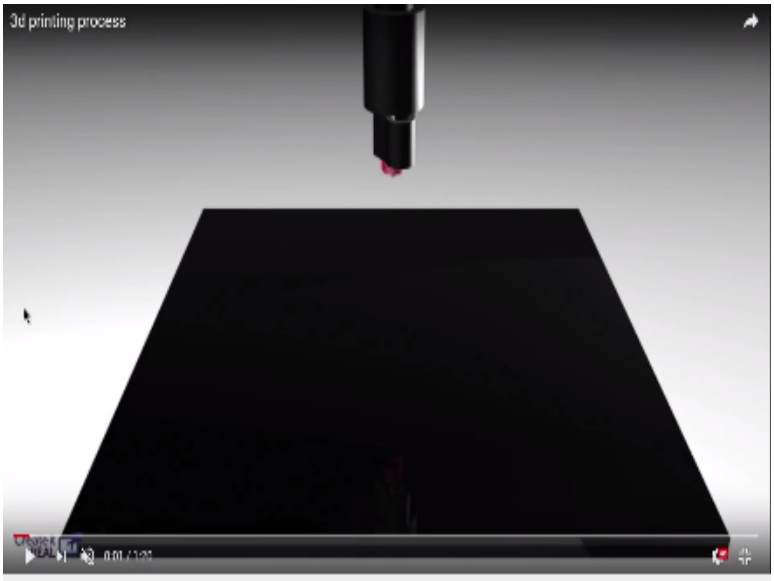
Physical Modelling for Electronics Enclosures Using Rapid Prototyping
Prof. N. V. Chalapathi Rao
Department of Electronics Systems Engineering
Indian Institute of Science - Bangalore

Lecture – 16
Metallic, 3D, Build Up 1

Let me continue, where I interrupted because sort of I got tired and I could not use the mouse well, so once again I have 3 things, I have a computer which I operate by hand and then, I have a what you call touch we see in which I have access to the Internet plus I have these 2 cameras, so I do not know where to start.

(Refer Slide Time: 00:48)



But maybe for today's this section because you may have been saturated, allow me to start with this monitor in which what is called see, number of these what you call YouTube videos and these things are available, very large number are available, so my suggestion is just to give a hint on what the 3D printing process is and then you can see how to go about it, so obviously there are 2, 3, 4 different items to it; one is the 3D printing itself, there are several variants on it.

One of the variance is that it can be very simple fused filament to depositing method by which you know small filament goes around and a lot depends on the thickness of the filament, so you will see some of these demonstrations. Secondly, related to this; this is one part of it is the technology, other part of it is actually, the application of the product.

(Refer Slide Time: 01:40)

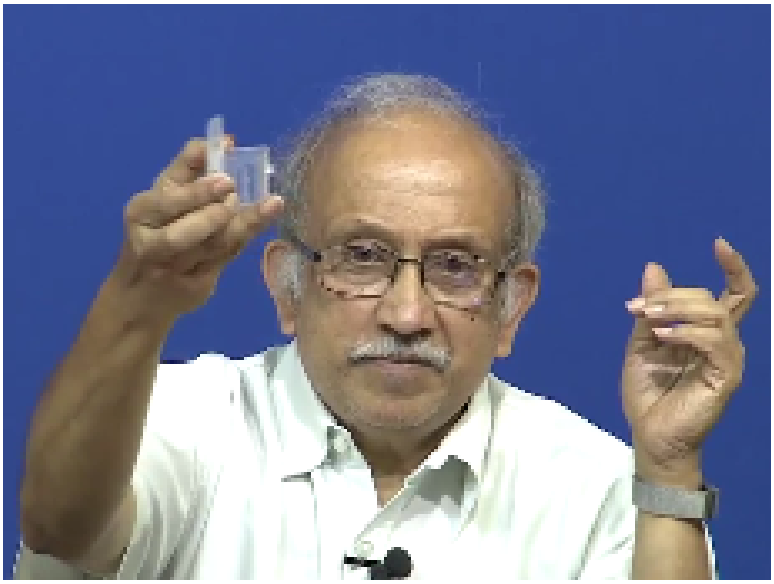
Please have a look at this model which have kept there, I am sure quite a few of you have seen this and felt the same frustration as I have felt about it, this is a (()) (01:53) battery bank you see this battery bank is fully loaded with cells, various types of cells and so on, this is one of the bigger ones, you have 10 cells and this is where know little bit of marketing and salesmanship is there meaning, I did not know something has to be done about it.

But why I brought it is the core part of it is here is the plastic part and you see here and in this plastic part, one of the first thing you will notice is okay that there are several places things are expected to go in step in place already, not just step in place, it stepped out of place with my repeated attempt to try to take it out everything is broken and same thing happens here, there is a small lip given here.

Now, and this whole thing is expected that you know it sits neatly here and I do not know, I know it is and you will not see any gap in this, while it is very convenient and easy for you to make this in mass production using what you call injection moulding, you still have a little bit of a problem when we would like to make this in our home 3D printer or in our case, our institutional 3D print.

One of the first thing is while application is known, the detailing is slightly different between our 3D printing which we can do in a low scale, professional 3D printing in finally eventually, large scale mass manufactured using injection moulding. One of the first things about it is the features size and the material properties, such material which is easy to load and continue with it, it is obviously little weak.

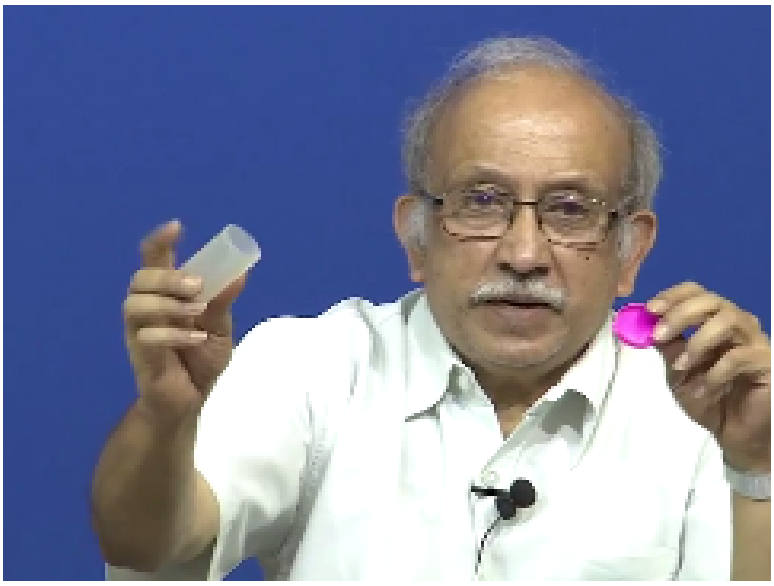
(Refer Slide Time: 03:57)



You see here, some of you would have seen it, did comes with the rechargeable cells okay, rechargeable cells is; this whole thing is injection model does a single piece, probably in the flat condition and yeah, the word chameleon is written on it, so chameleon has given this, so that you can carry 2 of them without short circuiting and the feature here is; you have a living hinge, you follow, there is a living hinge application here.

Meaning, once the material is done several times, you can continue with it without any problem but a lot of it again depends on the material that is used here, so things like this were just a simple demonstration and this thing you can do it on as I said home 3D power, then professional requires special materials to manage these things.

(Refer Slide Time: 04:54)

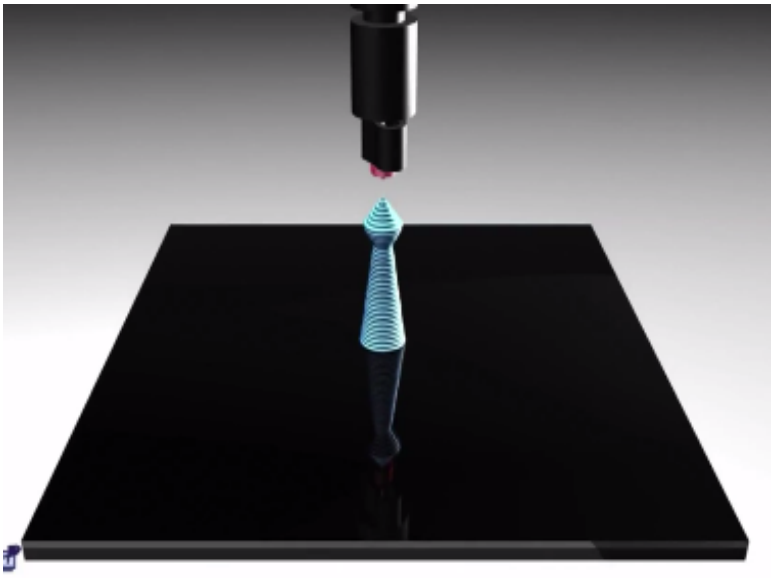


Now, if you see here similar thing, this one is a small box, I do not know what it came with and here, 2 components are there, one part of it; this also a what you call, it appears to be a slightly rigid plastic, I will not venture out to say what it is probably, modified some styrene thing, this clearly is a little lower price styrene, only difference is; opaque, coloured, this is translucent, transparent eventually, it has become.

And the certain detailing here saying, there is a ring here and how well it sits here, now these things are a matter of trial and error, so when you adopt these things, you have to think a little; think about it saying but right now, at least the manufacturers claim they can give you materials of any consistency any, what you call springiness, this is a little hard and then any type of the physical properties.

But I said 2 famous examples of household plastic items are Tupperware, if we see the Tupperware lid, it is the special lid and it seems to last forever and you know 20-year-old Tupperware containers are there, the base is one type, the cover is one type and they stay together, the other is Lego; Lego; I do not know who makes the plastic for them, I understand the plastic itself know is a very special thing which they have made.

(Refer Slide Time: 06:37)



So, there the focus is other; just other than design the material also is very, very critical, so this thing extends to various type of things here. Now, let me see I want you to see the demo here, table is raised and you will see this is of course exaggerated because it is an animation, that filament is being melted yeah, it is molten filament is being what you call spread on it, so if you see as it spreads on it, so several options are there, you see here, layer by layer something is being built.

See, the bottom most was a type, now just, so that it is you know it runs in front of you, they have made this layer, it is made a little faster and faster, so that you can see, animation is you know speed it up to see how well things get built up. If you look at it from the top, I am sorry, from the bottom looking towards the top, you will see that something needs to be done to ensure that things fit properly, you have a beautiful what looks like a communication tower, good.

(Refer Slide Time: 08:05)

So, we have this similarly, if you now go, so many of them may have what you call beautiful these things, let me what you call exit full screen and then check the organic shapes in metal, I am not very familiar with it except that I found it on the Internet I thought it must; it might interest you and then I have just shown it here saying you have all sorts of jewellery, then curiosities, then maybe eventually, right now they tell me that even engineering products are very much ready for it.

So, I mean you can see it here but eventually, know just see and afterwards try to go to the Internet and see how best you can do it, so we have a tray which is probably filled with some sand and I am not very sure what the exact process is, so some amount of levelling is being done from here, the actual the process starts, watch; say layer by layer something is being curable probably using lasers or some other technic, since as I have said I am not very familiar.

You can read it up yourself eventually, after all the curing and everything is over and they release it, we have after they, what they call that mould is; what you call moulding sand is removed, your object is slowly getting ready, at the moment this particular picture know shows a little, it looks a little like a novelty but when the product comes out, you will feel happier saying you see we have something which is there.

In contrast, it is very much possible for us to make, see here it is not a single stage process, something has been done and you know they; after the curing has been done, the moulding sand is being blown out, it is actually being you know blown out and sucked out, so you have an object which is I am not sure what exactly it is but you have at it, it is a piece of art, it is a piece of everything it looks like.

Now, you see what it is, seahorse sitting on something else okay, so then that seahorse is actually a support, so after that probably know now they will try their I mean, then you see here something else is being added and then eventually, it is being prepared for sandblasting, you see what will happen, after all this sandblasting everything is done and you know the object is taken out, you will be happy to see, oh it looks like a tumbling what you call shot blasting tumbling.

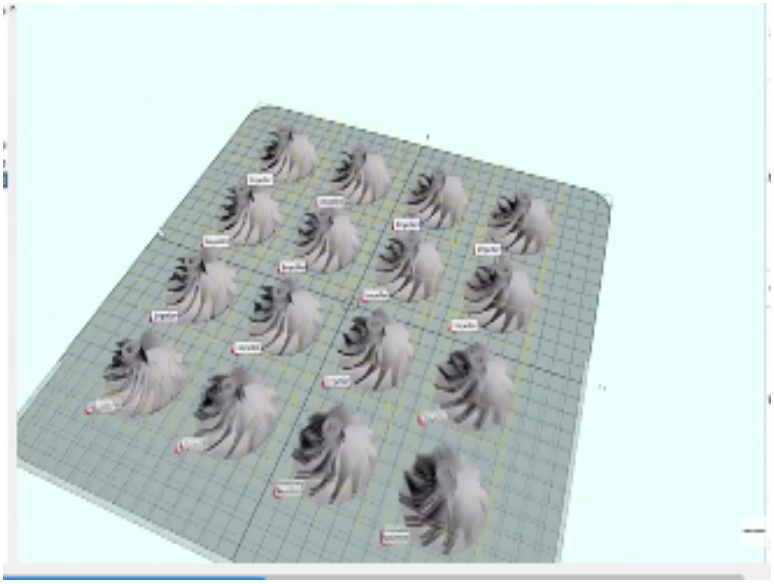
After the object is over, you will see here a nice beautiful seahorse which not very long ago meaning, may be around 25, 30 years back, that is only a dream, once all they you know, thing is sealed and then the whole thing is turned over and I do not know whether it is heated or vacuumed or anything, you will have both the things separated that is you have the support which is separated from the seahorse.

See there, oh my god, it is a handle with a marine motive on that looks cute, this is the beauty of and then afterwards, they have painted it in I mean, sorry, plated it, one of them probably has a gold plating and one of them as other you know options.

(Refer Slide Time: 13:00)

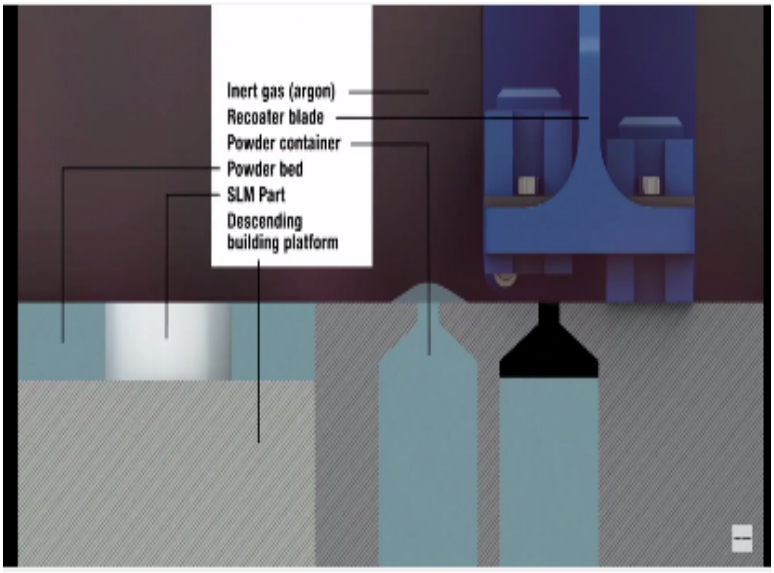
And then you have a series of beautiful structures and in fact, you see here all sorts of houses and everything is being made.

(Refer Slide Time: 13:17)



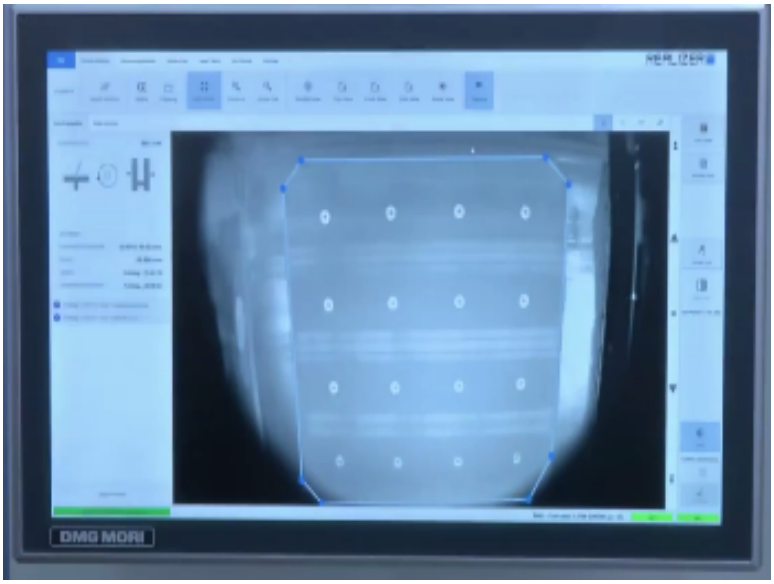
One more before I quit, I will just I want you to see this powder additive; powder bed thing, I am sure you will like it, just let it start after that I will go back to you to the dull 3D part of it, you see all of them, whenever you use powder handling, they, I am sorry; powder thing; first thing seems to be how to creating the object is relatively easy, you have mathematical equation and then you can apply the what you call mathematical vision and generate this.

(Refer Slide Time: 13:52)



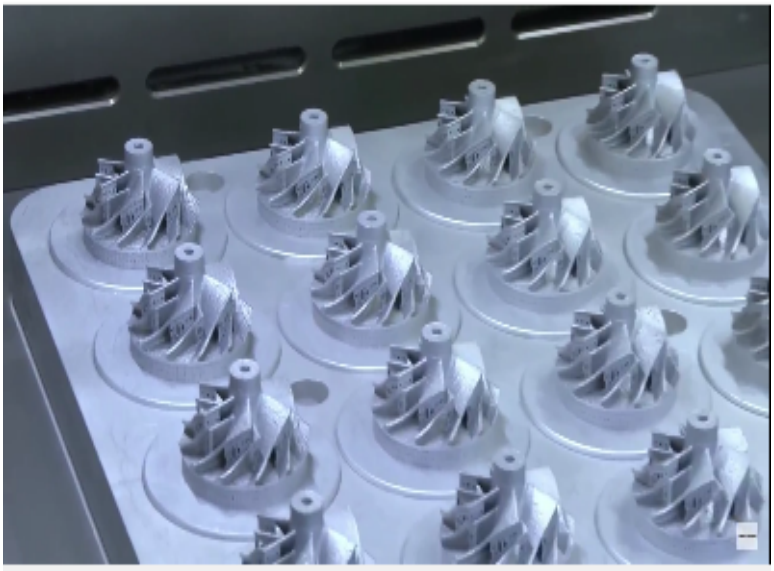
This looks like a turbocharger blade, so if you see the turbocharger blade, it has an instead of just normal 3D profile, you have so many other things. So, what is being done is; a laser somewhere is sitting and sintering the powder locally, so with this the only whatever material you want stays there everything else outside can be shaken off and reused again.

(Refer Slide Time: 14:54)



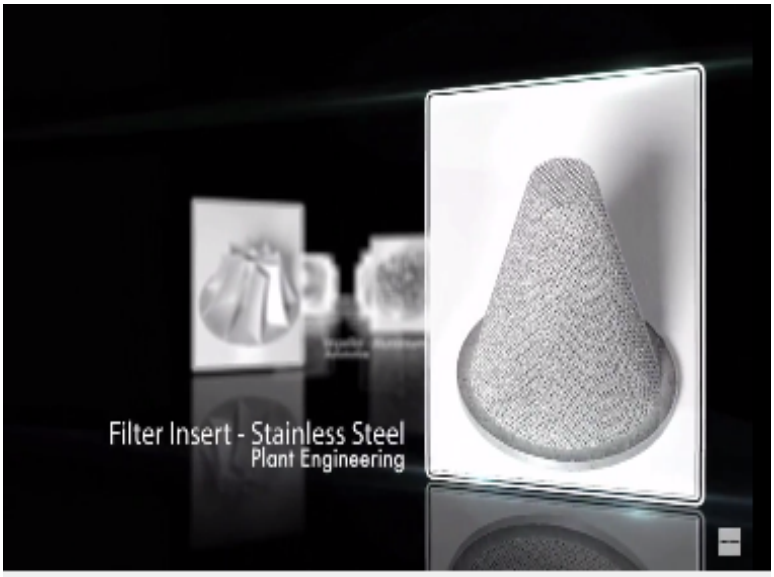
So that laser is slowly layer by layer it is sintering the spots, so that is the beauty, so a 1 kilowatt laser with about what you call 0.1 millimetres goes about powder is being applied and slowly that thing is being lowered.

(Refer Slide Time: 15:27)



As it is being lowered and finally when you open the door and you manipulate it, that is an animation of you know, how well it is taken and then if you remove all the powder from everywhere, we have the beautiful objects that is sitting there. It is a little like somebody asked a sculptor, how do you manage that you know is a beautiful things, we only have a strong there and all, this is nothing, I see the what you call my object inside.

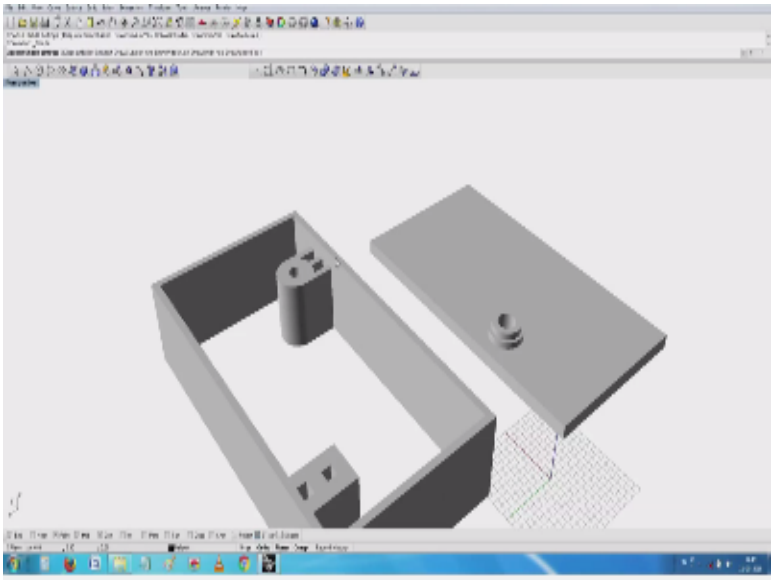
(Refer Slide Time: 16:15)



And I remove all the unwanted portion, easier set then done but you see here even here, those of the vertical things are not fully cleared, they still places which need probably a little bit of cleaning and knocking off and all that you have seen this know that is a various types of an objects including the previous object which have seen.

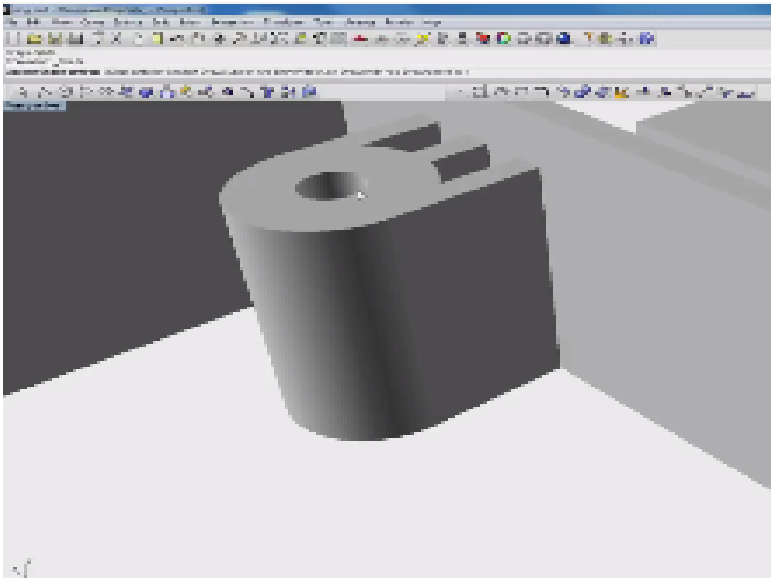
Anyway, you will see, you can; I suggest know, you can go back and see it while the finish part looks fine, there are little bit of stages for you to get into the stage, so aluminium impeller is meant for the turbo chargers, so I suggest you can go to the Internet and check these things. Now, I will stop here because it gets you know, extremely interesting and let me get to the boring part, one of my, our people said you know it was boring and it is my remark.

(Refer Slide Time: 17:06)



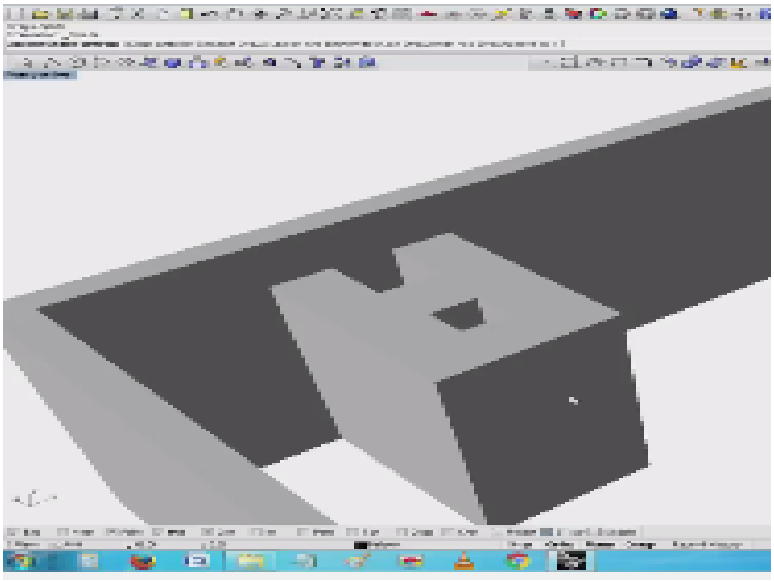
Please look at my computer what I was took in yesterday; yesterday if you are remember, I started with a funny looking box here and I made it full now, if I go here and make it here, do you remember this, this is meant for that printed circuit board to sit on it, so I sort of you know, I made it off-line and I want to show you because yes, it is boring unless, somebody is actually making it, it is not easy to now, 2 variants of details are there.

(Refer Slide Time: 17:49)



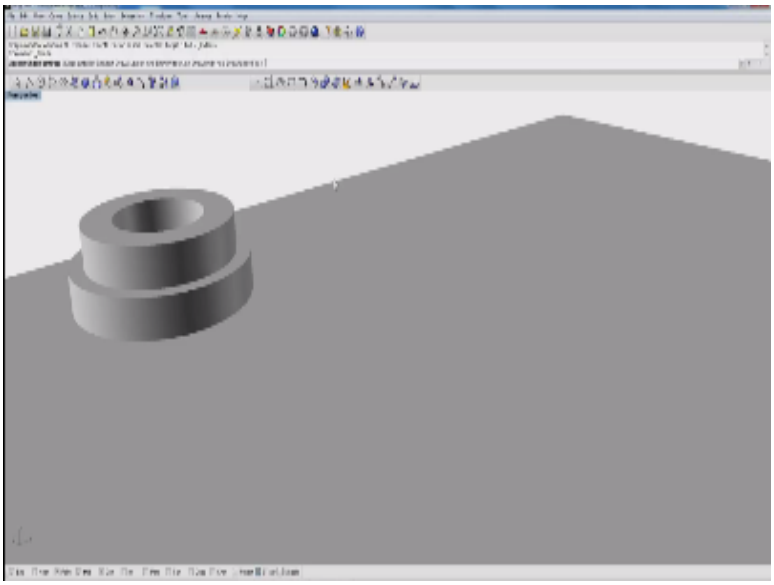
You see here this detail here shows same circular hole but supported directly on the walls through small supports in this, this is where you know, your trial and ingenuity and all comes and the lot depends very much on your application.

(Refer Slide Time: 18:11)



And in the other end, the same thing I have now tried to modified saying may be functionally, this itself is sufficient for me because for me making a drawing is easy and then maintaining necessary thickness is easy and it looks different that one was a circular hole here instead here I have a square hole. So, depending on if I do a little bit of a trial and error with one or two parts, I can get an ideal pilot square hole.

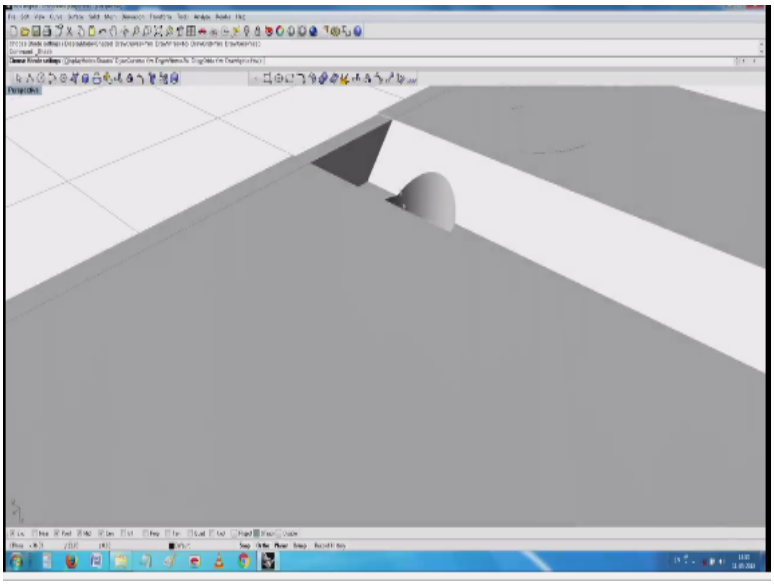
(Refer Slide Time: 18:47)



And then, see it needs neatly and right now, I will hide it, I will go back to the other object, which is here, you remember this, this was the screw hole, which for adjusting the potentiometer in the previous printed circuit board. I have brought a small step here instead of having what looks obviously like a something which is too long, it needs a tremendous amount of concentration and attention to have your that you know trimmer screwdriver into this.

So, one of our operator suggested that I provide a counter bar, this is very similar to the other square hole which I was talking to you about, the square hole also will be equally okay here and then, you will see other side to make it support itself and to prevent any untoward stress concentration I have provided a small circular opening here, so thing is you know slightly things are better now, I will just close it, then I will go on to the next one.

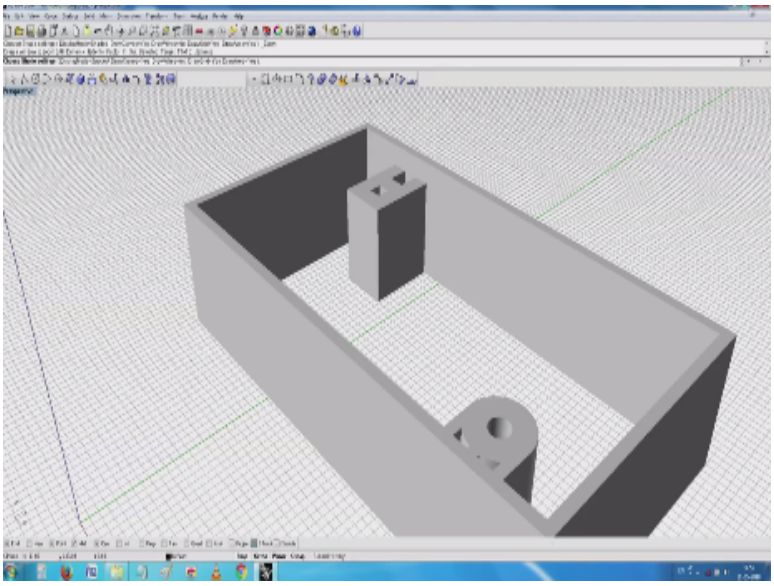
(Refer Slide Time: 20:06)



This, I wanted to show you actually first but then now, you will understand, can you see this, this is what I had started with yesterday, this one may take a little more, it may; it is easier to fabricate it, it looks familiar, it takes a little more material, it takes a little more what you call careful way of positioning things and while it is a very real novelty item, the finished product at this corner may or may not look nice, you see here, I have ended up with a very funny looking corner there.

We do not know how this corners will develop, so it is in our interest to go in smoothen the part, make them easier and easier to fabricate, so I will still call it a matter of you know what you call trial, in that I still ended up with a not a very comfortable thing there, what I just left it there because for some other point know, it may be valid, I will now close this, I will move on to next one.

(Refer Slide Time: 21:23)

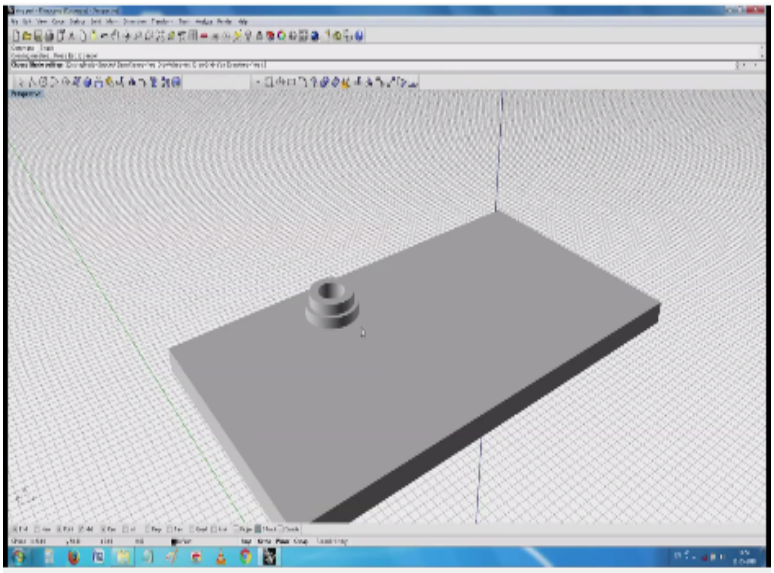


See, what has been done here is now, we need to take a call, the other previous one, not you had, already had a cover like thing now, it is for us to decide whether you know we would like to make it into 2 parts and we would like to put one over the other and this makes sense because if you are remember earlier know, one of them we wanted to make it out of a metal which will used as a heat sink.

So, in this case while the metallic portion can be used as a heat sink, the other side if you make a transparent cover, it will be ideal for us for demonstration, so if you make up as a hollow body like this, we can attach whatever you want on each side, seen this know on the other side, one side we can have a heat sink, other side you can have a hollow things, so that other people can your; whom you are demonstrating can easily see this.

Plus, one more very important thing is; you have access from both sides, so you can happily carry out any modifications you do whatever you like with it. I hope you got my point why I have made it open on both sides; I have access here, so that as a prototype job I can do anything in this and covering it is very easy, all I have to do is; it is made from the same job as before.

(Refer Slide Time: 23:02)



And oh, they just copied, you got copied, yeah, now if I, the same box, I have an option of having different type of a cover in case, I do not need continuous what you call tuning, while it is in circuit, I probably do not need this to tell it all because it is only likely to contaminate and we do not make these things, non-dustproof, so in that case, I need to do; I just need to have a simple flat cover, seen that know.

If you can make the box only with essential details in my case exactly, it is about the printed circuit board, so I can go around and then check anything, if you have things like a; thing here that is the reason why I brought it here, can you see here, you will not believe that is the small LED here, this small LED are supposed to come and show themselves up on the outside and it is logical for us to just make them as much chip like it is.

It will just show whatever the status is, now corresponding on to the other side, they have made a beautiful light pipe and a lens arrangement, underneath we have an acrylic light pipe, then I have a packing here and then on top, all thing is neatly sitting here. For working out these details, maybe it is very good to start with a plain this thing, make an opening here, check whether things are okay.

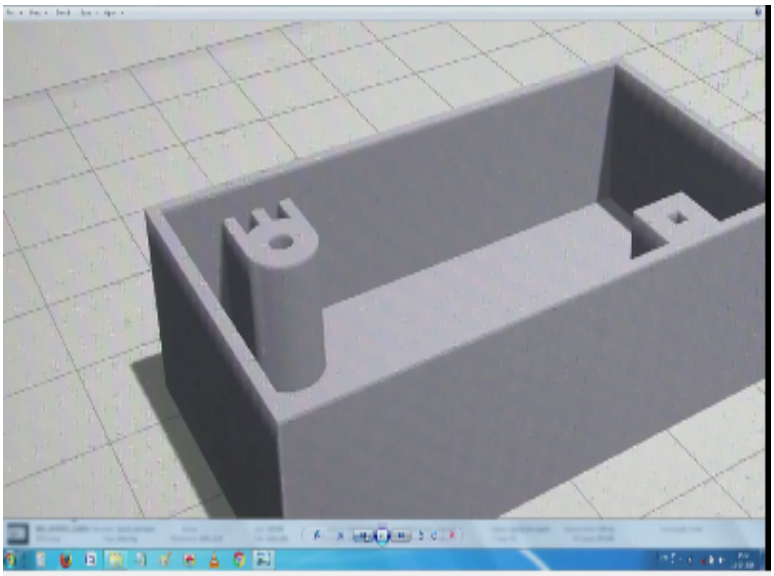
Finally, when you measure and does it make sense probably to make a small lens here, bubbles; 4 bubble lens maybe does it show but the moment you try to enlarge something totally intensity

comes down. So, in this case these are small chip LEDs, the smallest possible available and they do not take much current probably, there are around of 5 mill amperes and intense; I mean sensitive enough.

And if you put a pipe thing like this and closing it serves the purpose extremely well and it gives its lights, if it is your traffic lights, you see hooked around it, it is also like a hook and then you see here to prevent leakage between the thing, they have used a barriers which is a rubber; black rubber barrier, so that ensures that everything sits properly and this where I wanted to show you, you see this, we have a small tiny screws.

This screws need support and as if it were not enough we also have a switch here, so this activator may be part of this and the actual switch and all may be on the printed circuit board, so I am a little what you call, I am thrilled that things like this, it is very easy and depending on your this thing, large number of things can be made.

(Refer Slide Time: 26:33)



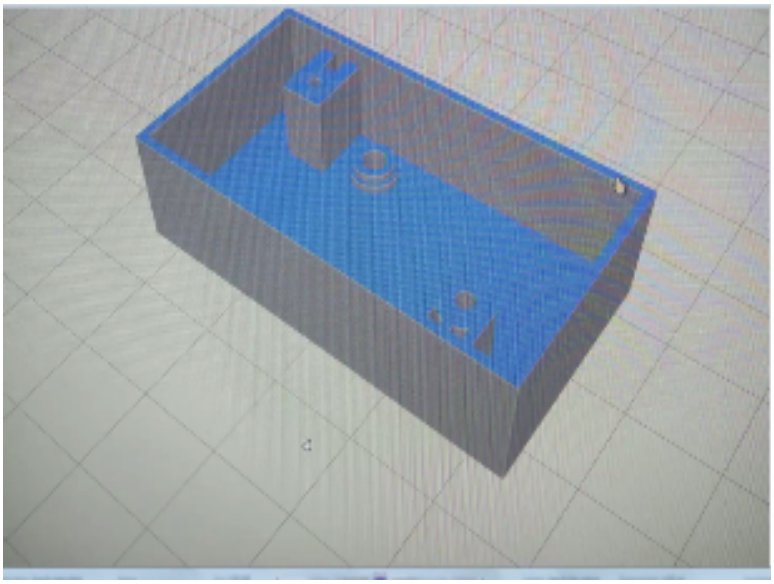
Now, at this point I will now show you something my colleague has helped me, yeah, yes exactly, see this is the drying has been loaded on to our patch program for making the part and you see here, first of all certain basic checks are done saying are the; all unintended things and most simple surface modellers are not very good in 3D operations especially, if we take to 3D what you call objects and try to remove one from the other use any Boolean operation.

So, one of the Boolean operation is you have some solid in which you remove, something you remove a core, so if you have a nice solid like this, I need to have this pen sit inside or I have to need to this pen sit inside, all I have to create is in between neutral object and one object here and one of the other if I remove, I have the cavity and then I have the matching PCR, the moment I have this, it is very easy for me.

And all this are very conveniently done in Boolean operation that is the advantage these days now, it is relatively easy for us to make what are typically beautiful and geometric objectives, does not easy at once upon a time, right now this of course is only a dead I mean, sorry, it is all a weighted object you can even may be build intelligence into it, wireless something you know, senses this and then when I play with it know, all this stuff can be easily made using Boolean operations.

Now, please look at my; that screen there, nothing, it is little far away object and then and the way the depending on the program that is build, they have try to make it appear instead of as a simple smooth object make it look a little like the structure that is likely to be achieved saying see it as a grainy looking structures seen that know, you can see there are, vertically they are build up and then in this corner if you see, it is likely the final project will actually look like this.

(Refer Slide Time: 29:24)



Finally, when you make the product know, it may look like this, so again coming back I have a circular thing here, I have a square thing there, yeah, now this is the monitor problem when we try to capture and I am not very clear about it when the demonstration comes, you will be able to see. First of all, each plane is identified here, in this case it is probably the x, y plane. Why this is required is; often, we have confusion when we try to build it up.

So, how do you orient the object which is the bottom which is the top and then do you make it sit on its side or you make it like this, this is where you need to use this colours and you have seen this is the opposite side of the same thing, same on here, same thing. So, finally this completely welded single shot object is probably will come out of it and easy for us to make things, this is where something else which I have spoken to you is also possible.

If you have the basic object, a middle shell and then I have the what you call top cover of different operations is very much possible for me to take it to the; this particular software and do the Boolean operations here, so we are able to actually build a various things here.