looks thin it is possible because of now using molding techniques and all that we can make this things.

Elements of this are very similar even with your cell phone, who would ever thought we all knew that you know is cell phone has a screen and all that, know would a thought the body should be made out of glass. So, this fell and it got shafted (Refer Time: 27:14) nobody got injured, but I continue to use it as this thing know saying a fantastic arrangement by with this glasses used.

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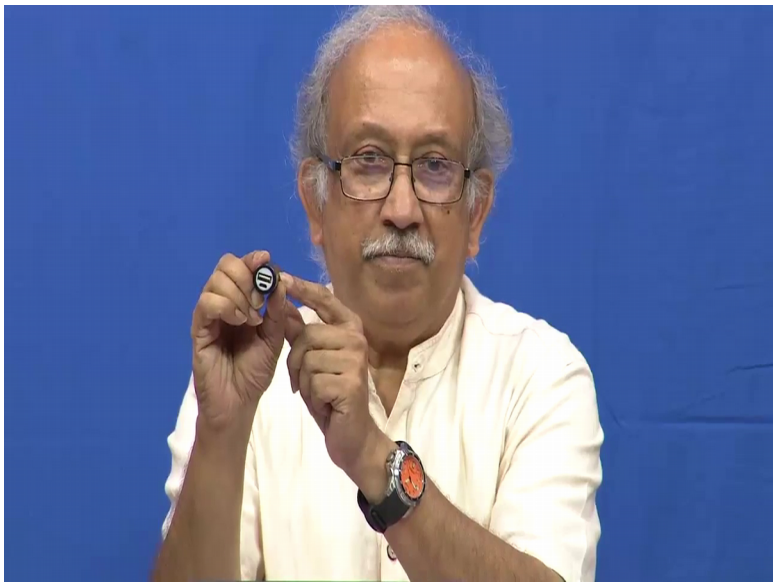

Now, we will come back to a my favorite I thing all of you know what it is know, it not just a torch it is a battery backup. So, thing is it uses the 1 6 I am sorry 1 8 6 5 0 cell in side and this is small what you call booster of this basic cell is scabal of holding 30.7 volts and it needs a charging current of 4.2. So, charging is relatively easy you feed in 5 volts, a little bit of the thing you charge the phone charging is easy and then during giving out there is a small circuit here we just gives us the necessary 5 volt and then regulate it. The thing is this covered can be made with anything including metal it will be strong, it would not break and just need to put 2 caps. So, this can be easily may wind metal. So, even if it drops nothing will happen.

Now, what if I want to change the foam factor, same this also has about the same what you call functionality, while the put a small switch here to make it .

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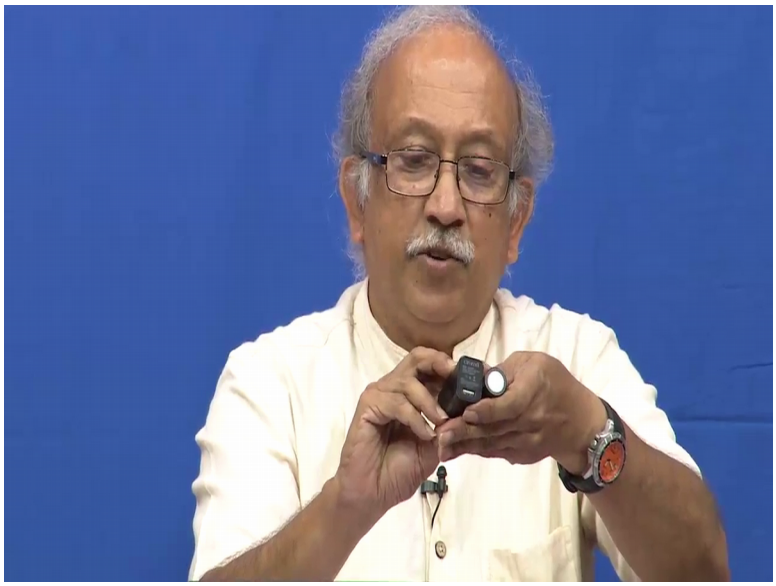

These they have played with their 3 leds which shows status of the charge and so on. same thing inside it is about the same, but by playing around with all the volumes and all that you see one of the dimensions has to be brought down nearly 20 percent it is less. Not much of compromise here; however, not much of compromise, but then the height has been compromised a little it looks like when they have run the tests with a focus group probably that have found out that this will cell as well as this that looks likely too simplistic not design.

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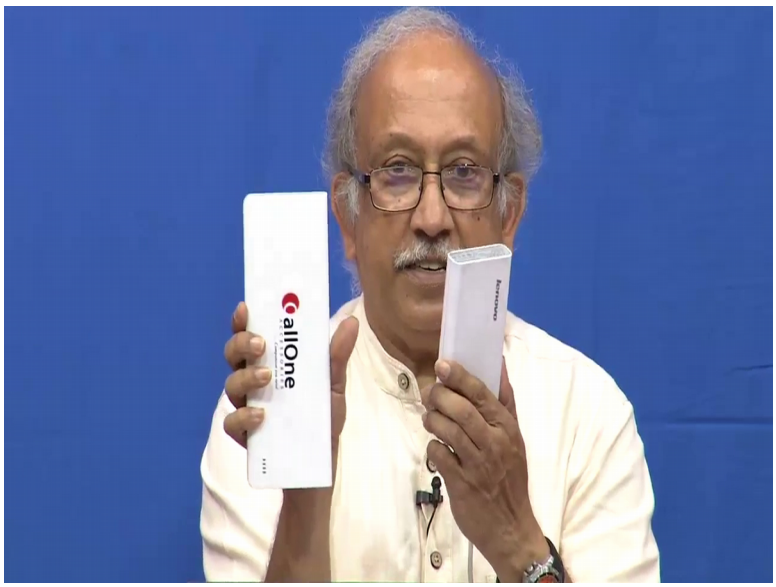

And this has some element of I will call it desirability by design. This I think I have shown you all along this has a same to cells now slowly we are coming to oh there is a beautiful thing printed 1 3 0 0 0 13000 milli ampere works.

So, it has probably thirteen divided by 2.5 and all that know so many of those cells inside. So, we have 3 plus probably 2 (Refer Time: 29:58) each is 2 5, I do not know it makes 5 cells or 6 cells.

Now, we comes to are pet monster oh this is really really monsters, and they have a happily printed a number like huge number 30 ampere hours that is a lot of ampere hours.

Now, when you look it an objective like this it is heavy. So, the design of this know already there is a jump and strength requirement from this to this. Extra extra it is heavy and this is light. So, someone has to work carefully even on the plastic what we have here it have to work carefully about it. And related little to this is you already have three output are each of the makeable of giving I think each of one amp one of the may be little more to amps like that which this has only two of them and then related to this is also have this charging device, on then we have a switch here, and movement you have anything here know; obviously, you require something which indicate is state of charge you seen that, you have some yellow colored lights here you have three leds it shows.

So, a an enclosure for this has to have slightly different thing, and then if you look at the shape have we seen this is flat there given a curve only this side. This is the formed detailing not necessary manufacturing, but it helps. So, here the objects inside know can be fully packed or populated and small thing has been done here, wherever the code they have done this small thing with immediately adds a small element of novelty and probably differentiation from an existing thing this looks boxy, this looks I can ordinary box as if somebody has taken a lot of cells and then put a tape all around it duck tap, and this looks a little bit design. Both use materials which are you know partly metal, partly plastic and then have electrical requirements in this case it should be fully isolated whatever happens nothing and then one very unwanted or you know undesirable thing is, it should not thermally insulate the what you call box the inside and outside should not be thermally insulated.

So, if you what look at your laptop charger and then if you are the good or bad luck of losing one of them next time when you open it and see the top half of top cover of it know is probably fully is an aluminum sheet, and then it is closely it almost touches the cover and across that small thickness of the plastic the conductivity is not bad. So, if you take a 100 va charger, which most charger are about you know between 16 and 18 votes I will just take it as the 20 volts, 5 to 10 amps there cable of giving, and then even if you take 10 or 15 percent loose that cell a lot of volts which is converted into heat which needs to be transferred across the wall. So, plastic what was originally very simple electrical insulator suddenly have to have a function of thermal conductors. So, people play around with a few of the properties. So, I am not know, I am not a polymer engineer, but there are materials if you consult with them you will be able to make things at all.

So, I will take leave of you here, so thank you, when I get back I will see whether I can come out with a few more samples the only exercise what you need to do is go around and say what materials you can identify in your lab, are in case your hobbies, all around the house most likely you will find more interesting materials and in your house then you would find in lab or on yourself ok.

So, we where have objects then if you are one of the persons who uses the phone, and then you can probably go to various website, which will show what is inside a desirable phone. There people whose spend you know over night and in a line to buy a I do not know you phone instead of using the other word know the buy this you phone or he phone or she phone, bring it home attempt a jail brake fast second break it open and then put it on the net it is faster than food pone faster than you know your kitchen food thing robot as fast they open everything and put it on the net. So, people like me I am I would not consider myself no see no see person, but I still I will be curious to see how the packaged all those things together, how thin they are and then which part of the inter connection has been taken, where how they have taken.

So, have a look it all the preferably expensive devices either you call it I know whether watch or a call a cell phone or you call a battery this thing what you call this power bank, you will find very very interesting and away to bit around the existing problem and then make sure. In stand know I was talking about you should have a seal so that external layer would not come in side, but how do you cool the equipment not easy know. So, all

it needs is probably on one of the wall you put a heat sink which has fins on one side and other side we have some more fins; to fin it can be conduction. So, you have internal circulation on one side, secondary air on the other side and that itself is sufficient for us to cool that is have in fact, is how all the larger action all are cooled.

On the panel at the back of the panel we have a refrigerator; that refrigerator is very similar to yours split ac. So, you have an evaporator inside which will do all the cooling probably somewhere at the bottom, and then you have a box like thing sticking out on the back of the panel that is where you have the condenser. But inside and outside are isolated only need a small opening for the working flow it to go through. So, air conditioned equipment and probably in your case know you may even rig it up.

So, very small commercial lays is available which are called you know 0.75 ton or 0.5 act on rated a refrigerators. So, if you have to make a rack, you need not know worried too much about it know try to make thing as good as this seal the whole thing, replace the back panel with a cooling panel then you are in business.

Thank you.