Oral Biology
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Lecture - 26
3-D Bioprinting

Hello everyone, I am Dr. Shree Rengalakshmi and I am an orthodontist. Well, today I am going to talk to you about 3D printing. It has various applications I must say and recently we have found a lot of applications in oral biology front. But, before that what exactly is 3D printing? It is an additive manufacturing process.

So, what does it do? It prints 3D objects in real from a digitally designed that is a CAD file, we call it Computer Aided Design file a CAD file. So, what applications does it have to us well? In the current scenario, the technology has been used in manufacturing, medical, industry and social, cultural sectors. Recently, this is being used for producing a range of medical items, prostheses, spares and repair.

From NASA to the food industry transportation, industry, fashion, health, education you name it and 3D printing has opened an array of possibilities. Well, is this concept very new? Definitely not. This was started relatively early in the 1980s when they introduced the term additive manufacturing and we have 10 different types of 3D printing technologies. So, the various 10 different technologies are FDM that is the Fused Deposition Modelling.

Then, SLA that is the stereo lithography technique then, the DLP Digital Light Processing, then SLS that is the Selective Laser Sintering, then we have MJ technology that is the material jetting, DOD is drop on demand, SBJ is Sand Binder Jetting, MBJ is Metal Binder Jetting, DMLS technology is Direct Metal Laser Sintering and EBM is Electron Beam Melting.

It is worthy to note that DMLS and EBM techniques are used for metal printing while rest of the other technologies are used for resin printing. So, in the resin printing technology we are going to focus on two different techniques. That is DLP, digital light processing technique and SLA that is stereo lithography. Because, we have through time

and through the time it has been realized that these two technologies are better for resin printing.

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Now, the printer next to me is an example of digital light processing technology. So, what does this printer have? First let us know, what are all the constituent parts of a printer?

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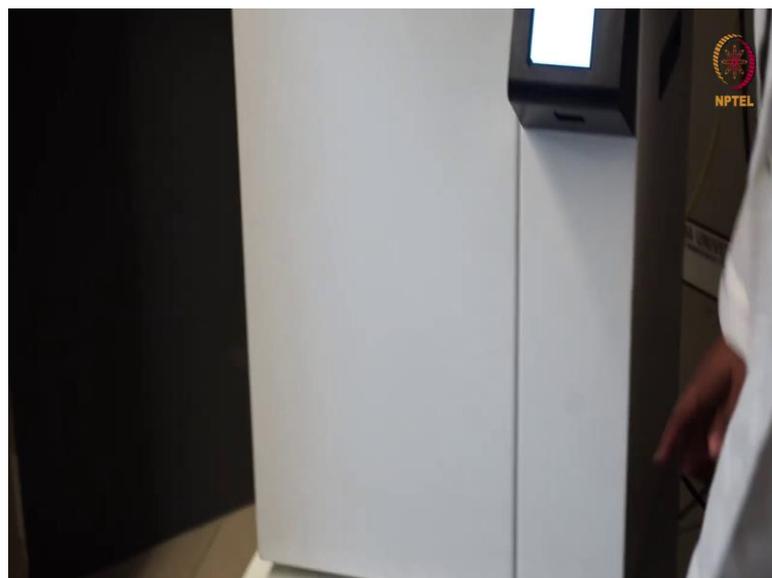
So, you can see that, this is the print table it is mounted on a table.

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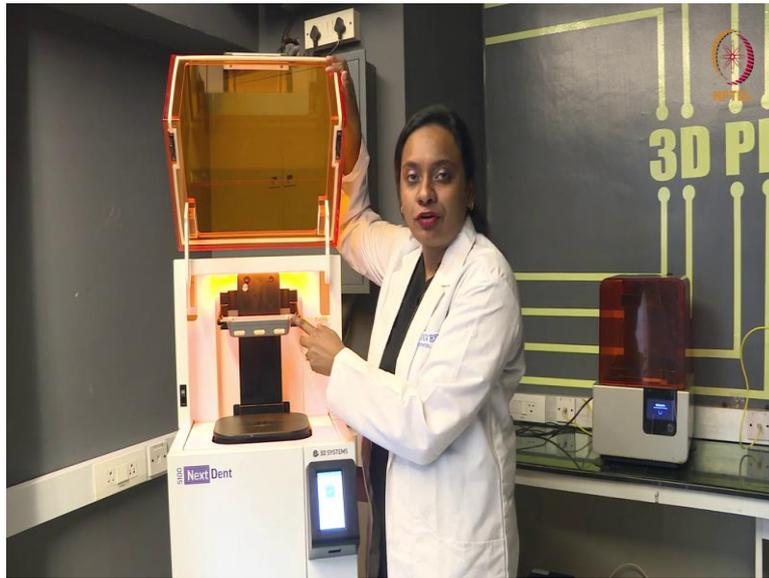
And then, you have a print platform.

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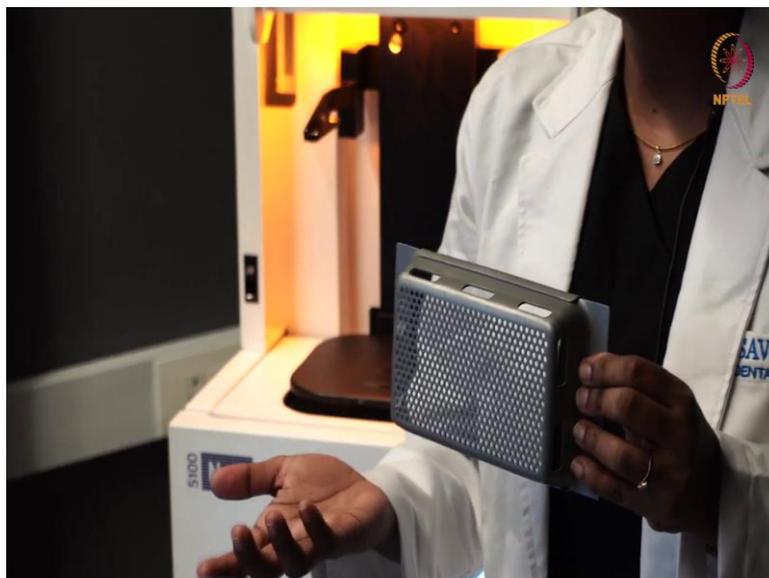
So, what is the use of this print platform? Whatever objects that you are designing is going to be printed on this platform? So, this area designs this will determine the dimensions of your print.

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Next you have the resin. So, this is the photo polymerizing resin. So, you can see that this is the resin tank in which the resins are stored. So, there are different resins for example, model resin which was used for laboratory purposes, surgical resins which are used for printing of body parts, then we also have flexible resins with in which we can print flexible structures. So, we have a lot of other resins also available for the printing.

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So, before starting we should ensure that the resin platform is full with resin and the printing bed is clean. Having known this basic about this digital light processing printer. Now, let us focus on the SLA printer that is the stereo lithography technique printer. This printer is an example for SLA technology printer.

This is also very similar to DLP and this has a print platform which is detachable like in other printers.

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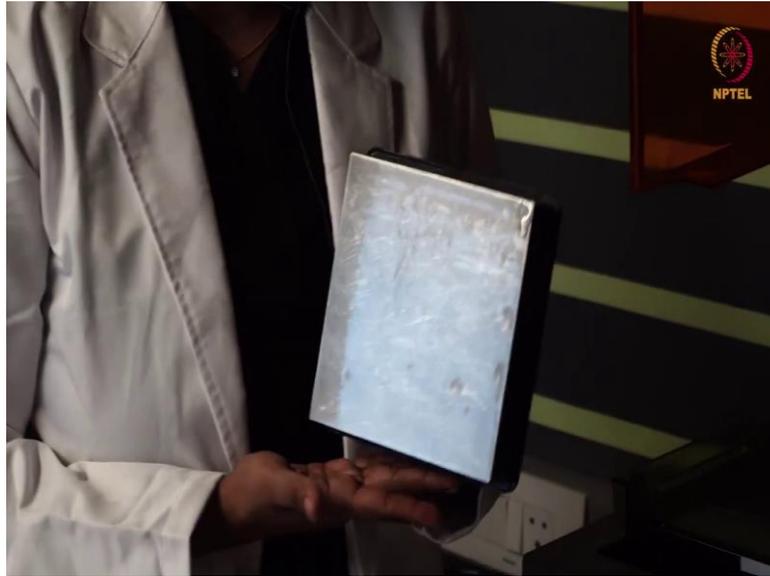
So, this print platform will determine the dimension like of the objects that you are going to print.

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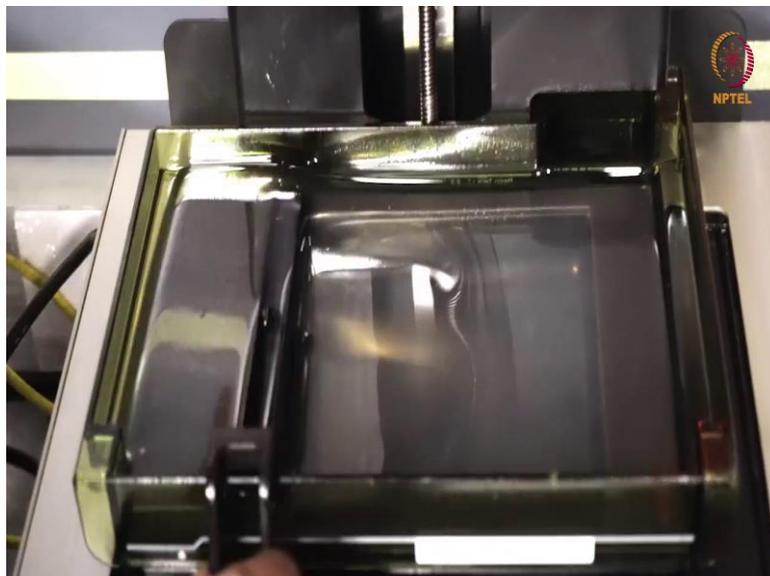
Next you have the resin bed, this is also detachable and this resin tray can be changed usually we have one resin tray per resin.

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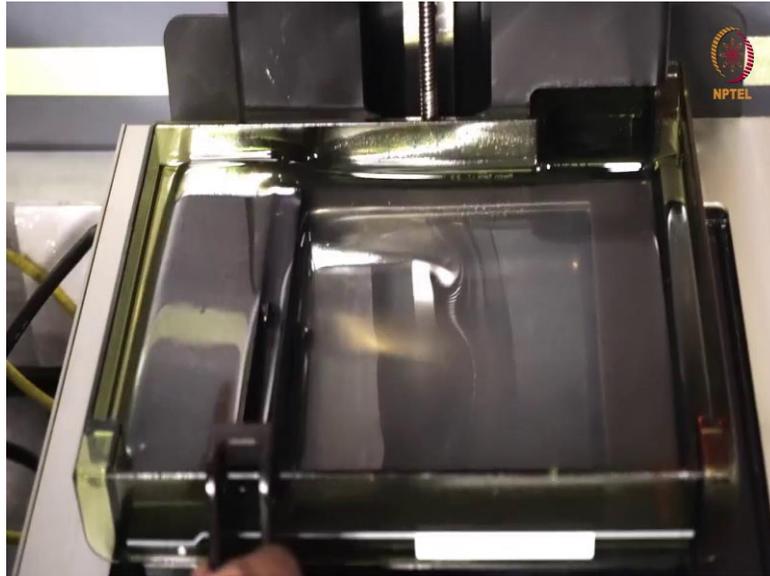
And the resin which I have used here is a clear resin. So, if you want to print any object in a transparent material then, clear resin is the resin of choice. We all know that there is a plethora of 3D printers available in the market.

So, how do you decide which printer you want to buy and what are the factors that come into picture when you are wanting to buy a printer? The first would be the printer cost. So, based on your budget you have to finalize which printer you want.

Next, the print quality and then, you also have to think about the print speed how fast do you want, because we have printers that can print 3D objects in less than 10 minutes and we have printers that can take hours to get the same file printed. So, speed is an important factor to keep in mind before investing on a printer.

Then the print capability. So, what are all the printer can print for example, you have resin printers in that which all resin is compatible with the printer even that is important and then, the practicality. So, when you install a printer do you have sufficient space how much of work space is it going to occupy and then, what is your expectation out of the printer. Because, you should know the guidelines of the printer to use it and what quality it gives and what size of the print gives.

So, you should also have knowledge on the size of the platform bed. So, you will know which object can be printed. So, next I am going to show you what goes behind the process of 3D printing. First, let us imagine I am going to 3D print a part of your body does that sound exciting to you.

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Hold your breath. If I say your upper jaw can be printed and even your lower jaw. How cool does that sound.

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Yes, we also can print your teeth the whole set of teeth and this is being used for dental purposes. So, where do we start? First, we start with the process of acquiring a digital capture. So, we usually use scanners to record the objects that are to be printed. So, this enables us to convert the physical object into a digital file.

So, the very first step in this 3D printing process is to obtain the digital scan of the object. For intraoral cavity, we have intraoral scanners available to capture the scan of the oral cavity. Now let us see how that is going to happen. So, now I am going to show you how to record the intraoral cavity.

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So, we use intraoral scanners and this is the scanner to capture the images of the intraoral cavity and this is converted into an STL format.

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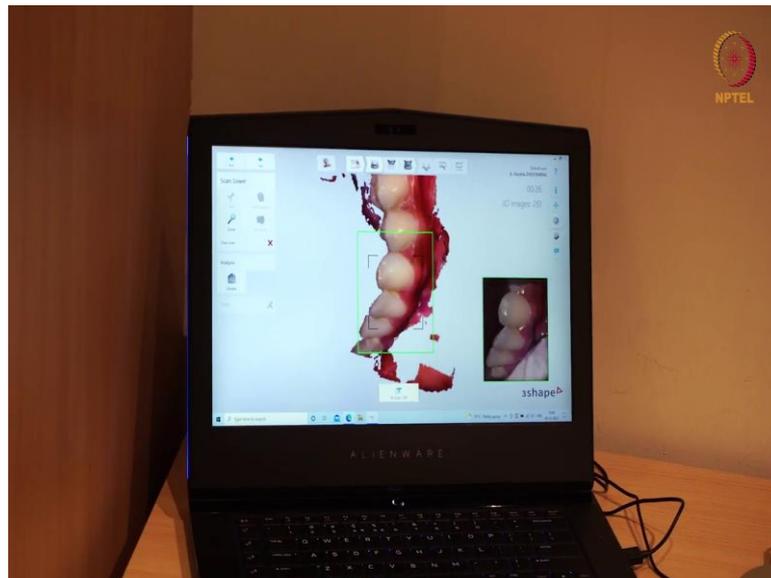
So, using the scanner.

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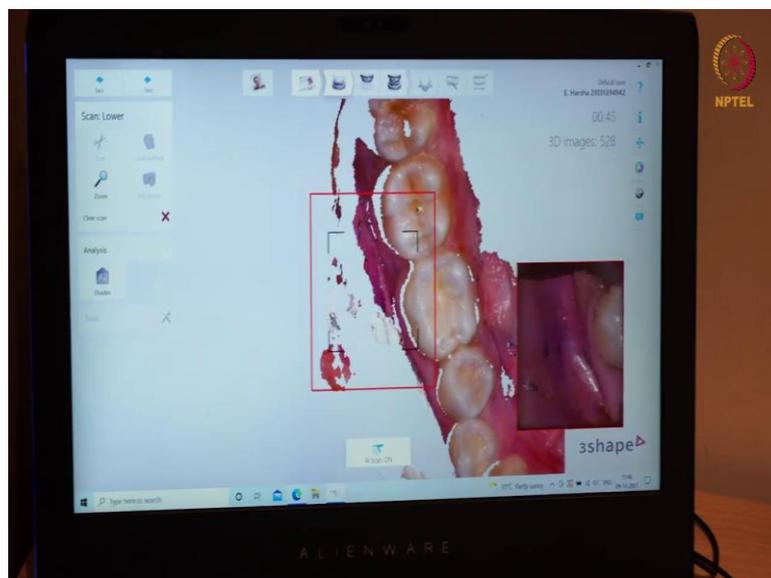
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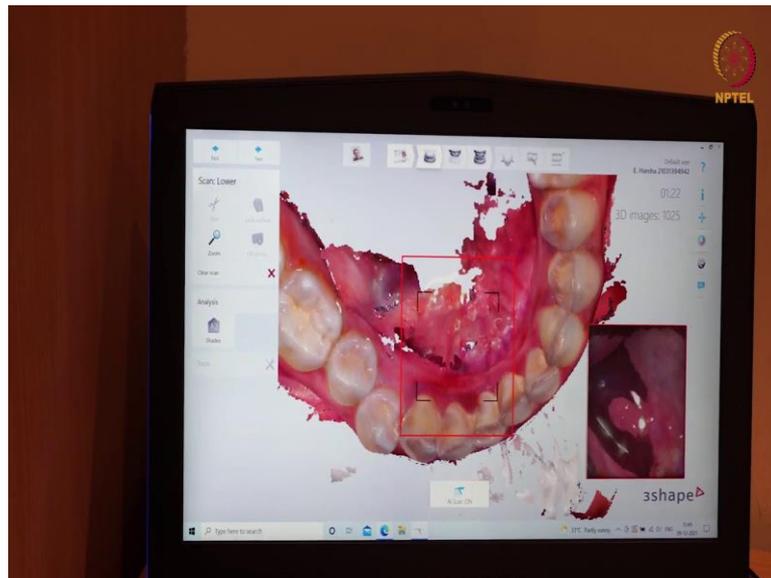
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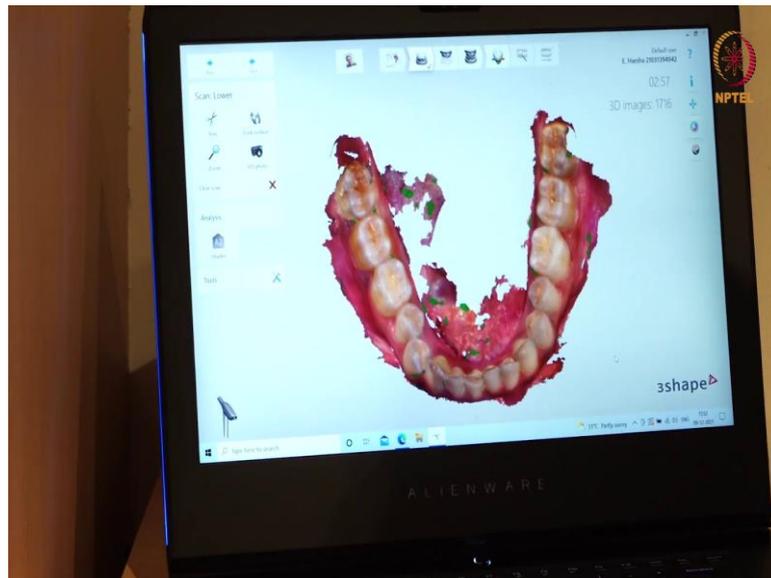
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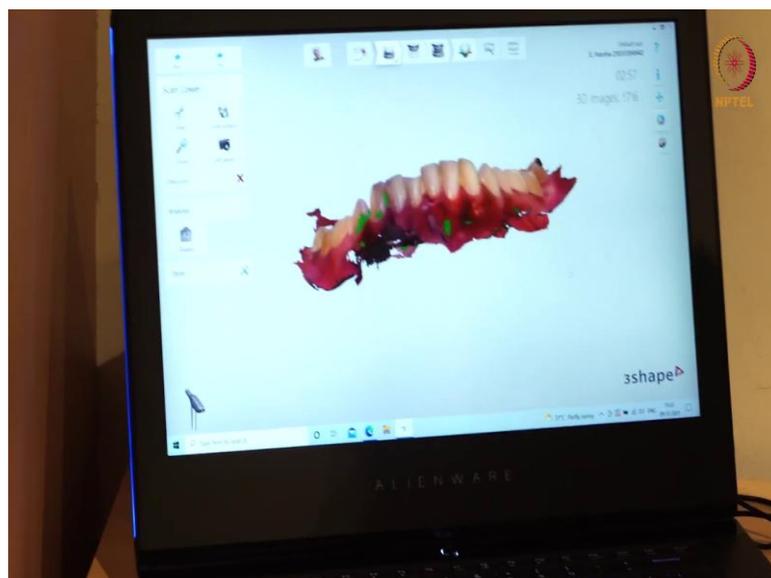
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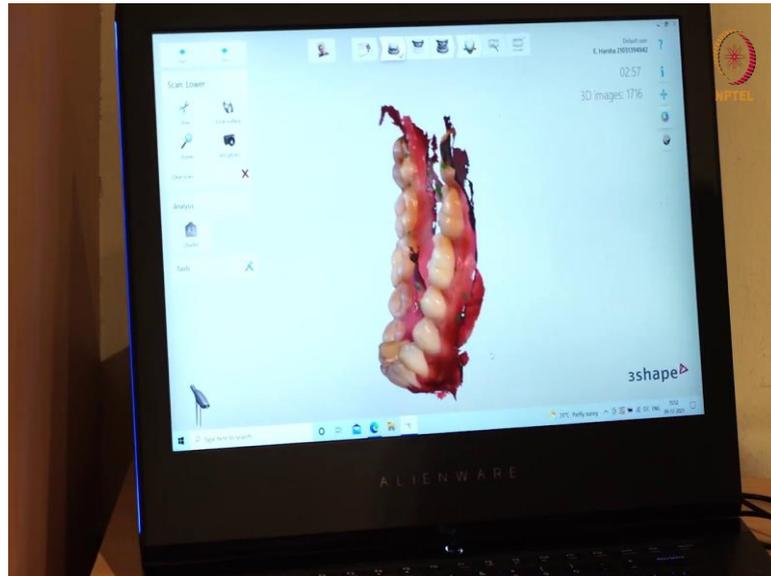
So, now you can see that the entire intraoral arch has been scanned. So, this can be exported into the STL format and then, we could use it in the designing software. So, once the scanned images are procured they are converted into an STL file and this STL file is loaded onto the software where we make some final adjustments.

Once that is done, we print it and this is the final product of the scanned teeth. Next, I am going to show you some of the other applications also. For example, when we are doing any surgical procedures we can have surgical templates that designed by the software and we can print.

So, what happens this guide acts as a template for the surgical procedure and it ensures there is more accuracy and precision? So, let us see the live demonstration of a surgical template printing.

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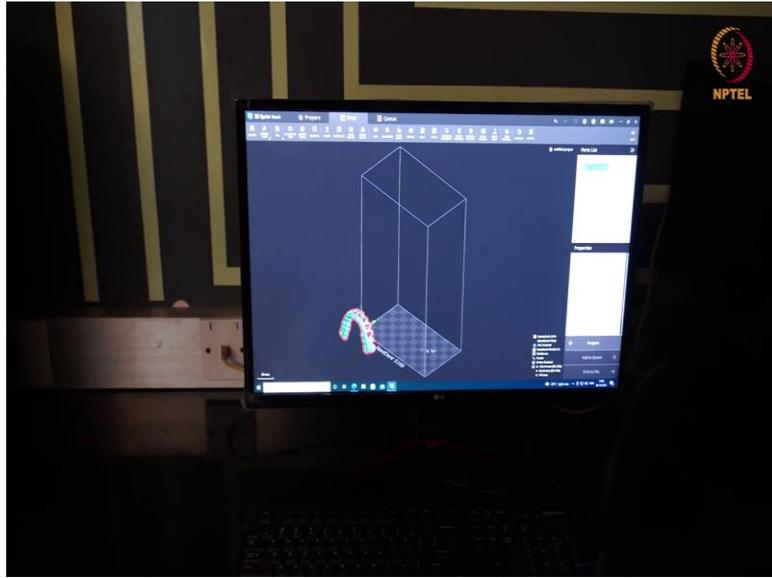
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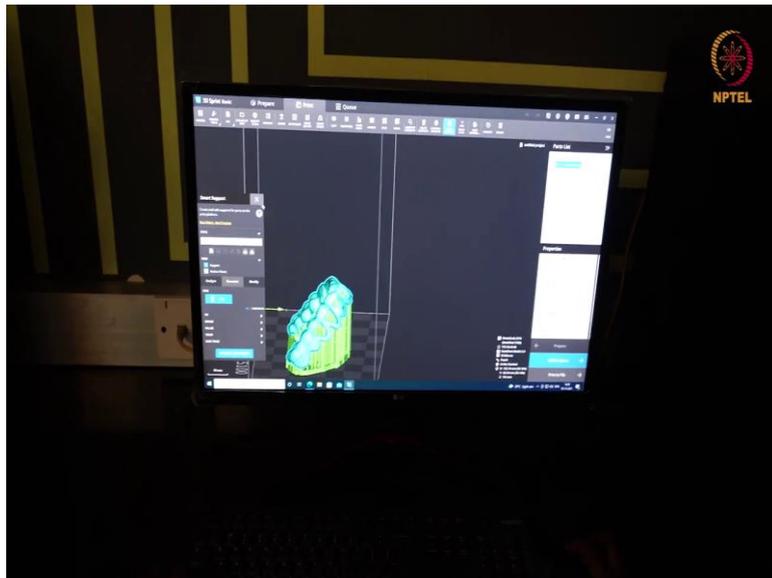
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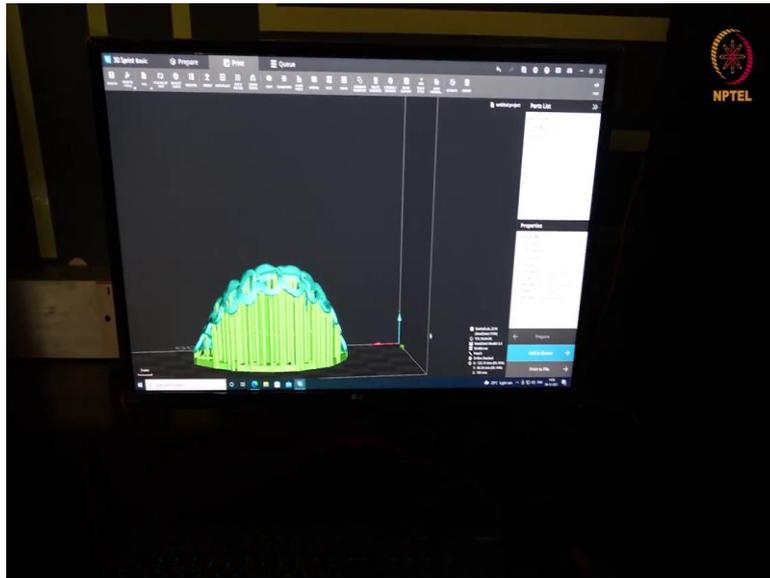
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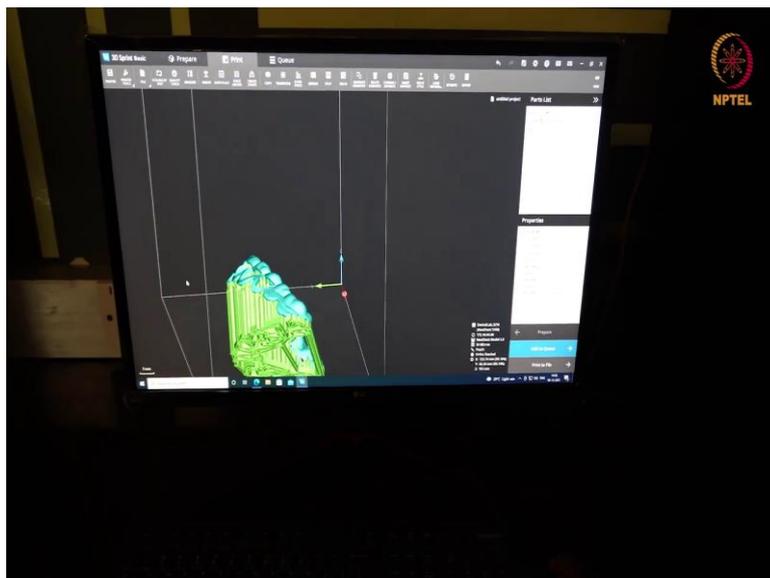
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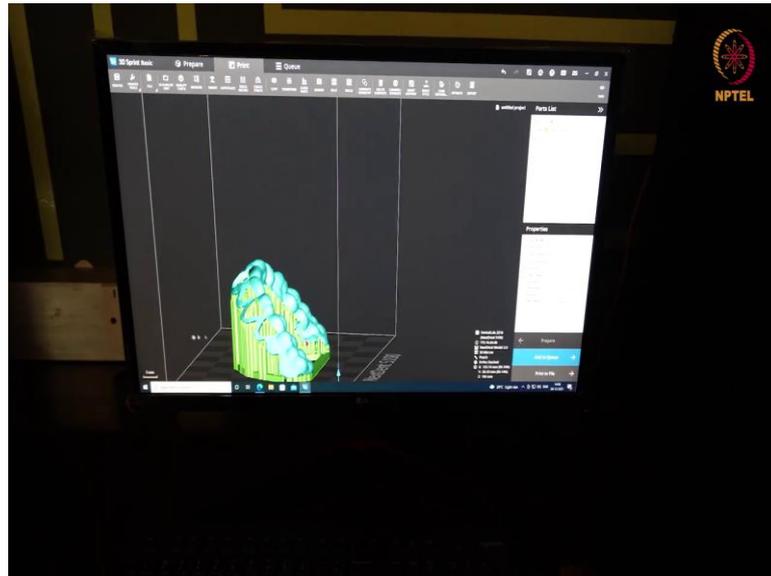
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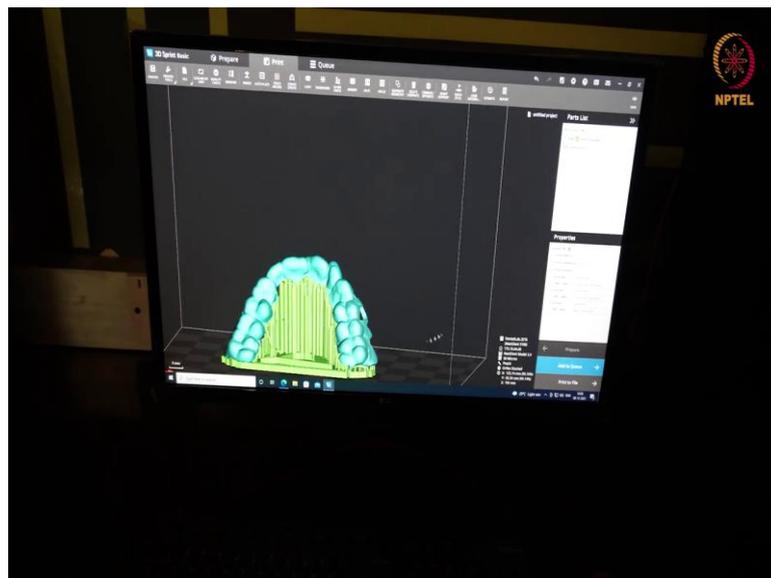
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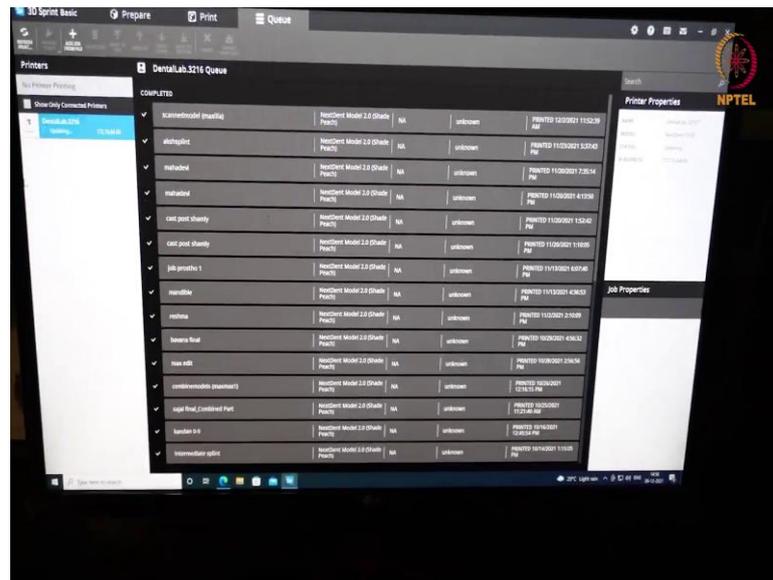
So, now you saw we have designed the surgical guide. So, it had lot of supports to enable the 3D printing. Once we prepare the design and we export it to the software you can see the same here.

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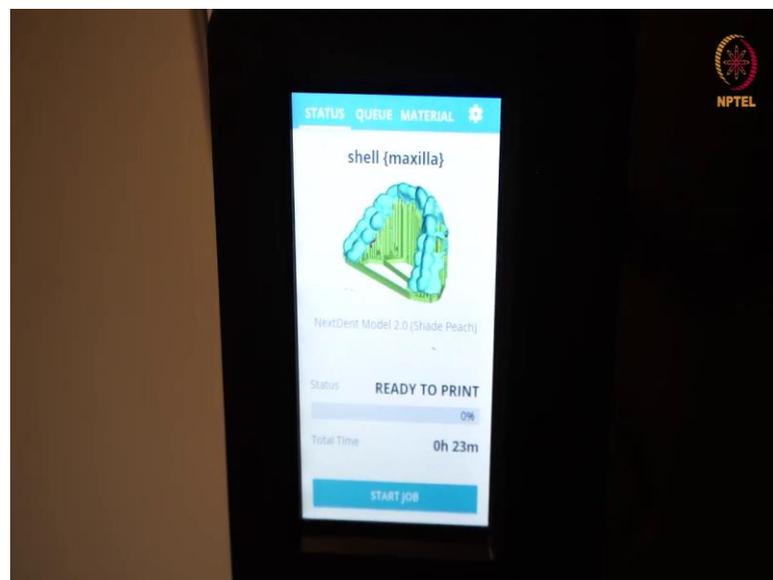
So, you can see that this is now ready to print. The surgical template is ready to print and you can see it hardly takes 23 minutes to print. But before that you should ensure the print platform is clean, how do you clean? You clean it with isopropyl alcohol.

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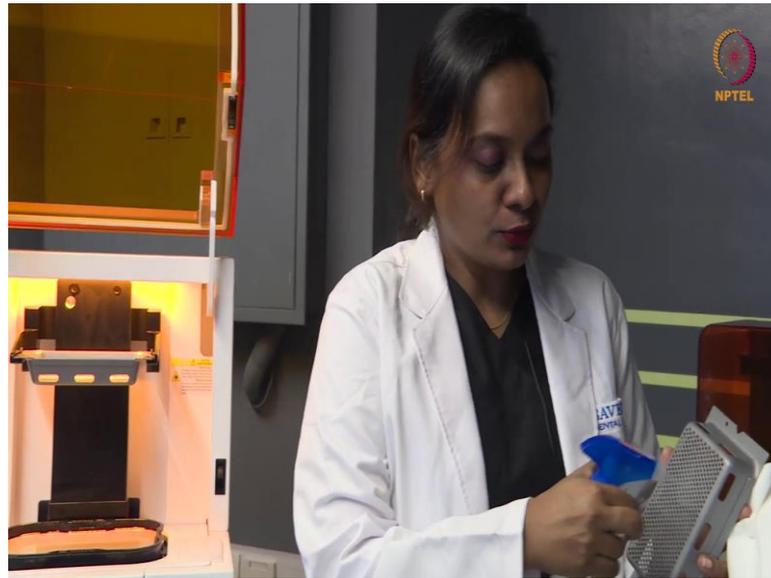
So, use isopropyl alcohol to clean the print platform and make sure it is fully dried before loading it. Once this is completely dry and clean then it is loaded here.

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Then next step is to ensure the resin is properly stirred.

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Now, you can see that the resin is in layers. So, I have to ensure it is thoroughly mixed before starting the print. So, all these factors will affect the quality of the print. So, now you can see that we have achieved a smooth texture of the photo polymerizing resin. So, this means that we are ready to print.

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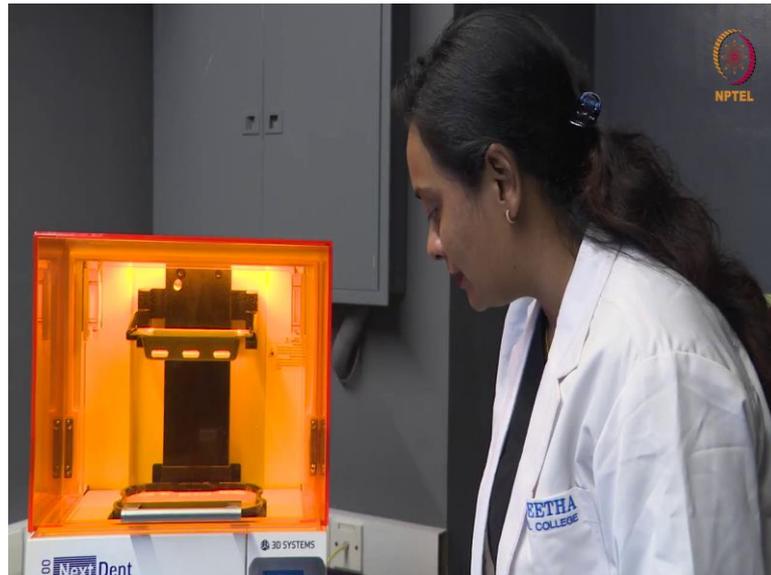
So, once this is uploaded we start.

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And then, the resin which we are using has to be scanned here. This is the foolproof system, because any outdated or expired resin will not be accepted by the printer. So, once the resin is identified next we have to double check whether the platform is clean and the resin is stirred and the printer is stable.

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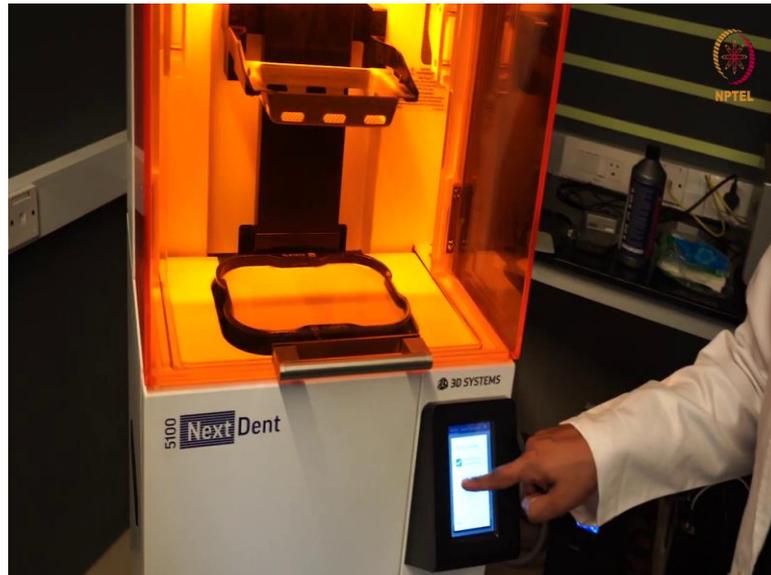
So, the print platform is empty and clean, the resin tray is full and we have ensured the resin is completely stirred.

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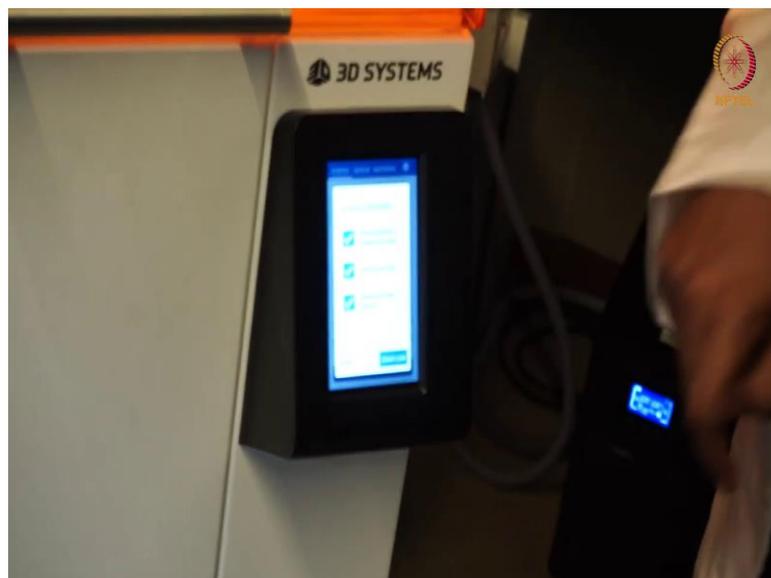
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So, now we give start job and in another 23 minutes you will see that the surgical guide will be ready printed.

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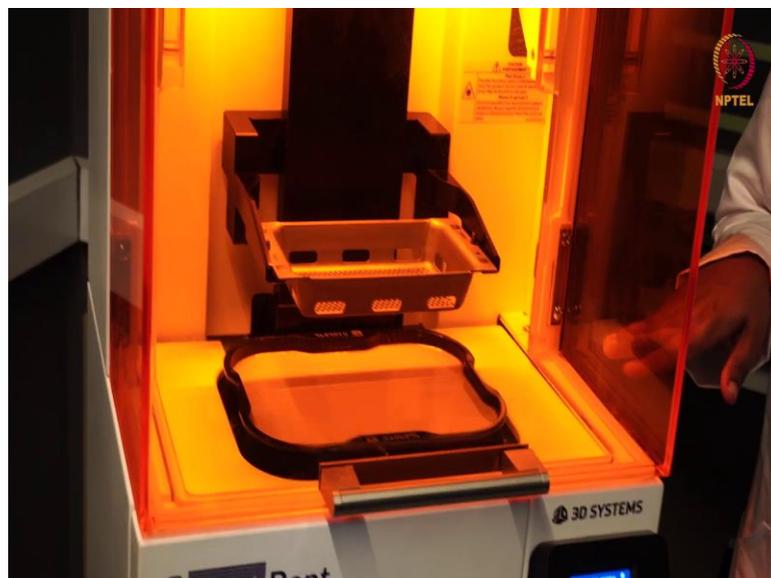
Now, you can see the platform is moving down and then it goes and dips into the resin and there it starts printing it layer by layer.

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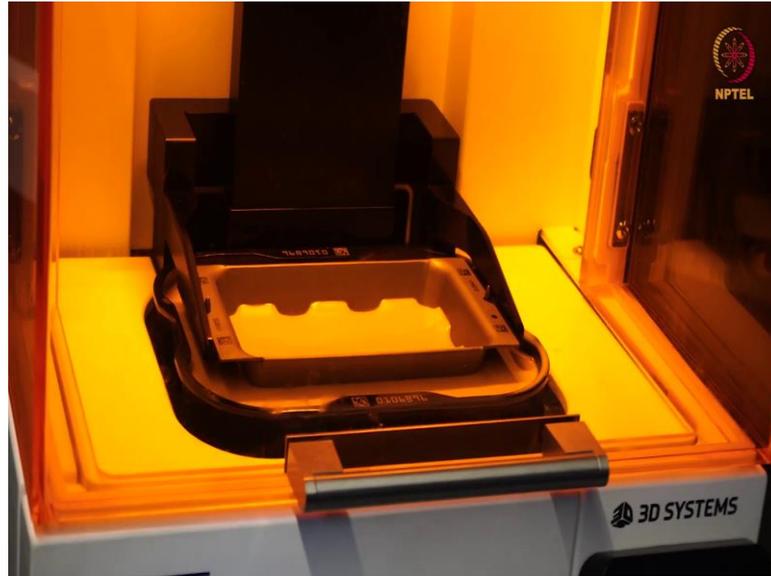
So, in order to understand the DLP properly first we should know how the SLA technology works. So, the SLA also starts working by lowering the built platform into the resin fill tank with only one layer of height left between the bottom of the tank and the built platform.

Then, the galvanometers takeover. So, these are mirror like components used for navigating the laser beam of a SLA printer to the bottom of the tank. And then, with the help of G code galvanometers navigate the laser beam in a path which represents one layer of a certain part. The laser then cures the resin making a solid layer of a part.

When one layer is complete then, the built platform moves up like how you can see here one layer in height and the process is repeated until the part is complete. Now, having known how this SLA works, what is the big difference between the SLA and DLP? Well, in DLP 3D printer the light source is specially developed and that is why this is faster.

So, in SLA the laser had to individually cure the resin in a point to point technique whereas, in DLP the screen flashes an image of a layer all at once thus all points of a layer can be cured simultaneously.

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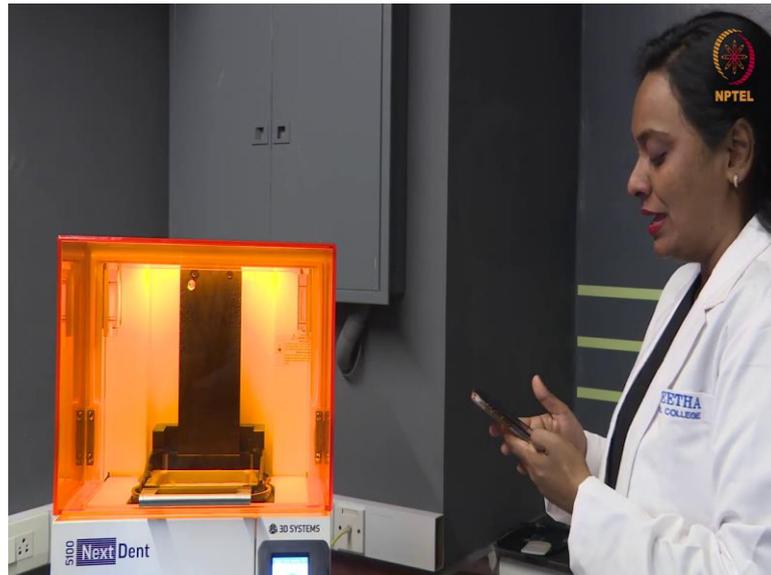
In this way the print speed is increased in comparison to SLA. So, here you can see that the in the DLP technology the printing happens in less than 25 minutes. Whereas, the same guide would have taken minimum 3 hours 15 minutes with the SLA technology.

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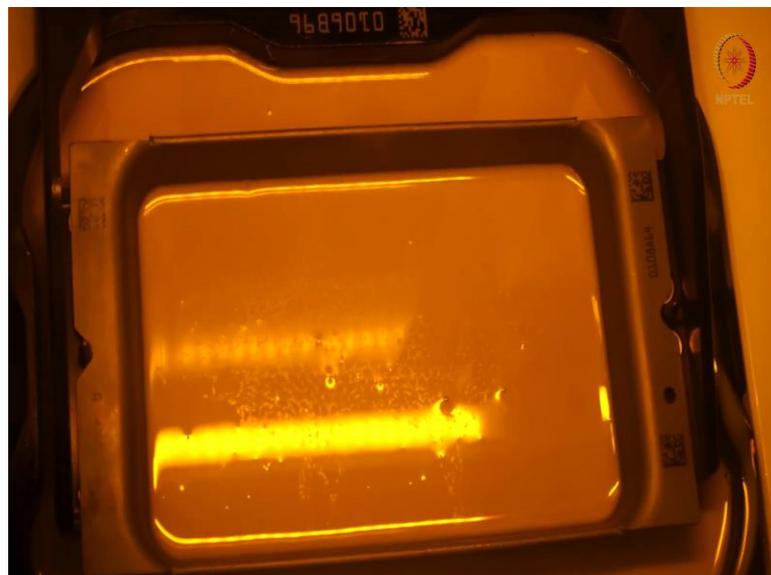
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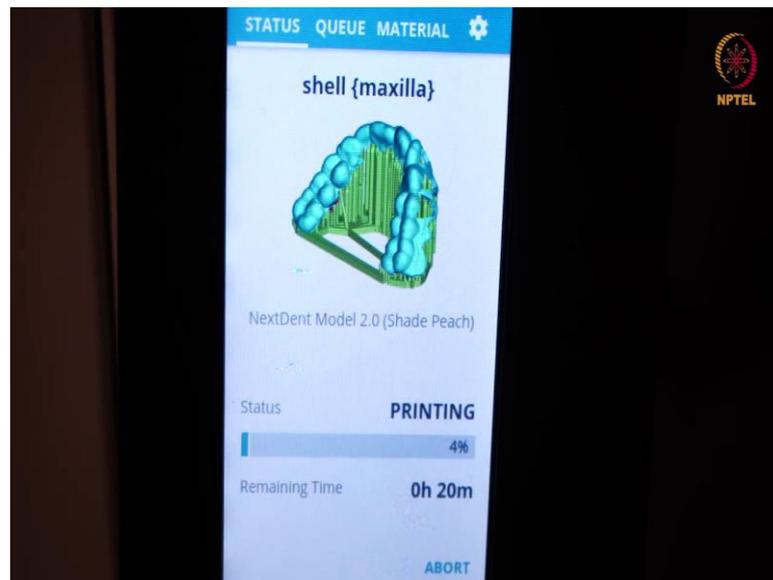
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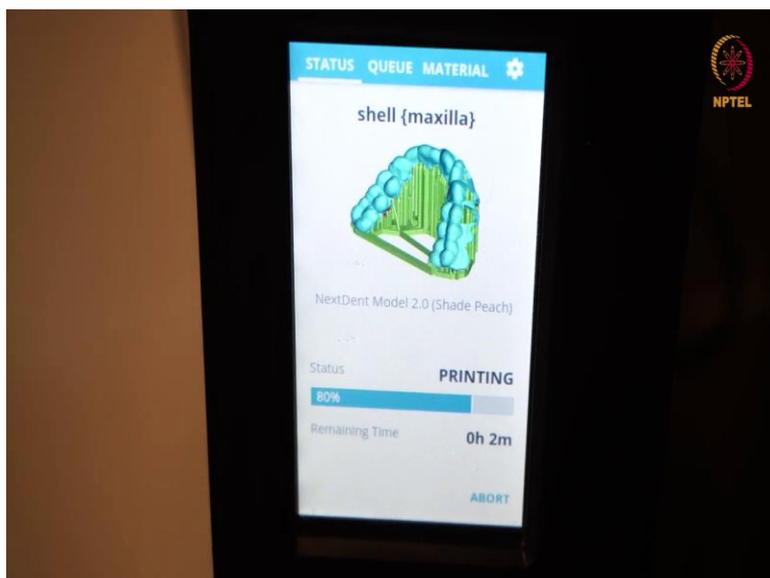
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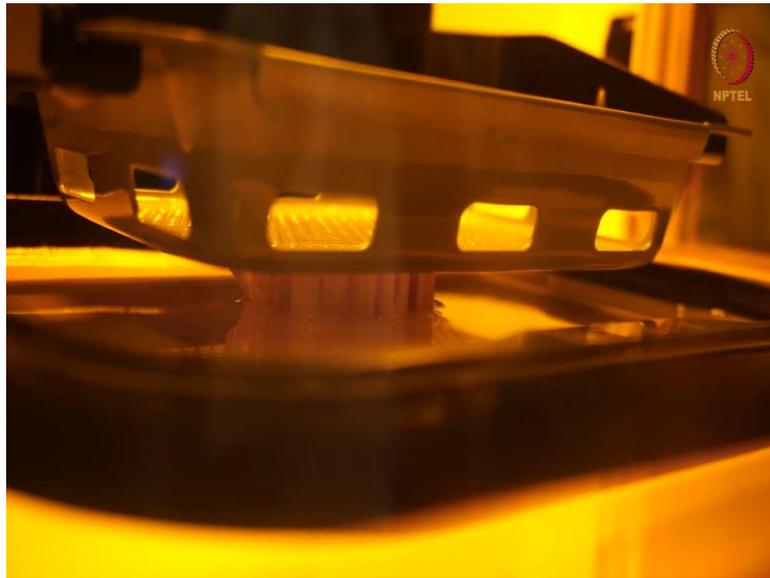
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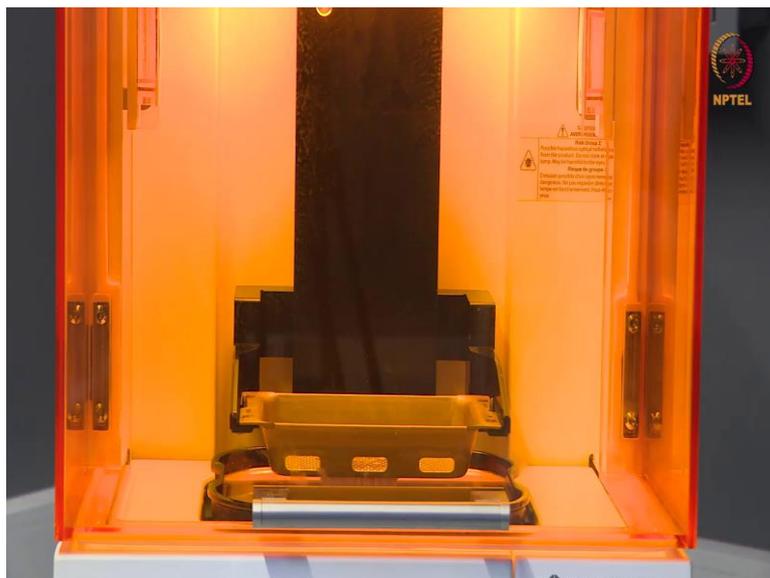
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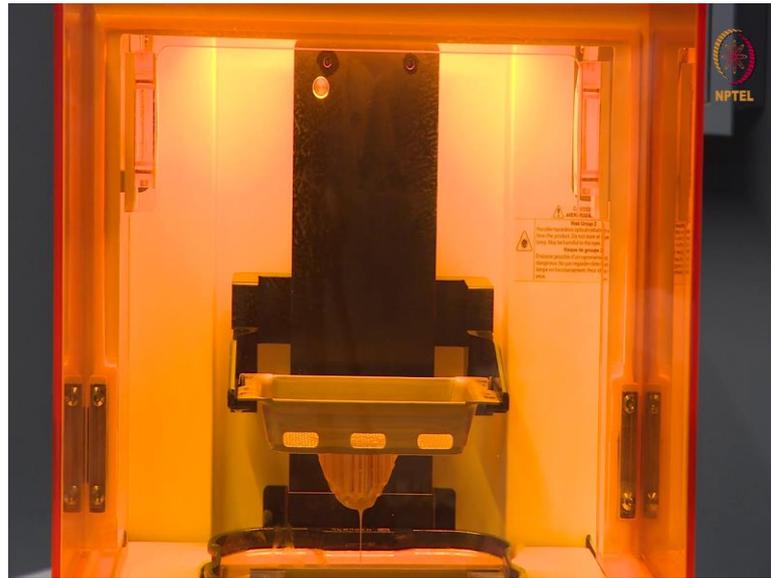
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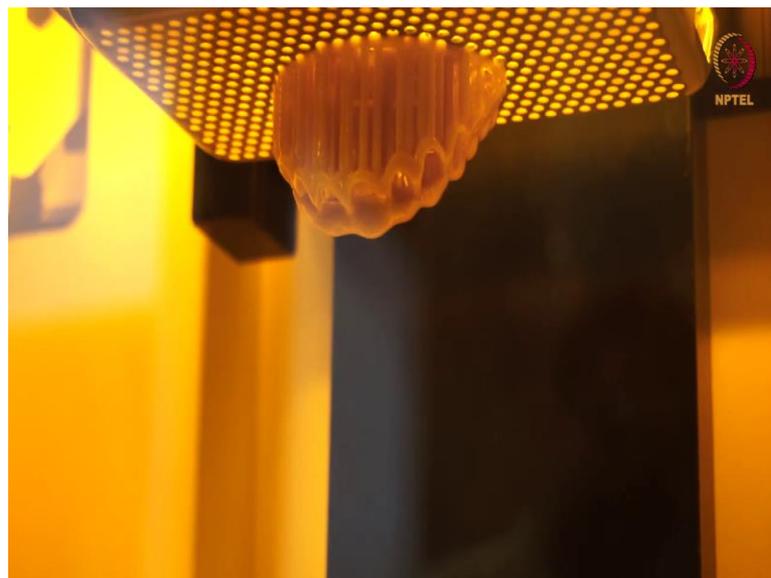
So now, you can see that the print is completed. So, in less than half an hour we have attained the surgical guide. Let us see how it looks like?

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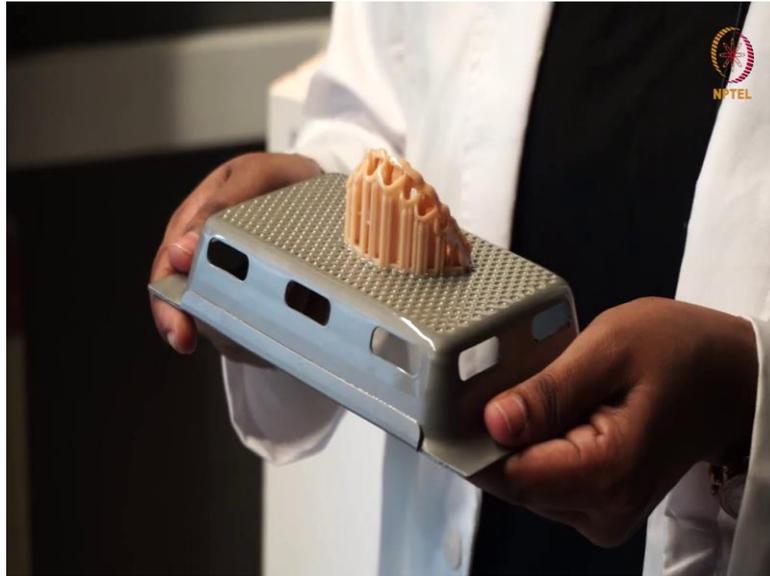
So, once this is done you can detach the print platform. Here you can see these are the support structures. Now, after printing I am going to wash it with isopropyl alcohol and remove these support structures and then put them for curing. So now, you can follow me.

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So, use isopropyl alcohol first to clear off the dripping resin and this is the tank in which the isopropyl alcohol is stored.

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So, let it stay here for some time until you do on your gloves.

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So, for all cleaning purposes since you are dealing with isopropyl alcohol it is best advised to wear gloves.

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After this, you could use this tool to punch it out.

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So, once the initial punch cut is made it is easily detachable.

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After detaching it you have to wash it in thoroughly in alcohol.

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So, this is now detached. Now, you wash it thoroughly in alcohol. So once this is done, now next we have to remove these support parts.

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They have nozzle tip attachment.

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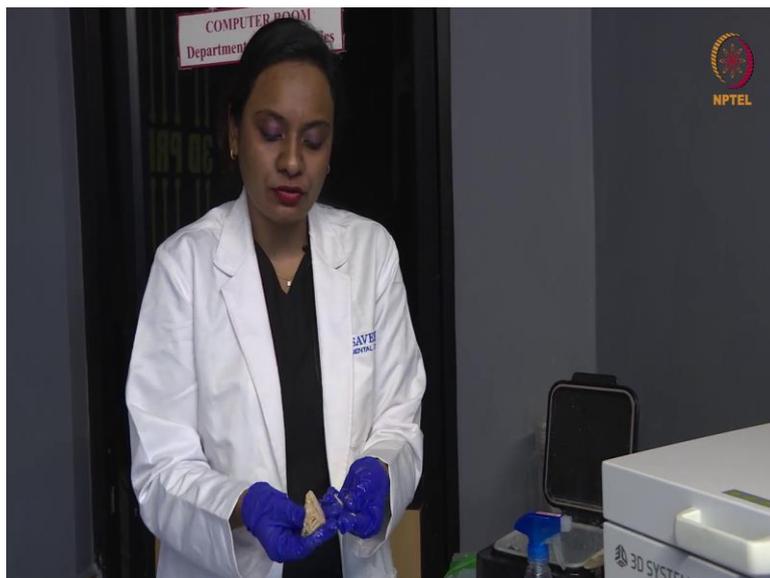
So, it is easy to break it, you just have to remove it with your hand. Keep rinsing it in alcohol.

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So, now I have removed these supports and the surgical guide is here.

So, you could see that this acts as a surgical guide. Now, this is ready to get cured. So, this is the resin and we have to cure it. Once this is thoroughly cleaned you have to let it dry for some time and once it is completely dry then, you put it in the curing unit.

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So now, you can see that this is completely dry and I am going to place this in curing unit.

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So, you place it inside and these are all preset for the particular resin.

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So, you have to turn it on and leave it in place for 15 minutes.

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So, once this is cured it is ready for use. So, now you can see we have completed the 15 minutes curing time. So, let us see the finished product.

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So, you can see that now it is very hard and firm and this is used as the surgical guide for corrective gump surgeries.

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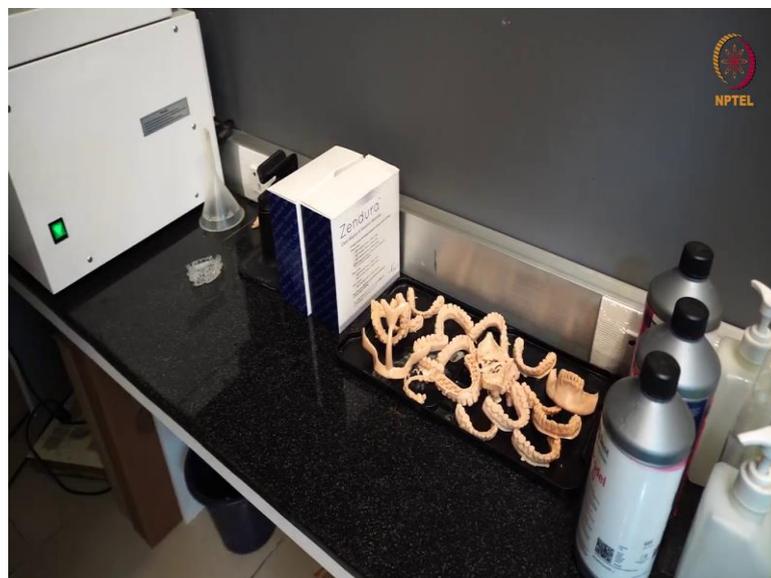
So, I hope you understood the process of 3D printing. To summarize it simply, first process is digitization of the object and converted to in any STL format once it is digitized then, you export it into the designing software where it is designed using attachments and supports once that is done it is uploaded to the printer and it is printed.

The post printing process is quite simple with advanced printers and it saves time. So, before jumping onto 3D printing know about the various technologies it is uses and your applications for the same and then go ahead with purchasing a 3D printer, good luck.

Thank you.