Physical Modelling for Electronics Enclosures Using Rapid Prototyping

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Lecture – 06
Advantages of Design Modelling

Hello, this is an introduction to one of the what you called suddenly everyone is talking about type of a situation and of course I am talking about rapid protyping. And one form of rapid protyping called 3D printing seems to has attracted everybody attention because what happened to the case of publishing. In publishing what do we do somebody writes it could be a novel it could be theoretical paper.

Or it could be anything which involves to be printed and distributed everywhere. So, in the beginning we had this typewriter somebody had to sit and keep on doing the typewriter. So, we have the Underwood and Remington and brother and so on and so on and then all writers invariably went and acquired one of those new typewriters including there were small portable what you called foldable and so on.

And the old business of writing by hand taking a pen and writing by hand sort of became a little advent to the background. But still people continued to use writing which is real now after the typewriting has come somebody had to go and do now what is called typesetting. So, if wanted in large numbers a few things you can do by putting what is called a carbon paper and hence the CC carbon copy came about.

You see all of them no now has reality in original and real products so carbon copy came about. Next after the carbon copy came about if you wanted to print a large number of anything any material we had to send it for typesetting and printing. So, somebody puts all those letters and then it runs in the press and you know something paper is pressed again and all that now so that came about and almost intellectual meant publisher and publishers needed money.

So, this whole thing became sort of expensive and from that thing came the concept of desktop publishing. Saying why do you need to huge calendar presses and photo offset, multicolor and all

that why cannot we do that it at home on a desktop computer. So, in the desktop computer what people used to do is print everything and probably format it and change the fonts and then make everything fit in to known format hand it over to somebody.

Who will print it and give it to us and get multiple copies. And it went forward a little eventually went forward and ended up with table top printers so it was easy. Allow me just for the argument right now we use the word xerox in fact xerox cooperation who incidentally and probably has a patent of this mouse okay. They started making printers, huge printers and to the extend that what was a trade name eventually became a verb get it Xeroxed,

And now we know photocopying is almost synonymous with it. But the thing what I am trying to stress is that there is this printing has become has been made very, very, very easy. So, you have printers which will give you a multiple copies, then they are you know institutional printers and so on. Now I have a small write up and which I will come back later.

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So, people were working on it saying if I need to make something typically I need these glasses and this also made with some black material and you can see it no and imagine I have a tube of acrylic or a tube something which will hard and fast like if you see the glue gun you would have seen the hot melted adhesive gun. So, in the hot melted adhesive gun what do we have a thick what do you call some device which melts that thing.

And we have a gun where in the tip it heats and makes it a little easy to flow. And people started dressing what do you call patterns and all that and what was adhesive between two things no also began something which you can play around with it. Almost you can make a type of glass you have seen all those huge what do you call church glasses, stained glass type of thing are possible all based on the hot melt adhesive.

Now while this is one side and another side what is called inkjet printing started getting popular saying why do we have to have photocopy type of thing why cannot we have an inkjet where ink is actually pushed in to small slots and that thing afterwards is cured and come about. As people started working on it suddenly somebody I do not who it is right now I am just not talking about it.

They came about with what was obviously simple printing using some wire or something you melt it and start printing things with it. And suddenly know the whole what is now almost you know we feel it is going to solve all the worlds problems 3D printing. But 3D printing is a small set of rapid prototyping what we want is that quickly if I have some concept in my mind.

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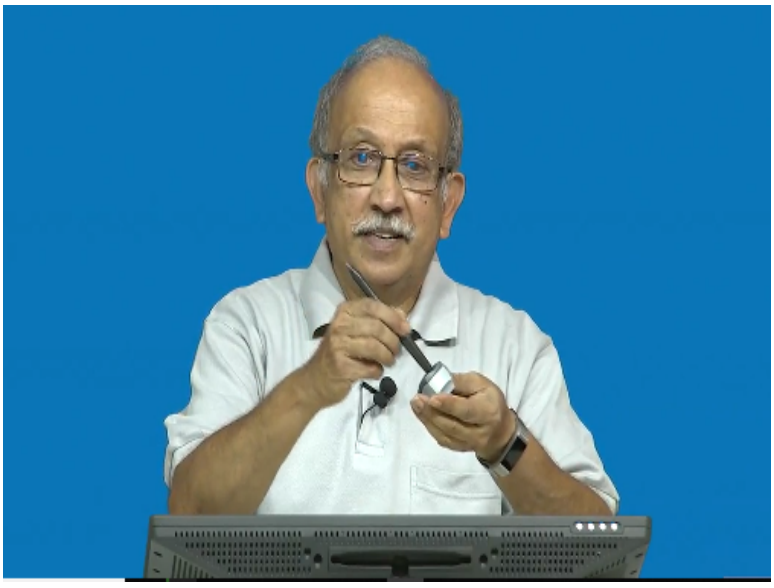

I have some concept I am not sure what the concept is I have this is a base and then this is something and it is a tip and something with it may be I need to erase and something which is

there in my mind has to come down so that I can demonstrate it to others. This is where the whole concept of what was prototyping and then what was what do you call rapid prototyping eventually an idea which time has come 3D printing came about.

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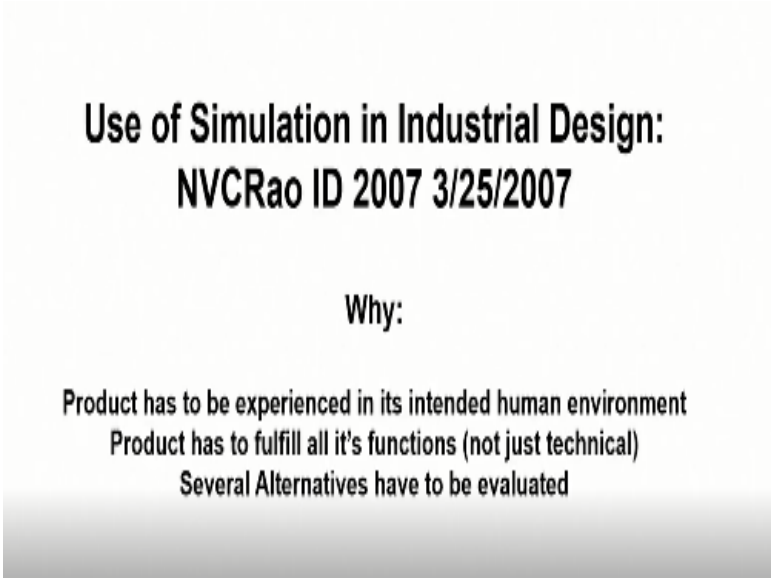

Now if if you kindly look at the thing one of the thing is why we need this 3D printing stuff is we need this simulation in industrial design a product has to be experienced in its intended human environment. And it has to fulfill all its functions not just technical and alternative step to be evaluated.

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So, you see here one of the first thing is how the products look like general look and feel

ergonomic. Ergonomic means how well it sits in the hand and how well you can use it and usability direct sensory inputs, touch balance, comfort, appearance and occasionally smell and sound. So, it looks very what you called counter intuitive saying why do we need sound we need it.

Many of you have handled a camera and you would have noticed that shutter sound and unless it gives the sound we will not get a feedback of how things have operated. Now we have got used to when we started we all started with that big you know clacket clack cameras which have mirrors and we use to listen carefully whether the mirror has gone up and then usually there is a focal plane shutter.

The focal plane shutter has opened and then the mirror has been restored to that All this you can easily find out if any problem is there.

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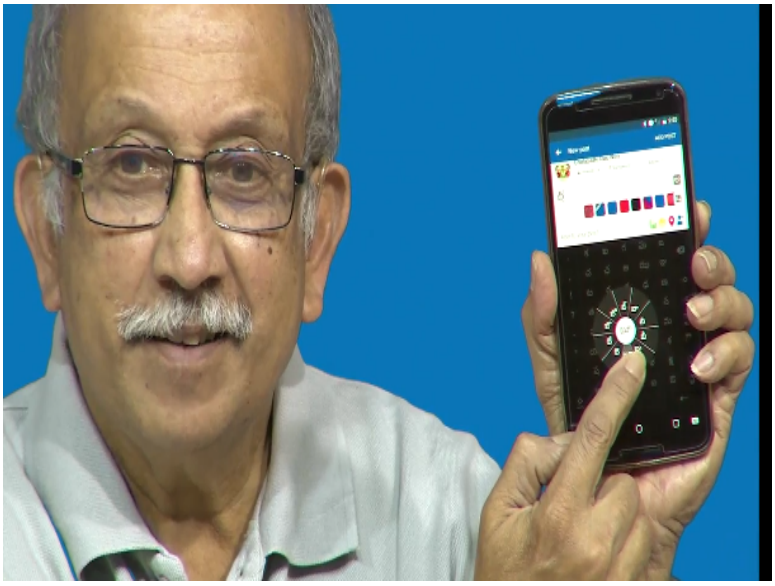

When these mobile phones came first time we have nothing here is it not? Really We have nothing to press in fact both the front and back of these are glass pieces. And when we press something, something has to happen and while it looks fine and sometimes you know buzzer at the back it vibrates or we have something. Occasionally we went up with a very peculiar things and I will try to show you.

You see I have a very peculiar Indic character keyboard here which is little similar to what we can start. But then when I press a key you see wheel like thing has come and I can move things around again and see which of these is selected. Suddenly what look like a tactile feedback not needed anymore and what you do with I do not know. It is called as chakra what do you do with chakra like this?

This is developed instantly by industrial design center of IIT Bombay and I am a fan of this that whole thing. Now you see here what we thought was generally a keyboard simple keyboard has several other ways we need to work with it. This is where now if you come back to my slide sound all these suddenly know make a what do you call comeback and this is where 3D printing at least promised saying very quickly.

I can make things and present it to the public the stake holders. In this case one is safety another is manufacturability and how easy it manufactures and it is the best way to produce and then tooling and then assembly what comes in first what comes in last. And all of us you know when it comes to maintenance and disassembly our good old friend is waiting morphy saying if you open one screw and something.

And invariably that not a screw and goes and hides in the most inaccessible place. So, how do you dissemble parts and then how do you update the system and then how do you diagnose all these things are generally the best way to do is by a manufacturing or prototype.

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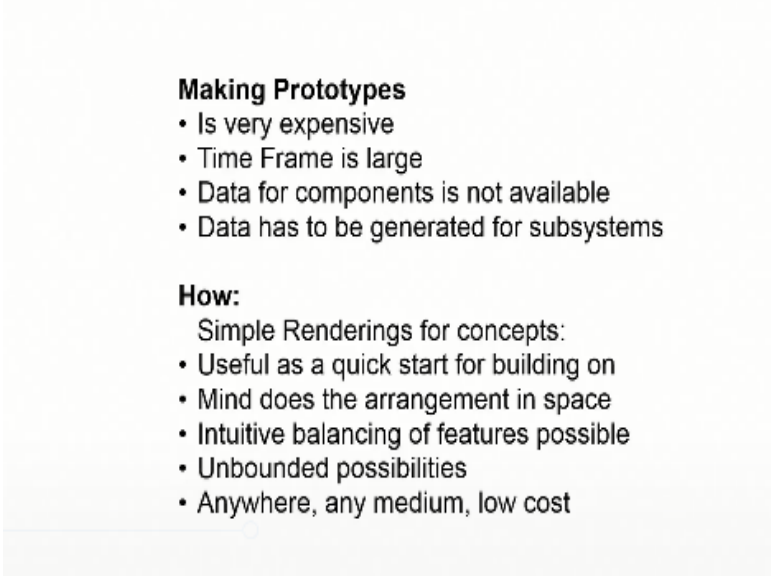

So, we have all these no and we have rendering and thing and all that. I will stop here and quickly go back to the interesting things.

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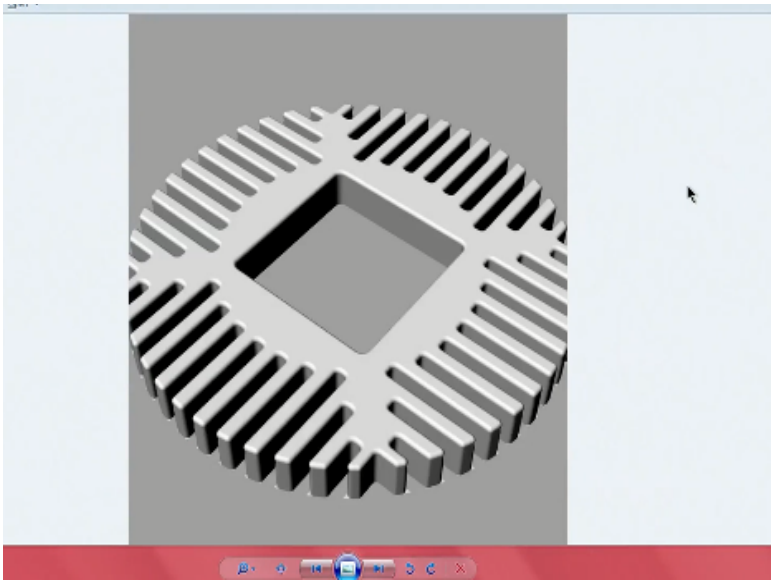

Which I am sure few of us are waiting. this is the concept of 3D printing which is a small subset of rapid prototyping you see here. I have a very interesting object which is probably nothing but it is a peculiar heat sink and if you see here it is yet to be manufactured. It has to be held in different places and a cutter has to move in all the directions and this has to be ready and from various considerations I would like to have one in my hand.

Because it is not easy to interpret these things. While it looks okay here such things suddenly

made sense to be made in 3D printing.

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So, in 3D printing that is typically a machine let me go back to a few more points. You see here notice something about this clock it is a 9 to 5 clock and you see where the 1 o clock is. This does not start at 12 out here in colleges we have a recess at 1 o clock noon time. So, the whole perception of the student is everything is before lunch and after lunch. So, 9 to 1 is you know all the sections before lunch and then after lunch is there.

And suddenly I have noticed there is no 6 7 thing is not there at all. Now this was just directly printed on a normal printer an A3 printer and it has been stuck there

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Imagine I need to now make this clock and you see some very interesting things that are written that are saying work smart not long and hard. Long and hard make sense and some other thing at least semantics of it working smart makes sense. Now you see other things that are that elements and it is 9 to 5 clock and then there is no minutes' hand in it only our hand. Approximately If you look at it just past 2 so you can look at it maybe it is 9.20 or anything.

In this case further it is not divided into 5 parts its divided into 4 parts so it is a quarter past 2. So, suddenly what was I can now print the whole thing. I just feel like to have the black and white printer here and I can feed it to a machine here and eventually I can have a beautiful 9 to 5 clock. And 9 to 5 clock is normal working hours. And 5 to 9 of course evening times people will get a little bit of relaxation.

Morning they start running around and there is work all the time. Now this whole device including the colors, including the shape, including the fonts everything can be designed in CAD and you can go head and print these things. So, I am amazed at it as I just produce this as a student exercise.

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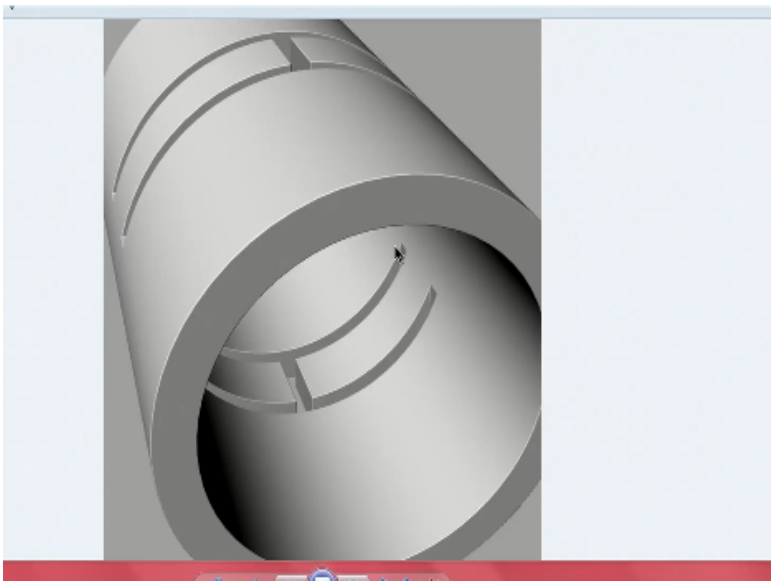

And you see here I have some other part I do not even know what it is except that you see a small detail as a (()) (15:29) here there is something here and then this was supposed to be something for a shape memory alloy motor. So, if we excite a wire that is if electrically pass through the wire it clamps and it drums something.

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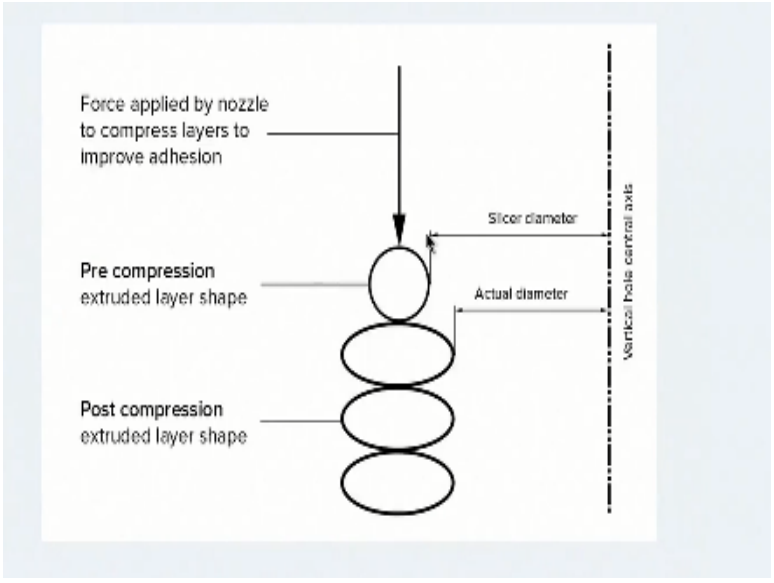

So, we have all this parts which can easily be produced using this 3D printing technology.

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Typically, this is what you would have seen this outside and why I feel I know I am a little happier for getting this chance of being allowed to talk about this 3D printing is, we have benefitted for quite some time. This machine has been and first I started it using around 10 years back and since 6 or 7 years I did this. I will show you the samples what we have put and this is a professional machine.

The advantage of professional machine is it will take any drawing which you make and drawing formats are typically what standard products I mean standard what we called as software gives. One of the standard software is probably related to auto desk started with dwj format and even earlier to that the initial graphic exchange IGES system was also there. And the advantage is if I make a CAD model it can be printed here.

And same file in principal can be used for carrying out other operations simplest thing being machining using a 3D what you called machining center inside CNC vertical or horizontal thing.

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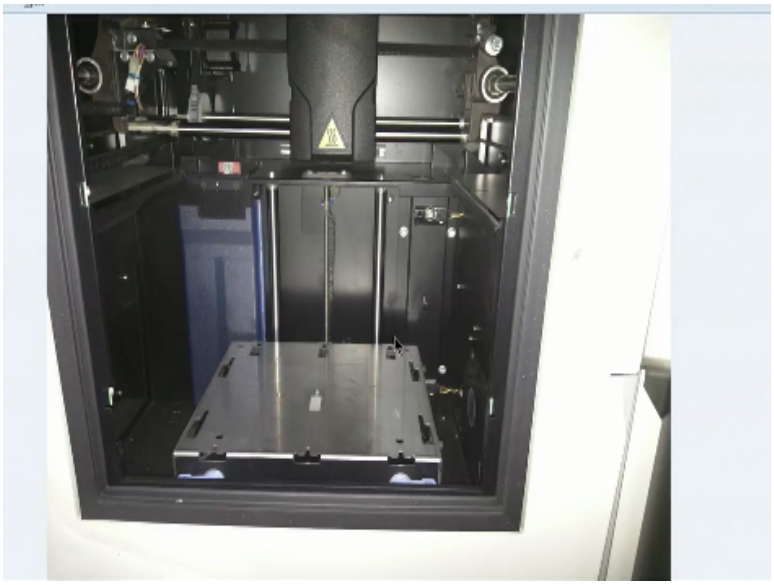

Now slowly things have changed a little let me get back to this simple thing and better to do it in principle there is nothing great about this machine but why this is costly I will give you an example later. There is a shelf here we load the base here and then there is a screw feed here. This screw feed gives a pushing it up in layers and this is where standard lithography files became popular.

And this one at the back is an xy system so the y is front to back x is left to right and this is the z or c coordinate.

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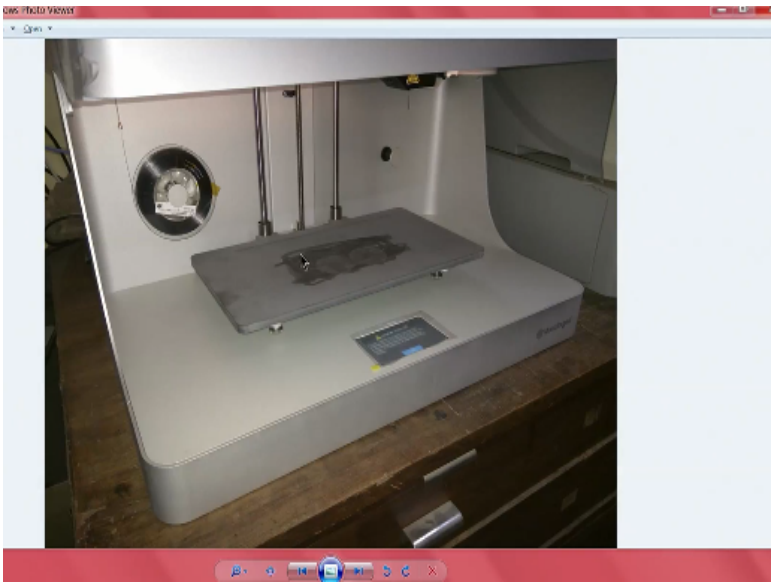

Now things have improved dramatically you have seen here this is the same machine 10 years

later the latest technology it has become much smaller and genuinely it is easy to fabricate these things and you see these are all the parts.

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That can easily be produced in a 3D printing set up. There are some things some is actually part of a frenal lens I will use the word Fresnel put up with me. Because even calling it frenal probably not the word how the French call it they call it as probably Frenal or something I do not know what it is. This is part of a frenal lens complex and the next slide shows you and you see here.

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We want it and you understand we want this face it has a peculiar what you called part a sector

radius the opening here and then this whole thing has to sit here and it has to come out of the machine. Now you see here and what I am holding in my left hand is the piece the right hand is what not many people tell you it is the support material. In the case of that professional machine there is a poly I think some acetate alloy acetate lactic acetate material which dissolves in water.

At a temperature which is lower than the basic other material. So, this build material after having built in we put it in that socket I mean there is a small agitator and there is an ultra sound and the whole thing know comes apart. And then we can take it out and use this part conveniently so if we keep going. This is one of the things you notice is a little coarse build up here is a little coarse and you see he here and see one thing the buildup is a little fine.

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So, inside and you see something else here. This is the base on which it is printed and this is where actually 3 D printing became very, very popular. Not long ago long ago means that around fifteen years back if somebody were to make a part like this and try to show it to an injection molder and it is use to take you know I mean ages to get this and first of all somebody has to convert what he has in his mind to a standard 3 view drawing.

So, you have various I mean views saying what you call you have a plan view evaluation and side view and several sections views plus something which not many people like as an isometric view. Suddenly you need not worry about it if you know a little about how to use it as a package

you can make this on the screen and print it immediately a little romantic.

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But its real but you see here same thing. How well all this small details know like a small buses then we have something here little detail everything can easily be made here.

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This is a one of the interesting thing a schoolboy wanted to make a ornithopter but not using the standard what do we call Da Vinci mechanism saying why cannot we use it using gears and using other things. So, when he asked one of us and we said okay you tell us what you want and we will print it and it is a perfectly perfect to form means good to the role involute gear and this section is a rack section.

Then this whole thing is a rack section what you see is a pure rack means taped like this and then slowly as you go here you see here. Now you will see the full involute tooth profile and this was only possible using generating the form by CAD and then later on printing it using the first filament method. So in a way I am happy and I do not know what has happened of him.

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And in the initial stages this became very, very popular am I sure at this symbol no all of you will know this symbol and I will acknowledge this. So, we have the original maker bot maker bot probably brought this to our genuinely to our attention. But if you want to make a replica of something first of all you need to do something you see the replica.

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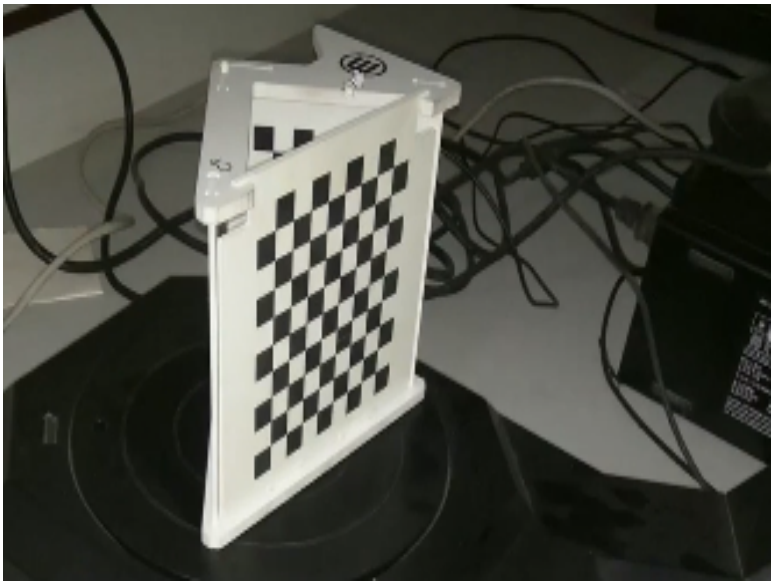

This is the device which is the scanner. And so you keep something probably I think this is the target which they have given and it is the maker bot target they have for the linearity and it rotates. And any object you can keep on it can be converted into a 3D file format and I will not say right now printing format is real otherwise it is a file.

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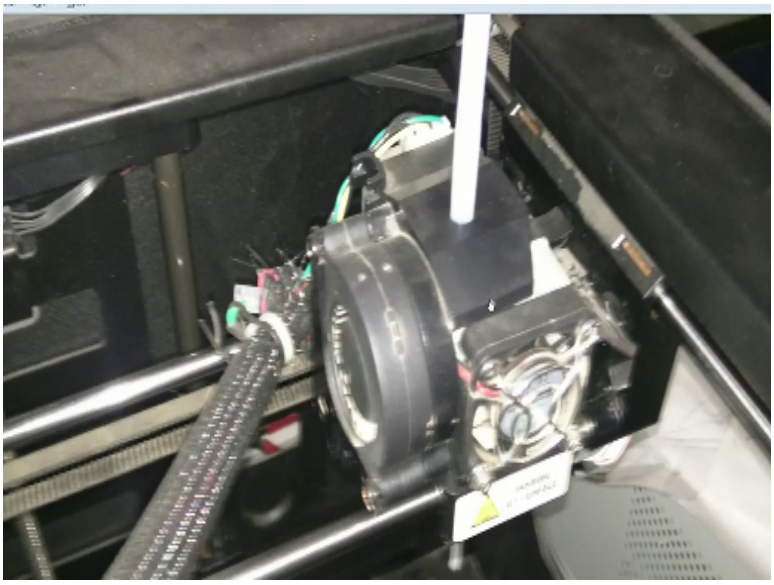

So, suddenly we are in beautiful company and the crux of the whole other thing is what I told you earlier It is lot like a hot melt glue gun. You have the build material flowing here and then you have a nozzle at the bottom and this nozzle sort of moves everything around. I will come back to it later about the actual mechanism.

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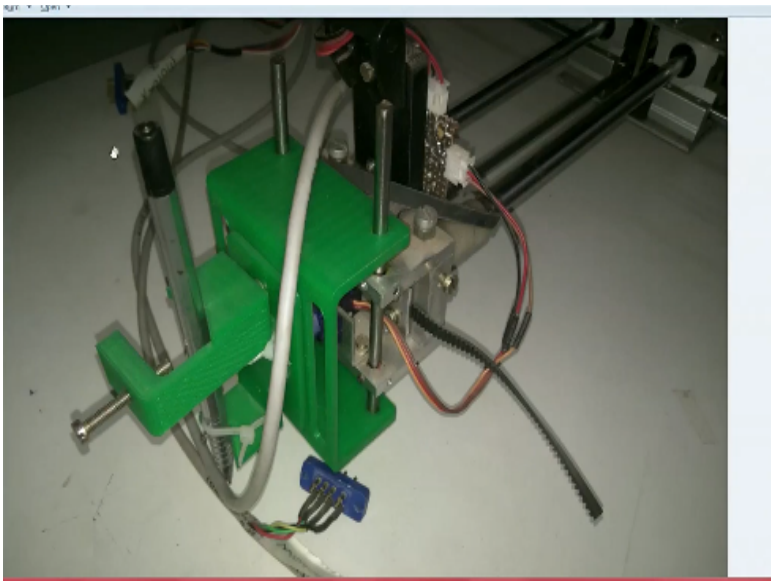

But if you can see here the whole crux of the whole thing is an xy table that is all anybody can make it and if you can make an x y table you can make your own 3D printer. So, this is taken from one of the students what do you call work and you will see there is a head here. This is used for various things in this case they just use it as a calligraphy pen you can have a font that pen right set for you.

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And it is not as if anybody invented it xy table is an old thing. This is taken from a type of a Gerber plotter which has been used for making printed circuit negatives so it has been there.

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I mean to make it short I will show you this is even simpler it is a kit and you have two motors and it moves up and down and if you can have a vertical thing.

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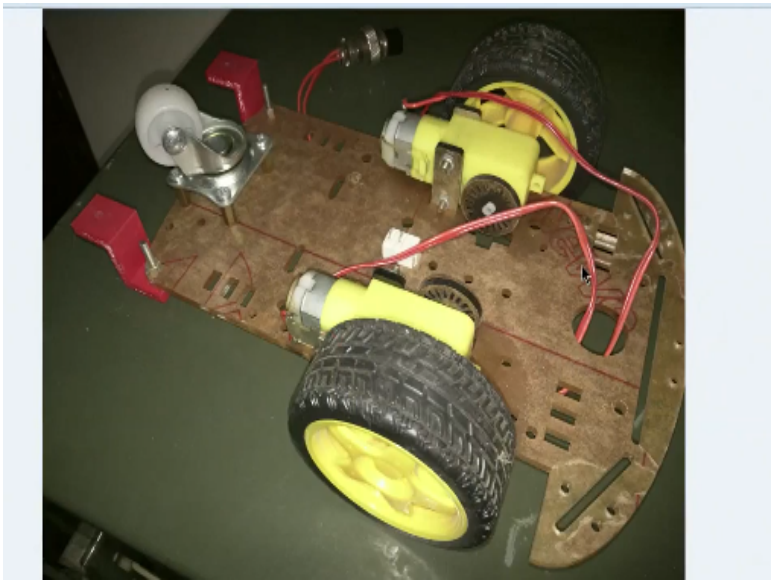

In layers you can do it and this is not a toy it is a serious learning experience and this one is a line follower. So, in a line follower you know what it is and you usually have three motors and the option there thing is whether you have a steering wheel or you have a caster. This is a caster and this whole thing If you see the base of it could have easily been made in plastic probably it is an acrylic in which all these openings have been made.

Except that in operations like this they use laser milling and laser cutting to make these jobs. So I

just go a little forward.

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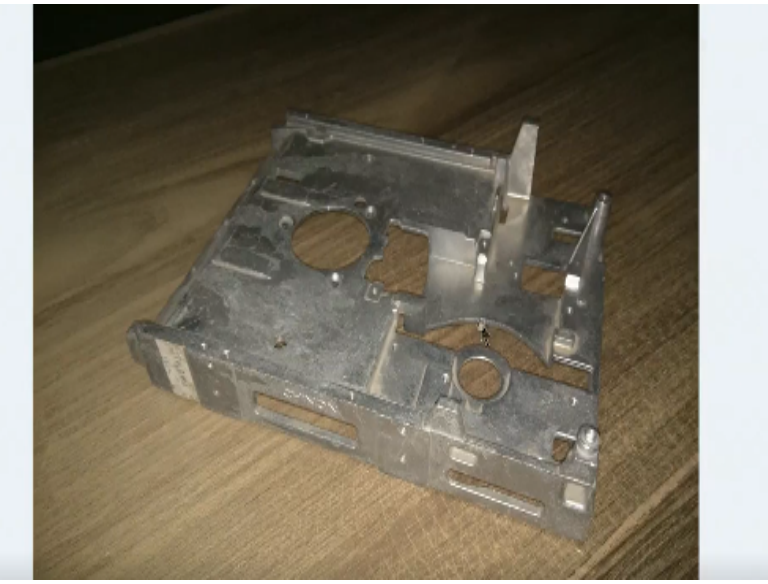

And things went on quite well and I think some of you know where it is and this is come from the original hard desk. I am sorry floppy desk made out of non-ferrous casting probably it is a zinc aluminum casting. And you will see the detailing and all so attempts have been made saying why cannot we print all this thing directly in things.

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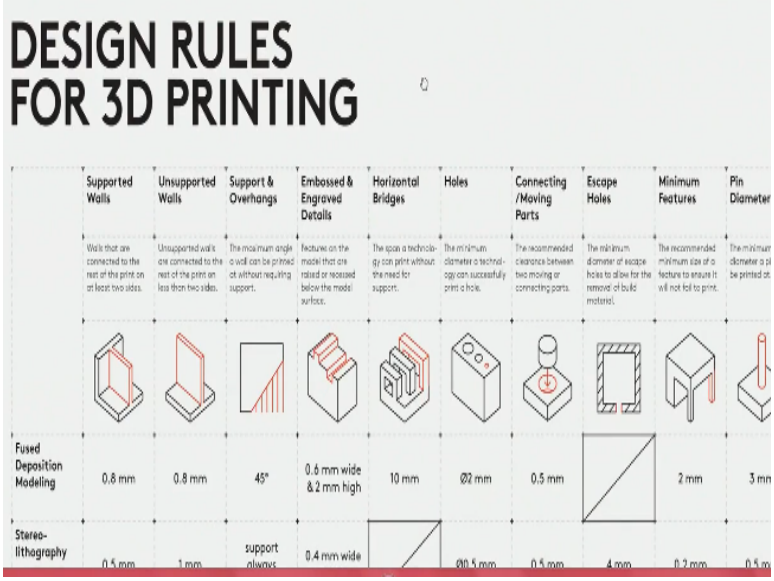

And as things have progressed slowly, slowly the issue of design rules came about saying in the case of you see here at the extreme left position no we have all these fused deposition, stereo lithography, laser sintering, material jetting and binder jetting and all saying how much should be

the feature detail supporting walls, unsupported walls overhangs and all this know several and this are actually is not the rule as such as much as guidelines.

Depending on your interest you can play around with it.

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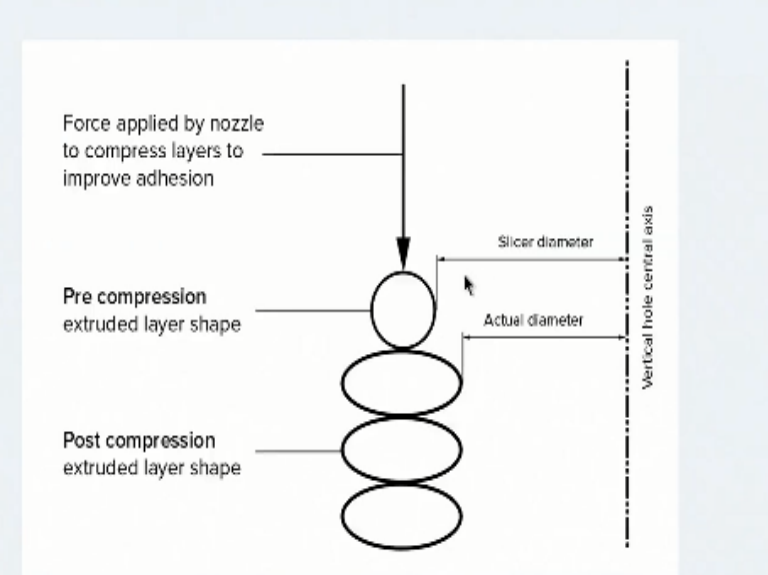

And initial stages people did not know too much about these things can you see here and now if you see that filament to what we call, just fuse and deposit does not really build up as we think as we are. We have seen here we have all the stuff and what is layer shape and what is the sliced diameter, actual diameter. There is still a lot be learnt about it I just showed it to you from at random thing so I thought I will just show you all these things.

Now if you go to the now I will loosely call it the internet. If you search on the internet you get multiple hits I just wanted to show you and you see here.

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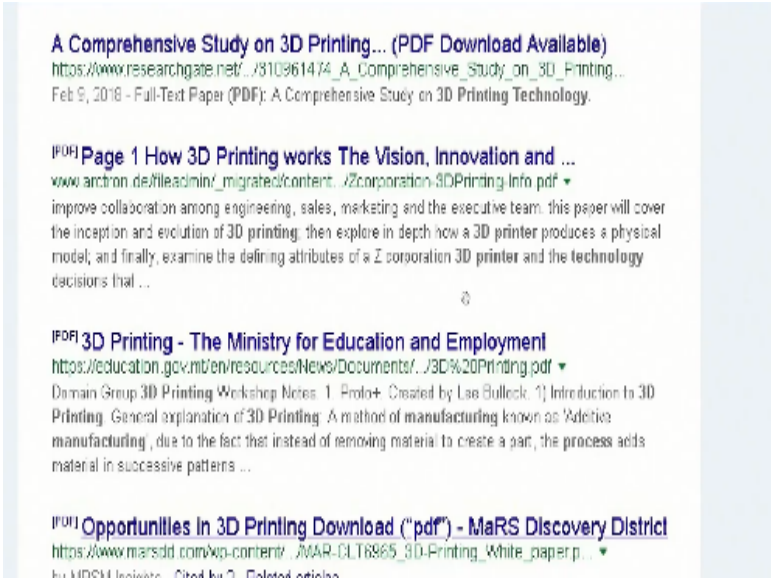

I just loosely gave I did not say Alexa give me a 3D or tell or anything I just typed actually and little about 3D printing and you get lakhs of hits now. Study on 3D printing and how 3D printing works and minutes and so on and so on. Now printing technology introduction to 3D printing and all that is fine for reading but unless you make a actually a part and then try to build it.

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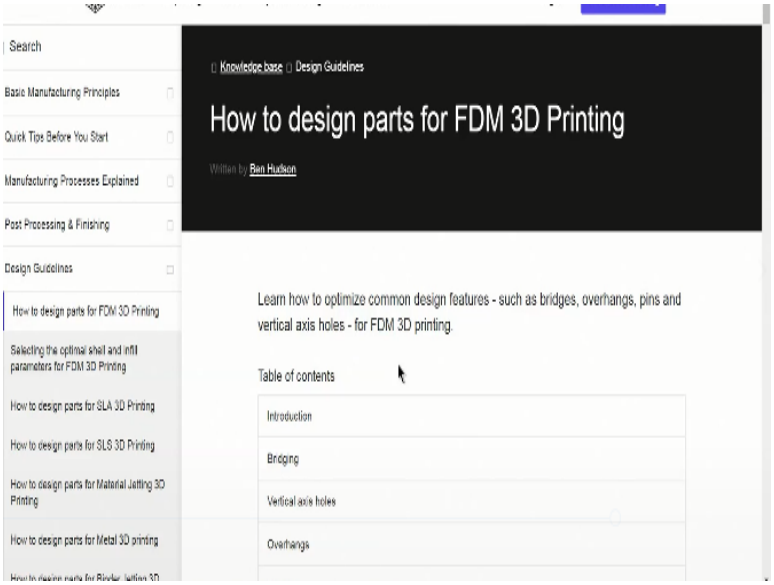

As in this we have a beautiful thing about how to design parts for FDM fused deposition modeling by what you called default this has become. So, lot of stuff about what is an introduction. And what is the bridge and how do we build these things and this come only by practice. Practice and practice, how to do vertical axis? This is taken from these things know.

And then What to do with overhangs you see here is something which started here.

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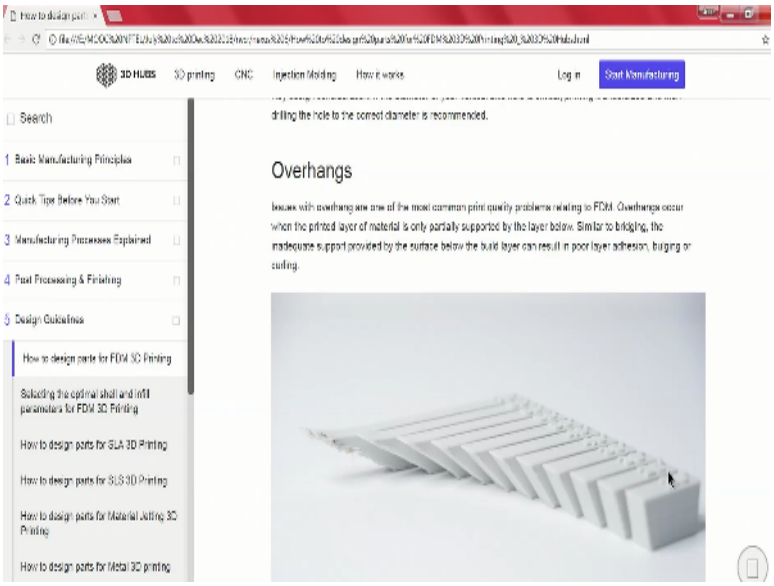

And coming up so much as you start making and you see you cannot build anymore here it is reasonable here they granularity should start after about maybe 10 degrees maximum and then by the time it reaches 60 degrees it practically it is no usable at all. The things like this and then what to do with all these things.

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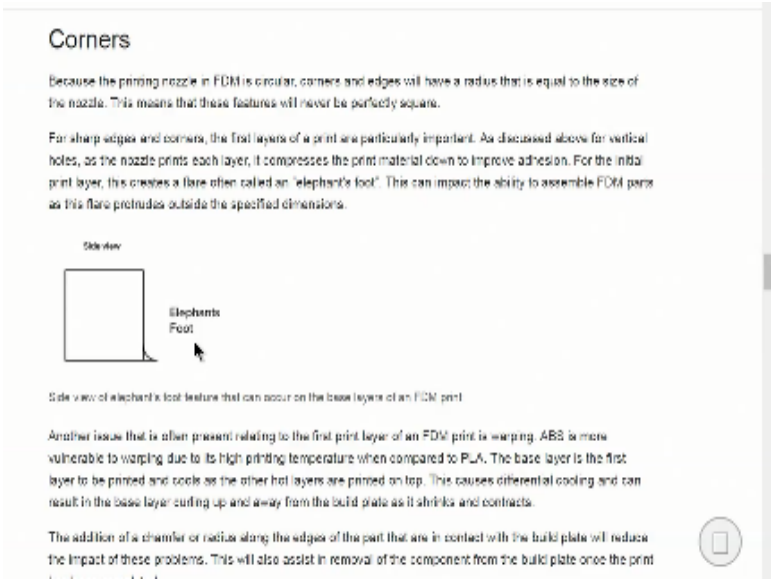

So, what is called simple filleting so it has got a new name for adjacent corners. First layers are particularly important as discussed above for vertical holes so on and so on know it compresses the print material so what is called elephants foot and it has to be created. So, we have this stuff

about how to build things so it is not automatic as if you somehow make a beautiful 3D model and things print on itself.

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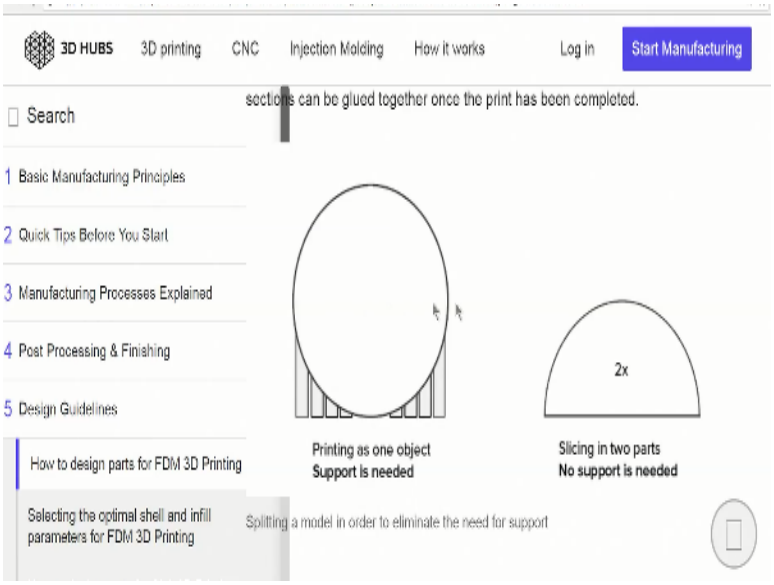

This is the most critical thing you can think of If you have to take a circular part and try to print it like a cylinder similar to what I showed you shape memory I think. It weights lot of support material and often it leads to errors. The same thing is it possible for us to do something about it saying if you build it like this is probably no support is needed like when we build an arch as you start building an arch things get easily built in it and this I have already shown you.

So, things have been very, very conveniently made.

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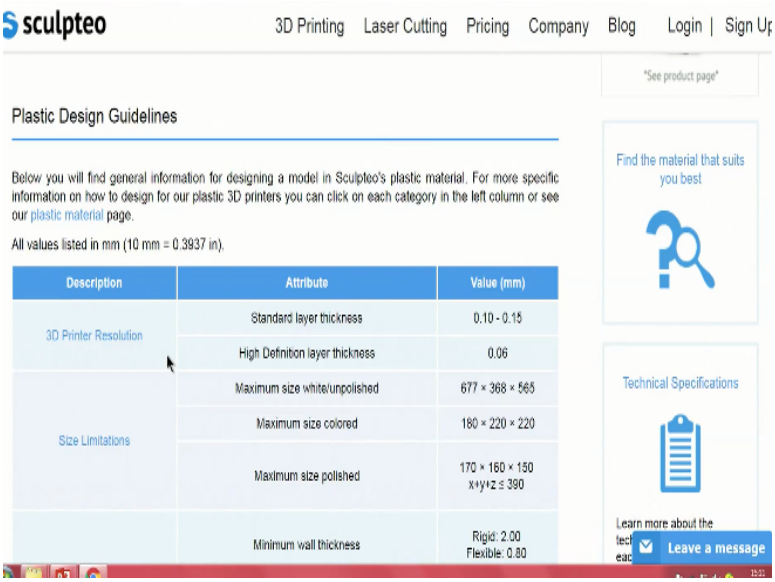

And we come in to more and more what you say interesting things saying directly material is available on and the design guidelines how do you do you know plastic design sorry a lot depends on 3D printer resolution. What we assumed is automatic and it is not automatic and it is varies with parts and these things I thought this what we call I will try to stress a little and then try to things like spacing and clearances, interlocking volumes and piece assembly.

And so something related to tolerances and how to deal with flexible plastics and these suddenly have become very very popular only thing what you see in what we called commercially literature is saying If you think it we can make it. And I wish things were so easy and it is not so easy if you can think we can make it that not at all that easy. So, I can only say welcome to the course and who will be benefited somebody who is keen learning little about it.

And the good news is that there are printing services that are available just like earlier you could take in even today know you don't need to own a printer because printer is given away cheap but the cartridges are expensive. Over here in India right away we here in table top what you call this inkjets and all may be 5000 but the cartridge color set cost 1000 rupees and it just dries up it has an inbuilt time bomb and kill switch automatically it goes.

It means if you do not use and if you open the seal it looks like it is 3 to 6 months everything you know shows empty. Hence your need not own a printer same way a lot of open source solid

model or 3D packages are available. So, if you somehow learn how to use these packages innovative and it will be very convenient for you if you can make a solid model and pass it on to one of the printers you do not even need to see the printer.

Just give it to him and beautifully I have a key chain so I was thinking the other ways know. Saying why cannot I try something why cannot I hide it and why cannot I have a LED light and all these we can think of a part like this it is very easy to be made when I pull it can be like this when I do something and slide it the whole thing can probably be hidden inside it. Right now I have kept at the back.

Can I make a part like this or can I make it like a pouch side is open? and I slide it in and then it goes inside all this if you can think of a design and probably follow all these various considerations you can post it and you can send it on to us and not on social media. But you can send it by a regular paid e-mail and you can have the part mailed back to you. So, as a trial thing I think it is worthwhile thing. I think all of us know should probably try it and will be better of that.