Physical Modelling for Electronics Enclosure Using Rapid Prototyping
Prof. N.V. Chalapathi Rao
Department of Electronics Systems Engineering
Indian Institute of Science – Bangalore

Lecture - 23
Building a Model 1

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Hello. Please look at this monitor and I thought I will explain to you a little more about how this product has come about. So if you look at the few samples that I have brought here.

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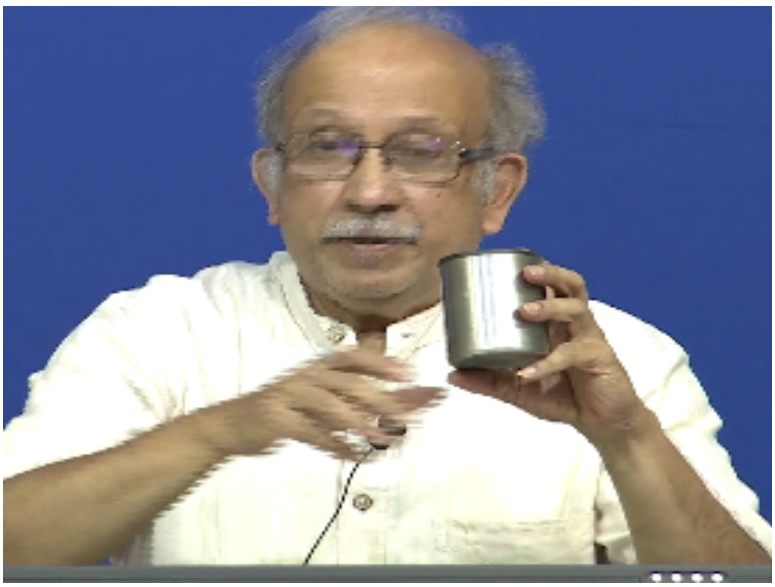

As I explained to you this one is a cup so that I can have tea as and when I want. Now this is typically one of our nice what you call (()) (00:46) projects which we can attempt. It is a little technical and a little personal and you can configure as you like.

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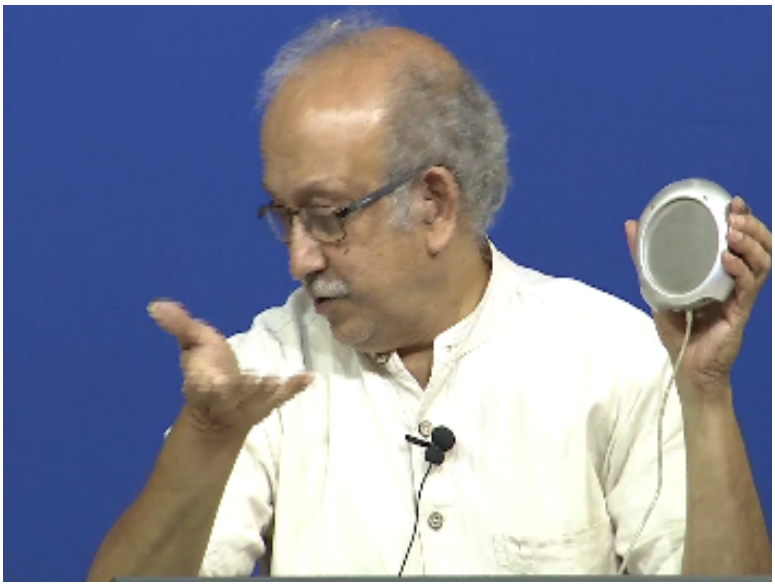

So traditionally if you want to heat tea. You had to buy one of these so called USB heater. So we have a small issue with it. I do not know whether I should call it an issue or a technicality which you need to work around and so on. One of them is typically any one of these devices can give you 500 milliamp set 5 volts. So if you take 500 milliamp set 5 volts it will give you only 2.5 watts.

So if you have an already made what you called tea you can keep it on top of it and keep it warm a little longer than this thing. Now if you see here what we have inside this is some device which has I do not know what you can call it a heater inside and it makes things easy.

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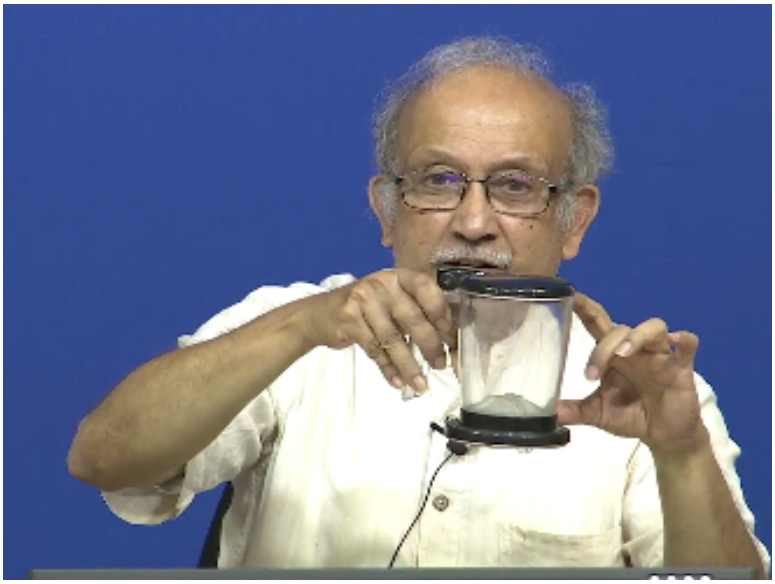

Now the challenge which one of my students took is sir I want to make tea. I do not want to

keep warm tea meaning he has a typical what you call coffee or tea brewing cup here and then he wanted to put hot water in it. One way of doing it is having a kettle outside and then put it inside. Alternatively, instead of carrying all this is there a way I can make tea directly and now we come to the important point.

If the ambient typically for us luckily the ambient is around 30 degrees for you to make any useful tea you need to step it up by 60 degrees at least to make it up to 90 degrees. And if you can steep the tea at 90 degrees for the duration you want you get very nice good tea.

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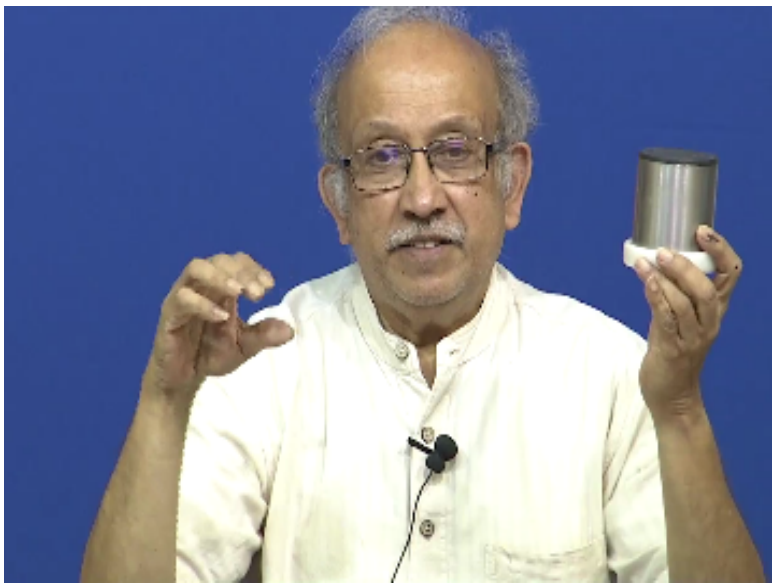

Now comes a question saying we have to do some heat load calculations saying how much of voltage do you require here to warm this cup. So these things as I told you typically this takes only 500 milliampere and 5 volts it will come to 2.5 watts. There are not enough of current for us to heat water to make tea. So the challenge was how to have a heater which can take more current.

If you go to the internet and check, there is something called the water heater calculations. So typically it says find out the amount of liters of water you want to do into the temperature rise you want * 4/3142 that is a standard formula that directly gives you the heater in kilowatts. So if you play around and typically at a time see if you need to fill this you need to make 250 or 300 ml, but if I just need to have tea whenever I want I can probably manage.

This is a 150 ml cup maybe I can even manage with a 100 ml cup. So typically we want to heat 100 ml around 40 degree or 50 degree centigrade. It requires at least a heater which is 10

to 15 watts. So I need 2 amps and it is not correct to say I will take a parallel USB thing and now all that is fine if you have a huge what you call power supply. If you are running a small laptop like mine, you cannot afford to discharge the main battery.

So (()) (04:50) saying what do we do now. I need to heat the water quickly, but to use only one what you call USB port. So if you can kindly look at this monitor. So one of the students came out with this thing saying sir it is obvious whenever you are talking about any what you call battery or anything you are talking about.

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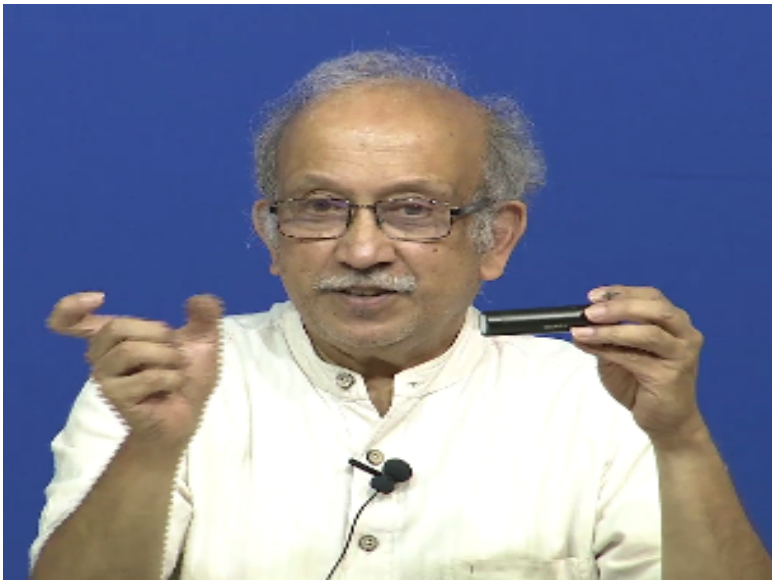

You see here I have one of the smallest, cutest what do you call USB stick other than lighting itself I do not see giving too much of.; see it has a green light and a red light other than that oh it has blue light and red light other than that it does not seem to do any good. Thing is inside have a battery which is typically 250 (()) (05:46) 2.5 ampere hour. So there is an hour feature also.

So I have 5 volts actually in this case it is 3.7 so if I take 5 volts it will come to 5* typically 1.5 ampere hours also. So 5* 1.5 or if I take 5*2 I have 10-watt hour of this. So one hour it can give me 10 watts. So how do I play around with this hour thing. So what was decided is nothing prevents us from charging a device continuously like this. I have this beautiful device why do not you packet with batteries and I connect it to my usual USB output and then continuously it keeps charging.

And once the battery is charged I can go around playing with it. So 2, 3 different strategies

have been made. One of that is take all the energy and store it in a battery. Secondly make sure that no heat is lost you insulate it and thirdly you need to do some temperature control.

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Some of you would have seen these devices which we use all over the place especially in wherever we have mosquito we need this mosquito mat thing. This one gives a bottle and then there is a ring heater all around and then I can go around trying to kind of use that (()) (07:21) switches inside.

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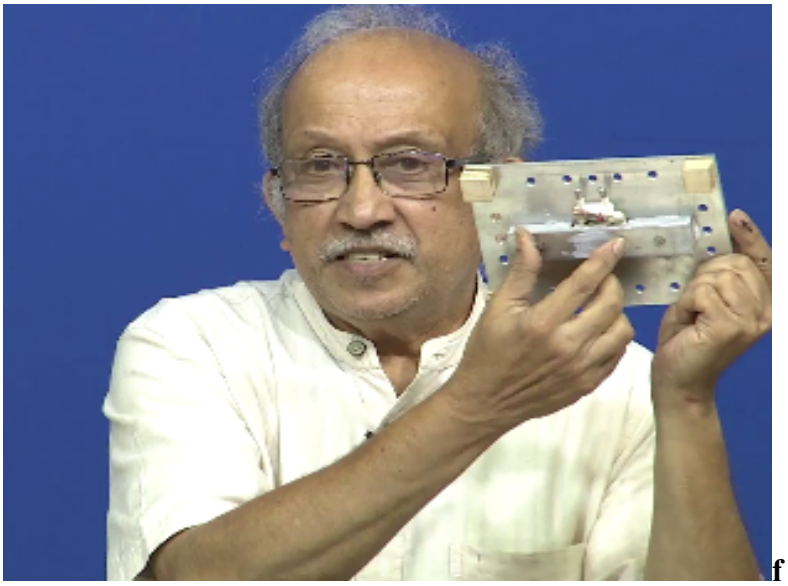

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So after having searched everywhere we got this thing. This one is a heater which is built into flat mosquito pads. So at the bottom we have a heater and the whole thing has been what you call put together typically the rating of this is about 5 watts to 7 watts. So we did an experiment on this saying it is 5 to 7 watts is it okay. And then this one is taken from a insulin

yeah.

It is a human (()) (08:03) so it is a human insulin thing which comes and we made a heat sink made it here and then afterward.

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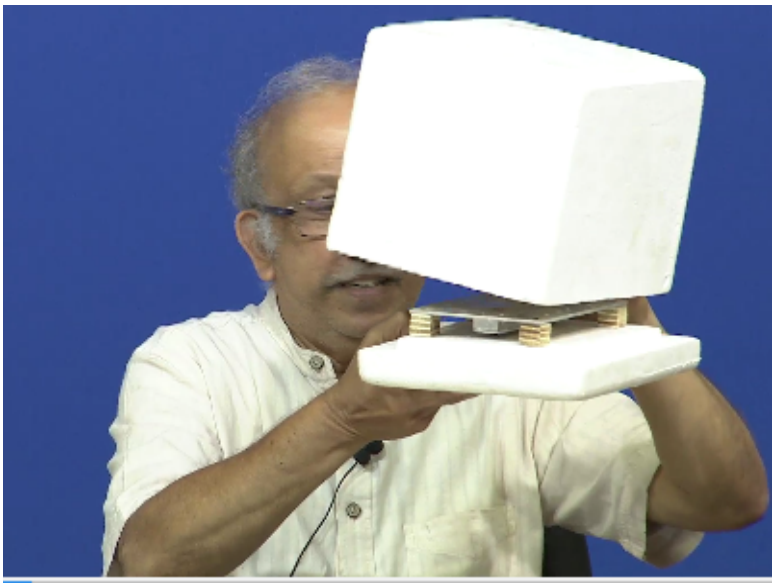

It is actually in reverse it has a cover this whole thing is placed on the cover like this and I have a AC inlet here I give a AC inlet and I keep it covered and measure the temperature. Then to our surprise we found the 7 watts if we leave it for around 2 or 3 hours and insulate it fully does reach a temperature what we want, you understand now. It looks a little too empirical and trial and error.

Reality is you can also calculate these things. So that was the starting point for this thing. Now coming back to my product there if you have to look at my product it has several interesting things. One of them is there is an insulation all around.

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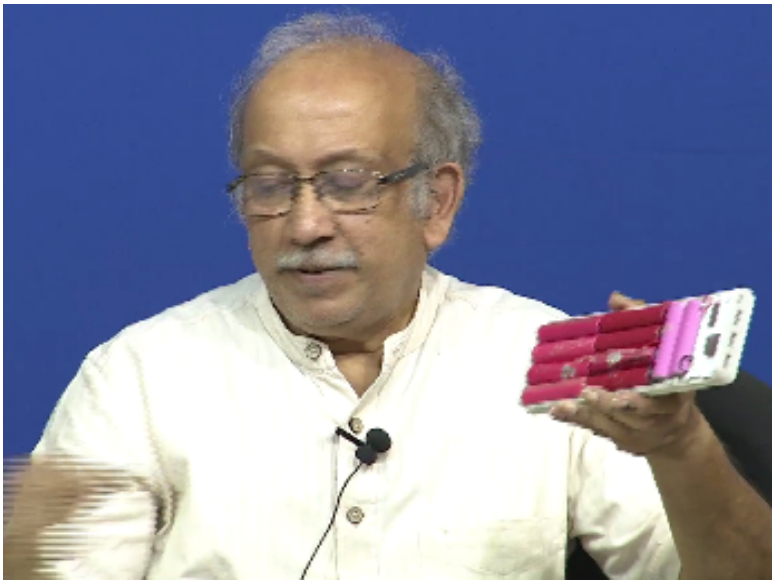

And second thing is again I was talking to you about. I will show this what you call thing here. This is a beautiful battery bank and then I have all these cells here. All these cells are 3.7 volts nominally if you give 4 volts also it starts charging. So all this have been packed into a box here. So I have 10 of these cells nicely packed into a box and even if I give 5 volts it does not matter I have a charger here. This one is a 5 volt, 2.5 amps charger.

So I charge the battery as I want or I can even use the laptop power supply. If the laptop is being charged on one side continuously it can charge my battery. So energy storage has been achieved by using external cells. This external cells depending on your size and all that can come. I do not have what you call sadly connection to the internet has been lost I thought it will be there now. If you go to the several sides we have positive temperature coefficient thermistor on cells.

And the advantage of the thermistor being if you have on the x axis what you call I forgotten what it is on vertical you have a temperature on this case some other thing. I am not able to recollect it. The advantage is irrespective of the time and current (()) (10:54) until the temperature reaches that said point is usually 70 degree centigrade that has a one slope and the moment the surface temperature reaches that said temperature they are usually made for 120 degree centigrade for some reason we need that.

Suddenly that slope goes up at all. This dual slope is the positive temperature coefficient. So it is almost self regulating. So the current in the initial stage what takes around maybe 2 or 3 amps will finally come down to less than that rated 300 or 250 milliamps.

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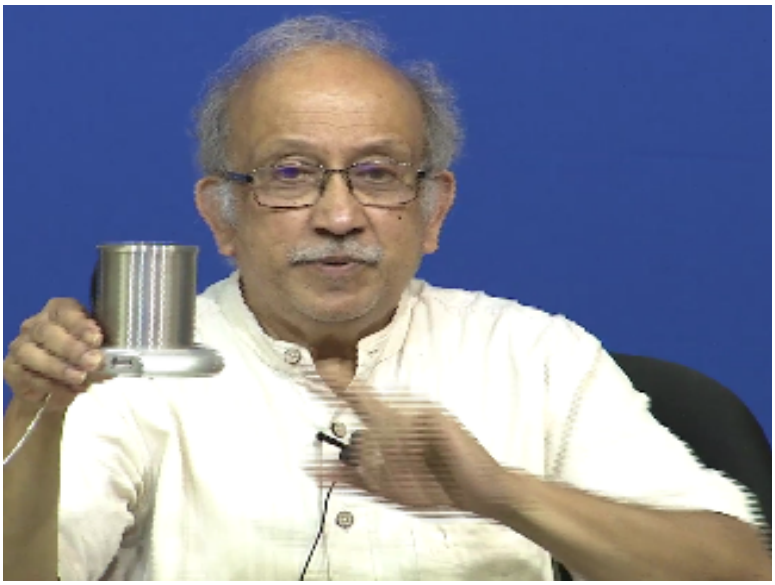

So if you can get a PTC thermistor and mount it on one of these things we can happily have a water heater which can heat temperature from the bottom. Now the second point is this is traditionally a cup except that this is insulated by a double wall cup. It is possible for us to do something. One of the easiest things is to probably drill a hole and fill it up with more water meaning I fill a hole here fill it up with more water.

Then it is up to 100 degree it can easily do and then if I have a way of probably ceiling the hole it will be a little like my pressure cooker which temperature can rise above that and then inside it heat this, but a little risky business. Other option is go and look for a simple stainless steel cup which is not insulated and place it on that. Now heating this has been solved to one problem. I have a temperature controlled, PTC thermistor plate which can be heated up.

In this case only for a simple demonstration I am showing you this what is built into this thing. These are all made for 350 milliamps and 5 volts which will come about 1.5 watts just enough to keep things warm and then I now replace it with something which is a 10-watt thing saying it takes to 2 to 3 amps at the bottom but PTC thermistors. Further, I can have in fact a control by which you can even increase it to maybe depending on the storage capacity available.

Maybe I can increase it to even 5 watts. If I have, I mean 5 amps*10 it will come to 50 watts. So I can heat it nicely. This is where the next generation thing has been taken I am saying I have got the heating problem solved, heating problem is solved well. Next I have got the

energy storage problem solved. Next thing is saying I need to insulate it. So if you kindly look at my what you call the demonstration you see here what this people have done is they have insulated this whole thing all around.

And even if you see what you call the taper that is there. So probably I need to get some cup which is tapered so that it makes even firm contact everywhere here. So I have something in the base and all around also it is heated to prevent from various what you call thermals and all that a little bit of (()) (14:15) used here saying that heater is spread all around like this. So naturally it has a tendency to make the top layer little warm.

So you can always drink keep it back there. When you keep it back there it keeps increasing in its top layer continuous to get hot. So it does not matter what is the input you give. Input could be stored all over the thing and then you keep your cup and probably close it keep it covered. You have another insulated cup and the volume inside the cup gets hot. So if you have water.

Water does not evaporate very well when it is around 60 degree centigrade or so only if it reaches 90, 95 operation starts. So keep it normally constantly keep it at 50 or 60 degree centigrade. Whenever you want to make tea flip a switch let it come up to the maximum typically at 90 degrees and the moment you have 90 degrees and there are 2 switches something which indicates a temperature put either tea leaves or put a tea bag and then steep for whatever time you want and then take it off.

Now we have a beautiful what you call arrangement by which I have a tea warmer is also tea maker and you see life is very, very easy and convenient for me and the same water if I can take it in a water and they do something.

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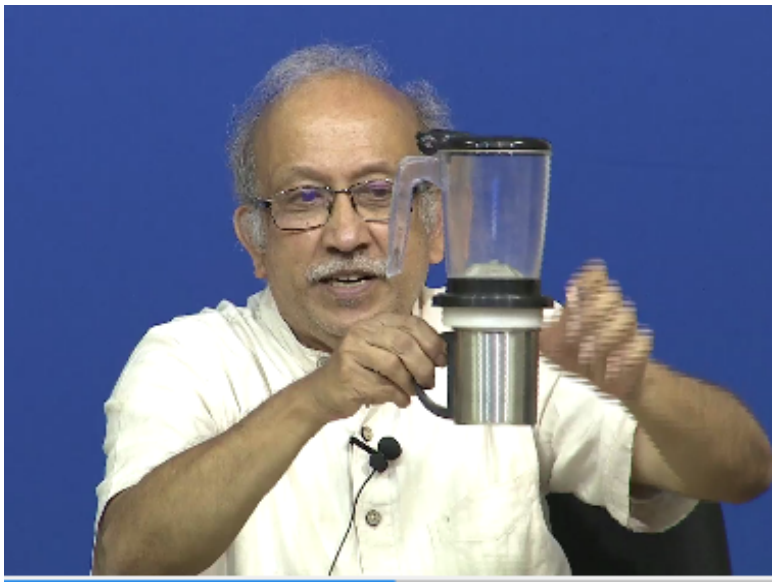

I can even put it in this tea cup device which I have here. So when we went and got this is not sitting comfortably on this. You see here what you call standardization we need to offset a little. So my students have been good enough to make an adaptor for me. So this adaptor sits on this now I keep it here. So probably I will heat water or if the water is heated I put it inside it comes and I have a nice beautiful valve here and I use it like this and this people have given me a very convenient what you call coaster also.

So I have a beautiful thing here you see here. It is conveniently here and maybe I can even keep it here and do whatever I want with it you see here. So I have a beautiful tea cup warmer, tea maker, coffee maker maybe this is where let me be little careful. If I can replace that base with a thermoelectric plate maybe, I can have a chiller also. So some people prefer having water at room temperature and what you call most fruit drinks are probably taken at room temperature.

However, if you are one of those person you would like to take them a little cooler maybe take it around 20 degree centigrade because it does feel little more refreshing in it and I should not mention things like wine and all that. So those things if you want to chill them by converting the bottom PTC thermistors and removing it and replacing by a Peltier element it is possible for us to make it into a cooler device also.

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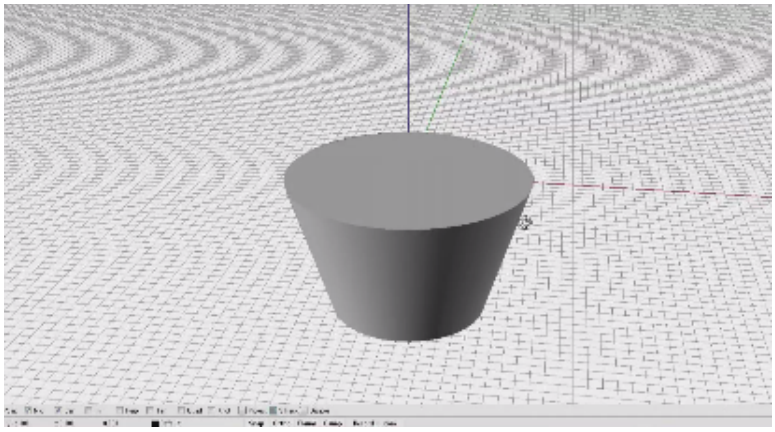

Now if you come back to my computer it is just what you call it is nothing kindly in just you know nothing it is not a big deal as I say it is not a rocket science. So one of the easiest way is already in most of the geometry primitives we have things like these cones, pyramid all these things are already build inside. So center of base of the pyramid cone. Actually there are better ways of building see here I have a cone already in this.

How about the angle? and all that we just need to go to the shop and find out which one of these things has better thing for you. Now I see what best I can do is there a way of making into that product which I have shown you. The easiest is obviously to cut this so I have here a surface which is a cutting plane. I take this object and I try to trim it off. See I have got something here which is I think if you remember in one of those pictures.

We have shown you be careful about the thing. This is the shortcoming of this particular program. This is not a universal thing in this case. In this case, you know, this being actually a surface modeler it does not do if you do trimming it will end up with this logically I should have done a normal regular Boolean operation. So I will go back and do a Boolean operation and show you how stuff is easier to do with that.

See here I have this. Now I take a solid and cut off the material at the bottom. Oh what happened oh very, very good. It was not sitting here properly see here it was only sitting in a half way serves me right. Now I see I will try to oh it is not done properly sorry it is a bump. I make a proper solid take it down, now do a Boolean. See here I have a reasonably well done cup and it is closed on both the things top and bottom sides both of them are closed.

Nothing I am just trying to create a hollow cup.

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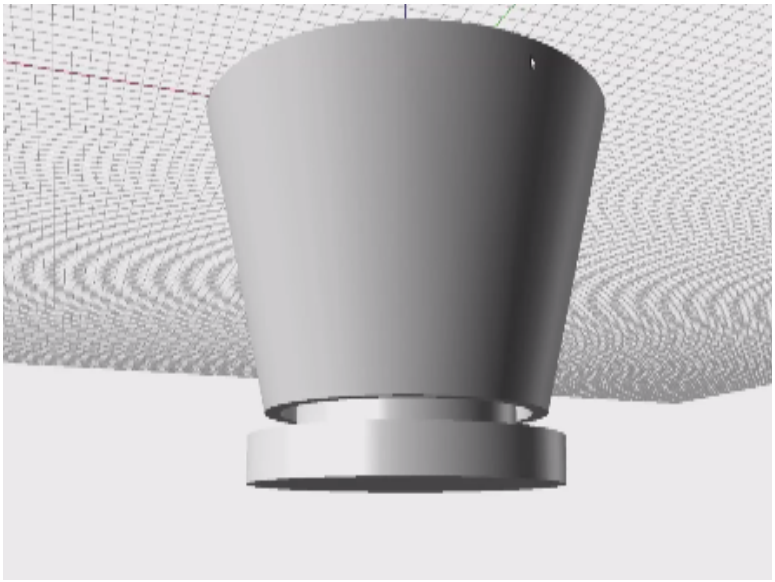

So what I do is now make it what you call hollow cup by probably copying on itself again and see got it. I have a nice hollow surface here. Now this exactly is not exactly the cup which I am looking for. However, this is the item which now inside this I need to make sure that I put groves so that a heat or wire also can be put. This heat or wire need not be of the PTC type which I was talking to you about.

The PTC what you call the thing can sit inside this bottom and I am happy that you have thought about it what about conduction. Yes, we need to have conduction. So it is likely that the PTC thermistor what we have now will actually heat up a plate at the bottom. So what I will do is I will remove this bottom and try to make a small cylindrical plate here. I make a cylinder here.

See I have a cup which has an opening inside which is quite a lot like this small thing which I have shown you here you have seen this. Now this base portion I have to make some arrangement by which conductive what you call aluminum plate or something else which sits a lot like this.

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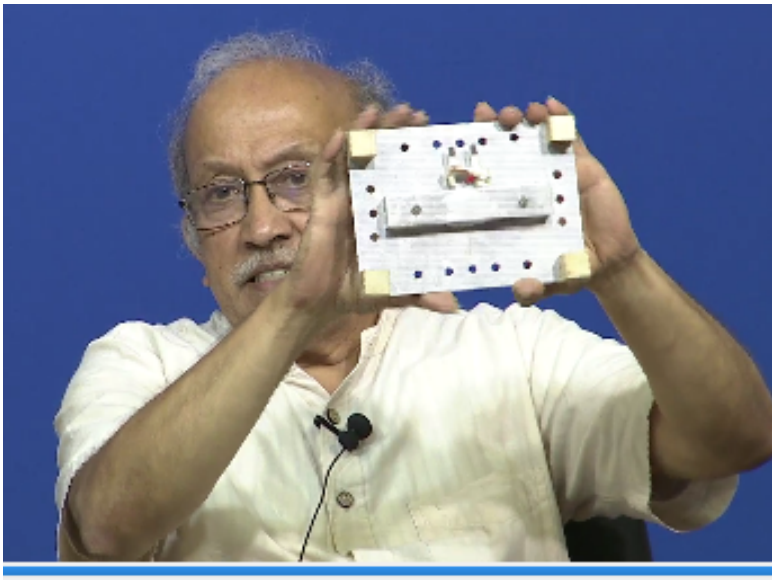

You have seen this here. Two things here, one is I need to make it circular. I need to make some arrangements by which I clamp this thermistor on to it. So since these exercises is a little more to do with rapid prototyping and not so much to do with the other details. I will gloss over the details and I will just assume we have a nice circular plate for see I have a plate there which for the present I will assume that it is a what you call nice thing which does all the heating.

And all that and it is possible for me by various operations to maybe even make a step. I can make this step by adding another cylinder on top of it and which sits neatly at the bottom.

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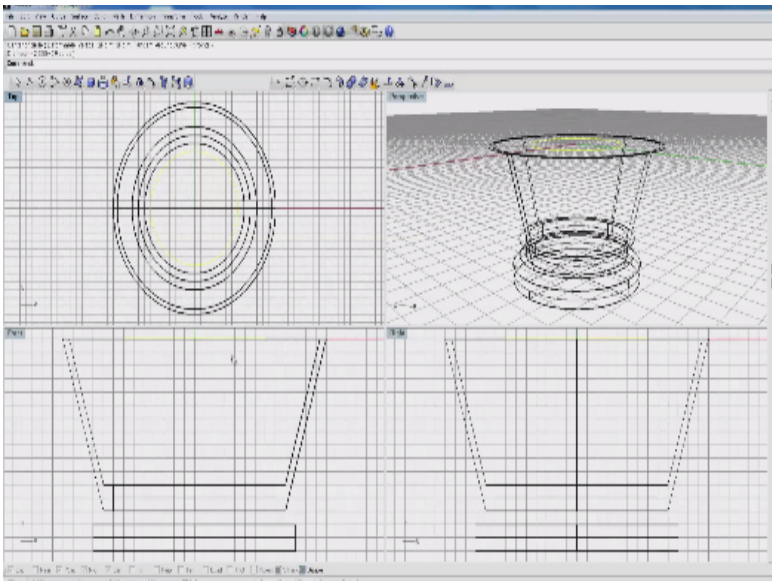

I will use this circle take it down here and see whether I can make a solid out of it.

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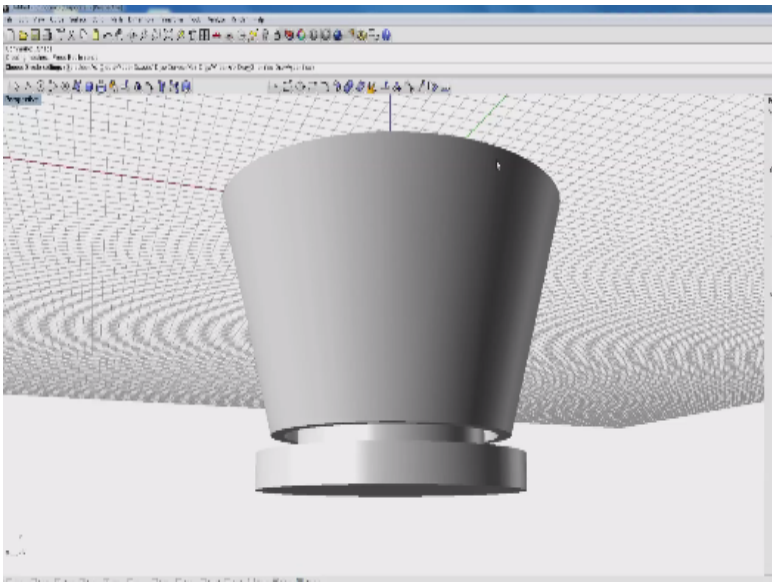

This forms a thermal bridge. See there I have a small plate which goes through this plastic and 1 or 2 features you will notice is it is not touching it anywhere. So that the heat is not directly affecting the plastic. I have left a small gap. Here I would like to give show your notice to any insulation all insulation works on the basis of trapped air. So if I make sufficient cautions such that the plate does not automatically touch the walls there is enough of an insulation.

Further if I want I can always put polyurethane form. Polyurethane foam can easily withstand 150 to 200 degree centigrade make a ring of polyurethane foam and just push it inside. This heater will continue to heat the bottom surface of my cup and inside of that I can have one more metallic cone in which heater wire is put. The only thing is the metallic cone the heater wires maybe only of the order of maybe less than a watt.

So I can have 500 *100 milliamps maybe 0.5 watt. So if I have a 0.5 watt that is enough to keep it the edge very much warm and further if I want if I want to heat it and all that I need to work more on it, but this is the starting point. Now having this, now we come to the other equally important things.