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**Lecture: 43**
**Laboratory Demonstration**
**CAD using Fusion 360, Rendering and 3D printing**

So, welcome to the second part of the Fusion 360 software demonstration, I have introduced a software to you in the first part of this. This is the final product here.

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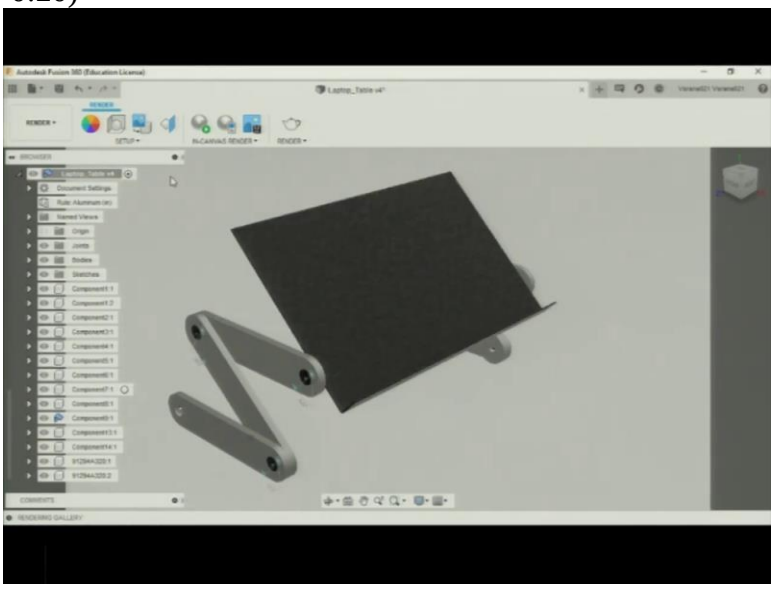

So, let us do the rendering part. So here, I will perform rendering for this laptop table here. So, we will choose the environment here. The environment is rendering, render is selected here, and his rendering environment. The background you are looking at here right now is imported, HDRI image or, High Dynamic Range Image.

It is very widely used in 3D modeling, and when you want to make photorealistic renders. So, one thing you can notice here that, you cannot distinguish between the boundaries of the screws and the links. So, we took paint emulator, the painting for different textures or different materials can

be done here for the rendering purpose, so I will come to the appearance here. So, I will try to make the links in an aluminum texture so, I will type in aluminum, anodized aluminum.

So aluminum anodized, draft gray, blue, and just dragging it over the link, and that link is changing its appearance accordingly. So, all these links are now drawn to anodize rough gray. Now the screws as well we need to change all that, and just putting black here. So for black, I will just try to put, so for black, I will like to pick here, coating here, black oxide coating on the screws, 1, 2, 3 screws on this side, and similarly 3 screws on the other side.

Now, we can also change the appearance for this top, this is the sheet metal component with this I can just put some texture over it. I can put some paint over it, I can put some picture over it and accordingly we can work on it so we will go for matte finish first, for what kind of matte finishes is required, what plastic matte finish, different colors are there yellow, white, grey and so on. I will make it leather matte finish, sometimes the properties are not available we can also download this.

Like, see this is a download available, download options available, see we can when we click it is being downloaded to the system. So, I know this downloaded and I am applying it to the sheet. Now, this is a nice matte finish, closing the window for appearance. You can also change the physical material but in rendering, we need to do so. Physical materials are more important in simulation environment where we need the physical properties of a material like steel aluminum, Inconel and so, so we can change the scene settings here we select the scene setting environment here.

Here, we can change the background from environment or solid color in solid color we can pick any color that we like. So in this case, I will pick environment setting, and we can try to pick different environments here. See environment libraries here. You can pick wooden launch that is already selected here. So, let me change it to grid light. Grid light. We can drag now it has changed the background in that way.

This is a virtual room with grid lights. Go back to settings, you can position the environment by which we can control the shadow effects here. Then we can change the ground scale here. Pick

some value 0.7, and the angle can also be selected for rotation, angle for the rotation here, we can change it here, in that we can change the reflections of the component that we have made.

See, if it looks good, I am just trying to, I am also changing the brightness manually to see, we do not even need to overexpose. Sometimes overexposed things does not seem very elegant. So this one seems ok. Other options can be ground plane, ground, ground planes, ground. Some of the settings can be in the ground settings and camera, camera can be put at different places the focal length for the camera can be changed, we can change orthographic or perspective.

Orthographic, it gives 90 degree angles. In perspective view, perspective you actually give a sense of depth, and importance of time. The depth of field can also be selected. But if we select depth of field is important to understand that design in the background has to be selected properly. So I am ignoring depth of field right now. So, we can see the focal length of the camera.

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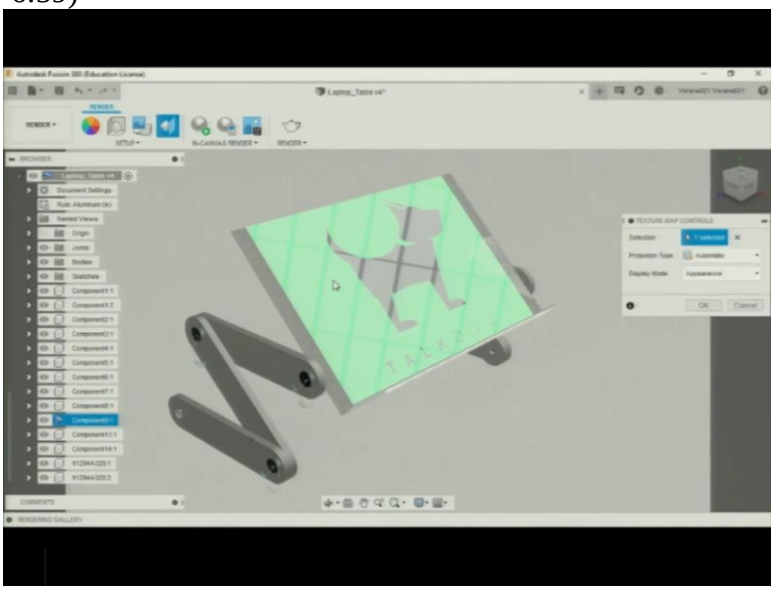

This looks ok. Close the window. Similarly, we can do many changes. So we can pick this command, that kill Command here as well, for putting images or inserting images or like or 3D geometry or so, so importing the image from the computer. Let me pick this talk dog, talk dog the image can be put here now that it is put here I am rooting it to make it vertical proper. So, placing

it at this center, almost center, we can scale up the image when we need, some scaling it up to the whole area.

So, already the setup is seen in settings tackle up system. Now and texture control texture map control, we can select the lightning conditions for the individual objects like for the links for the tabletop is a projection type planar, spherical. I will go for automatic in this case, display mode appearance. So, now we have 2 options for rendering, we can run it under here. So, we can run the render on our desktop computer that is the local computer itself, or we can also use the cloud rendering facility.

For the cloud rendering, we need to use our credits. They are daily credits, which are available for this kind of rendering, that is for photorealistic rendering, it needs one credit here you can see. In this case, we will select a render quality here, render queue times depends upon the job the job, so the other server, so we can select different sizes here like 4 into 6 inch, five into seven inch, and we can select different PPI, 300 PPI.

So, we will render it, it will use 2 grids on our rendering is happening. It might take a while for rendering. But we can also access the previous rendering from the rendering history wall here. A couple of renderings were done before, so we can also see them again. See, this was one of the rendering options where we use a texture surface, and it is also the room setting here. So, rendering is still going on. It will take some time, its needs down 10 minutes, ok. I will just wait for the rendering and come back again. Now the rendering is completed.

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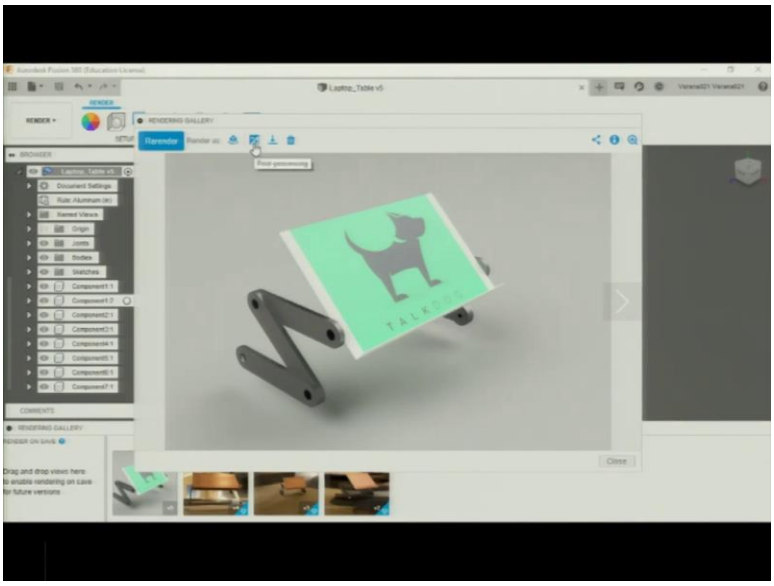

Let us look at it, this is the final rendering output it looks cool I believe, we can see this small little talk dog. You can choose anything that you like we can download the image as JPG or PNG depending upon what kind of format you need if you need no background image you can save it as a PNG, in JPG to have the background as well.

So, it is being saved as JPG here. Post processing is also possible here. In post processing, the exposure, light inclination can also be changed here, the saturation can also be changed. It will hide saturation, color correction, these all these things come with practice. People you can also set automatic which are visible and you can also keep practicing to find the final JPG has to be saved JPG or PNG or the other format that you would like to save here. So, this is completed. So, we can see it here it is opening, yes, this is the final output.

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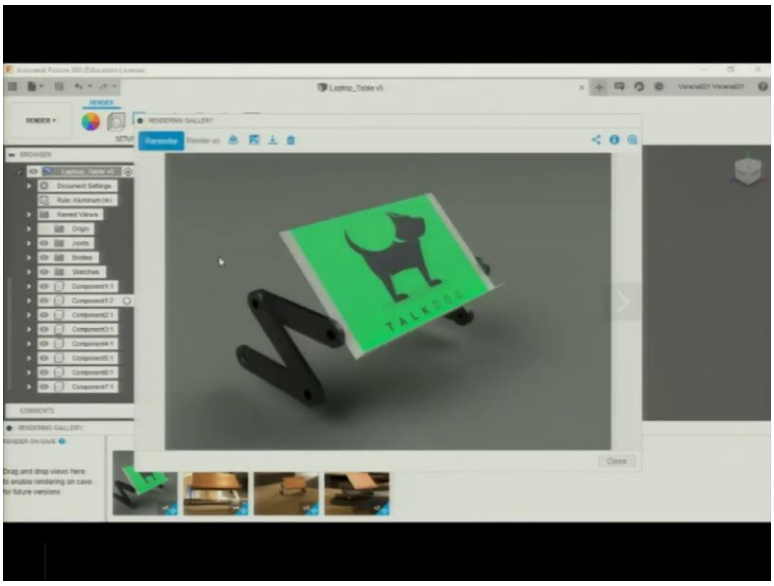

So, we need not to depend upon the rendering itself, we can also change the appearance in post processor here, JPG or JPG or PNG, ok. Let me try to save it as PNG with a transparent background we have PNG and TIFF options here, and the final one if you need to have 360 renders small video or multiple views of your product or so you can select render as turntable here, with the options for 6 frames per second, 36 frames per second, you can change the quality of your final video, if 36 frames, we do not have the as many credits here.

For 6 frames, you have exceeded 6 units of criteria not more credit for so for 6 frames, yes 4 credits are available that can be used here. So we can select render, it might take a while to actually do 360 renders. So, I am closing this video here. This was about the use of fusion 360 software. We have made drawings like similar to what we did in SolidWorks. But only thing is that this is a free version software completely free version software, and rendering is also very easy to do.

We had seen the differences between the 2 kinds of the software that are cloud based or the free version. We will try to come up with 3D printing. I will just import component that is scanned, reverse engineered, will try to see what are the concerns or what are the settings that we do while 3D printing software. We have discussed the 3D printing using Cura in the last lecture in the laboratory demonstration on rapid prototyping.

This fusion 360 has some other options than what we discussed here regarding the support substructure, how do we put different supports? How do we define how do we optimize the support structure, and how do we optimize the orientation those things we will discuss in this.

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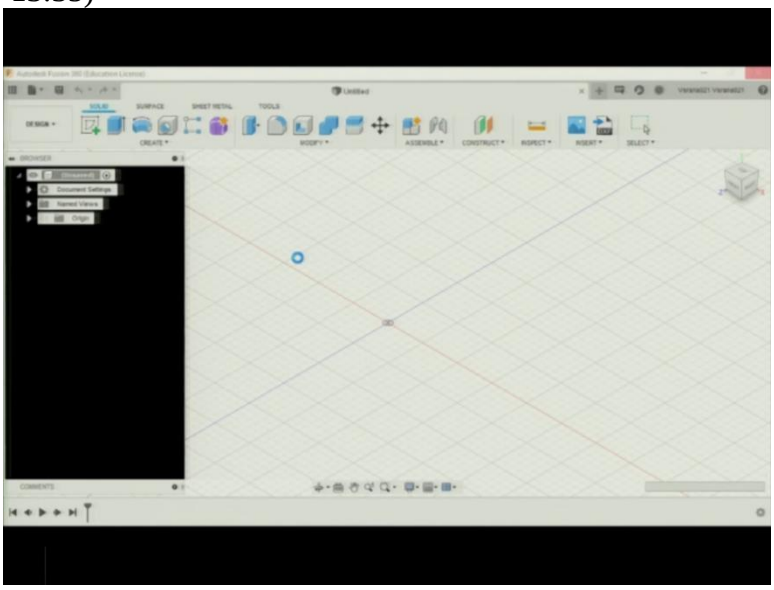

So, this is the interface of the software. So, let me check out some features of fusion 360 here to use or repair our 3D file for advanced 3D printing, usually, fusion 360 is used for prototyping applications.

So, we start to import the file, then repair the file if some as they are in the reverse engineering in the scan component. So, the import the file will select open and open for my computer. So, I will try to import a component. So, beauty of 3D printing here is that it is not limited to the design that we make it can print almost everything, it almost does not it might not produce completely precise outputs, but any odd shape that I can think of while making the different components, and join joining them in some time in a single go that those can be printed.

So, most of the 3D printing supports STL file, as we have discussed. So, other software also they like OBJ, 3MF. STL file as you know now is a combination of the multiple files and multiple triangular mesh.

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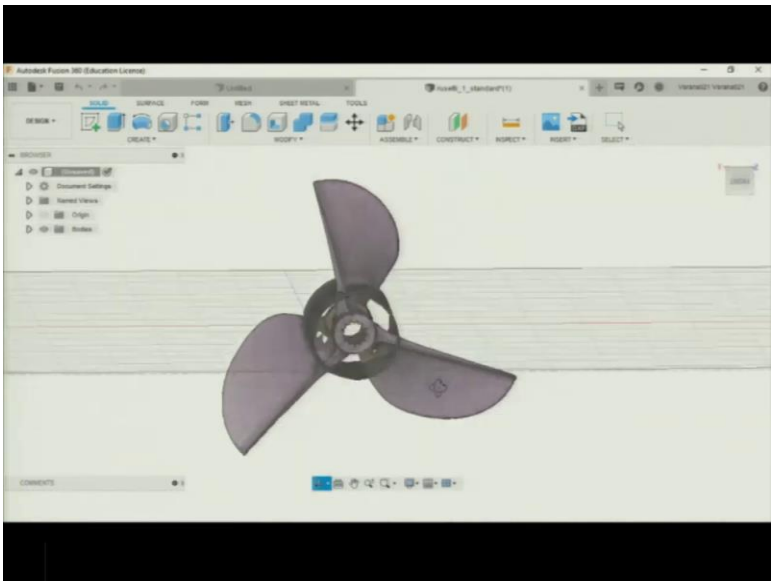

Now, this is the component that is imported here. But this is a propeller this was broken somehow and it is scanned to be 3D print again. So, this is a 3D image scan. With traditional manufacturing processes, it is very difficult to create objects or scan.

So, we have multiple limitations in doing that as well. Another reason to use STL file is that it is very simple to make. So, this is mesh body here, and nowadays, we have multiple formats like OBJ and 3MF. OBJ is a detailed version theme of most popular, it is a compressed version of OBJ which only provides you the information for 3D printing exclusively. Now, here is add-on, mix feature where we have mesh mixture.

Mesh mixer is a tool that is used to prepare the 3D file to manipulate and to prepare the file for actual 3D printing. So, I am working here in 2D environment. I just said that 3D printing can be used to produce many almost everything but still, it should not be considered as a kind of a magical software or magical technique that can produce anything because also it has to have support for different components which are overhung, which kind of a cantilever system is there.

It has to take care of so many things there. So when we have to go for higher accuracy or different applications, or the 3D printing technique analogies like SLS, and SLA so many technologies are there, but here I am concentrating on FDM again, it is Fused Deposition Modeling when which filament is used. So, we have so many options here, mesh mixer print studio preform repeater host,

but I will pick mesh mixer here, mesh mixer is integrated component that is provided by Fusion 360.

I am choosing mix mixture here. So, opening there it is opening the part in mesh mixer now, repertoire is also one of the software that we discussed in the laboratory demonstration. I will guide you through various steps in mesh mixer to repair this component, see mesh mixer is opening. It takes some time for the components to open the component is too big here it is around 2 meters by1 meter by 1 material so it will take some time.

The file size is big. Now so I am now running on my local desktop computer itself. So, it is opening mesh mixer, mesh mixer update. So, let it take its time to open. Unlike Autodesk fusion 360, mesh mixer is a resource intensive software. So, we have a file here, we can select over a 3D printing environment here. So, we have many options available here. It will try to emulate the similar environment for different kinds of the printers those are available here.

So, we have already selected Ultimaker original here. So, it will just simulate the one environment according to this Ultimaker. Ultimaker is one of the printers providing company and it is one of the very broadly used so Ultimaker Original, it has its own work volume or what can develop in which this component can be printed. So, here we have the geometry, this is a scanned geometry there are certain defects, you can also see here this small defects are there.

So, these defects are to be repaired, this will not be printed in the way it is scanned. So, these might be the defects in the scan or these might be the defects in the component itself, so, we have certain options here like import, and mesh mixer, then we can edit. I am not going to discuss all of them, it is not even possible to discuss all of them in this 40 minutes lecture. So, only necessary options I just showed you the mesh mixer we have certain saves that can be created.

As we can select we can also stamping, after all, is not required now. So, it is for different engineering applications. So, analyze the kind of the mesh that we create. See what is now happening? This is our 3D printer envelop. The small cube at the bottom is the 3D printing envelop

and this is the object. Object is of the order of 2 meters or so they have been 3D printing envelope is smaller.

So, we have to first fit this object into envelope, we need to scale down the model. According to a print volume, it has to be scaled down for that, I will come to units and dimensions. See the dimensions here are around 2.6 meters by 1.4 meters by 2.5 meters, it is too big. So, let me try to change these dimensions here, see 2685, if I change dimensions on of any of the 1 axis here it will fit other dimensions accordingly.

So, the x-axis now is 100, others are fitted accordingly. So, it has now come inside our work envelope, we can make it a little larger also the grid size is 10, I can save then, so, according to print form, it is now here. So, either I can even make it a little smaller, we can also change the grid size is our, the grid size I have make I am making it 20 here and let me make it a little larger 150, now, it looks Ok.

Now as you can see, this part has so many overhangs, it is not very digestible to print all the overhangs, but still, we need to see the different positions different orientations for this object for before that let me try to see what are developed with various defects in this object. What are various holes errors are there? So, it is showing these many small holes and voids. So, these are to be repaired, I selected repair all, smooth will I will just fill them, then auto repair all so, it has around 69 defects, exactly 69 defects it is showing it is repairing those defects.

So, if we define the component by our own is defects would even count. So, this is an important when we do reverse engineering to repair the defects or the voids those are there, these are the small meshes or small group of the nodes which are not selected properly while scanning. So, mesh size is also important to be selected here, if we pick very dense mesh, so, it takes some time, more time to print actually.

So, if the mesh is selected a little broader it will take lesser time, but the quality also has to be do depending on the accuracy it is quite abundant for the perfect finish, the mesh has to be selected. Also one of the advantages here is with Autodesk mesh mixer is that it is freely available with

Fusion 360 software. So, it is available here. So, in SolidWorks, we have to generate the STL file and edit it separately.

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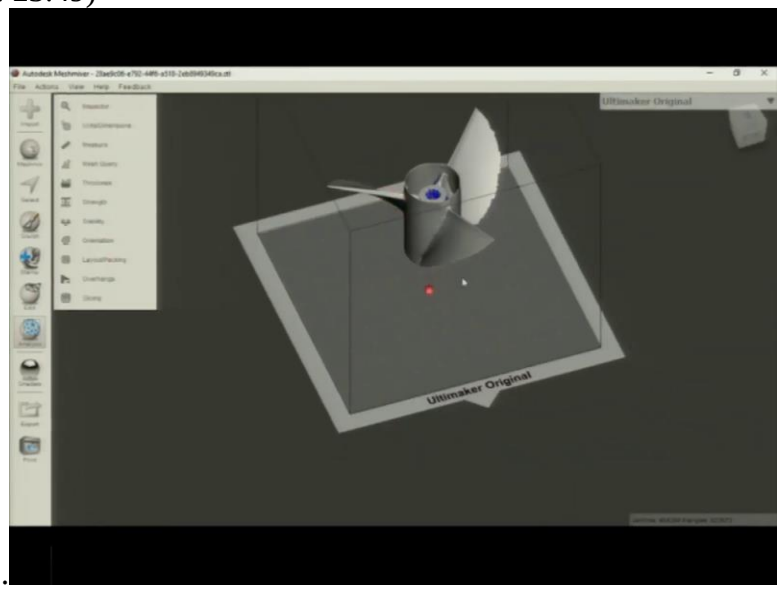


But this is available with the free version. This is a produced object with the defects almost covered. Now, the almost important factors to be considered in any FDM print; one is, what is the orientation of the part, second is your support structure, the orientation, and support as you discussed earlier are 2 defining parameters for the product to be produced. So, for orientation, I can see the automatic orientation that is trying to produce.

So, let me see the layout and packing, packing can be put in here. So, the software automatically pack your file by using minimum area. So, it is it has taken the component to the corner then select accept here. So, now you have secured our part successfully to the bed. In FDM 3D printing, the adhesion of the 3D print part with the bed is very important to be considered, in the repeater section, so we have seen brim and the raft part that how do we put our component on the bed and what we do is select raft or brim.

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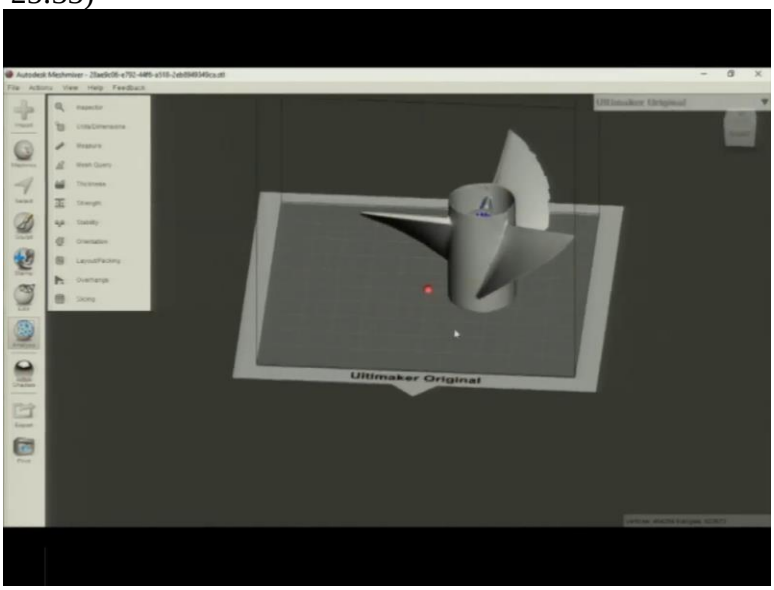


You can see here these are very fine boundary which is placed over the print bed and this spot boundary this small for this very, very small thickness this would not have strength to stay on the bed, so it might pop off. So, we need to consider all of these conditions like brim or raft what is to be put in here. So, one of the interesting things here is the orientation, the orientation can be selected with experience, and if you are not very experienced, we can select the automatic options here, we can optimize orientation because if we set the orientation, which is analyzing, it will analyze all the options for orientations, those could be done.

So, see it is analyzing 2692 around 2700 options. So, each and every possible option is being seen. It will enhance the time or accuracy or sometimes this automatic optimization is not even. We can see we will just see whether it is proper or not, is analyzing all the options here. See, here we have the part to this place the part on its fins, overhung angle is also to be selected now. Now, in orientation, we can also set the overhung angle see the orientation it is showing the component out of the print volume overlay angle has to be more than 45 degrees in selected 60 degrees here is fit to the print volume.

If I do not select to print volume, it will make it keep it apart outside the print volume. So, we have to see with traditional manufacturing processes here like CNC, milling or turning, we can provide complex geometries, we have freedom to design only condition is that that we need to provide

different supports. So, this analyzing might take some time just let this happen and come back again.

So, now, now it is selected. While putting it back in the volume it has readjusted this rotation again. So, this is orientation that is set by the system fit to print volume. So, it is pretty symmetric in x and y directions. But if the print or the model has uncertain geometries, so, this option will be greatly useful to have a successful print. Like for instance, the small model of animals or humans or some biomedical human ligaments or so.

Now, the print is pretty stable right now. So, I will see overhangs now, this is an overhang portion. Now, what is showing the red portion is that this is the overhang portion where support is required. So, this can be handled definitely why providing support, support structure is having small geometries, it helps us to keep the print or the overhung portion of the print at its proper place.

So, let me try to optimize support here. In our support generator, certain options, we have maximum angle of 61 degree post diameter post diameter is the diameter of our support. So, diameter, diameter of the pillars of this support also to be is also to be selected to support it properly and also it has to be as far as possible minimum because supports are to be removed and a tip diameter, tip is the portion that will be connected that will be finally in contact with our print.

So, the tip if it is put smaller, it will be easy to remove it will leave less impressions on the print on the model. Tip dia is 0.5 mm, it is ok. So, here we go, in the advanced support settings we have optimization allow top connections 50% is ok. Now, I will generate supports it is all generating the supports will see the support will be created just like a tree.

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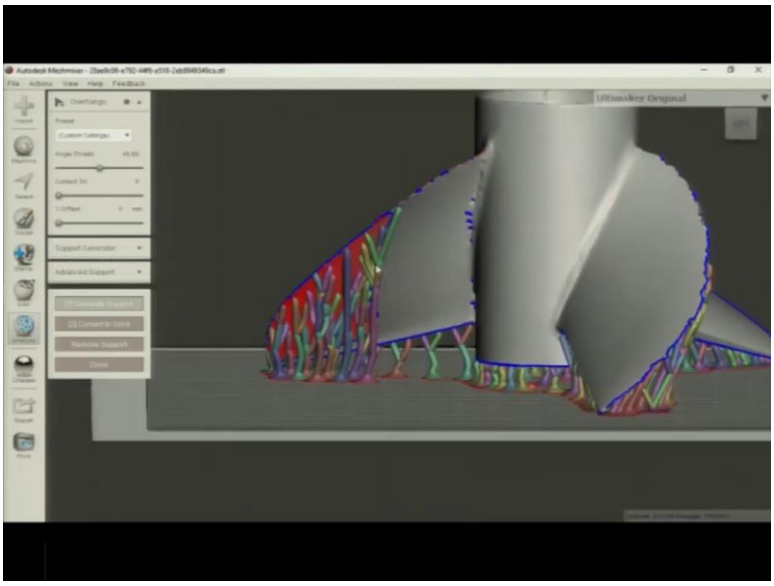

555 nodes are being created. Now, it has produced the supports here you can see the supports are ready, you can see here advantage of choosing mesh mixer is that we can provide ergonomic support structure to our 3D printed file. One of the issues that is to be considered here the supports are very easily removable here. So, this is1 of the issues that should be taken care of so, because the tip dia is 0.5 mm that can be easily removed here.

So, this supports would assure that a print would not fail. This looks ok which is very much similar to the tree modeling, and how the tree works. So, as you have done and this is almost done. There is so many options as could those could be discussed here. But in this small lecture, I am just trying to just cut the support structure and small repairing part here really. So, we could do slicing here the slicing can be done here in the mesh mixer itself or we can export it to deputize or different platforms and slicing we have already discussed.

Here, I am saving the component or the product into an STL file. Propeller, and it is done. Saving would also save some time. So, this is a small demonstration on using the scans component scan component and scan product and trying to do some repair and putting supports. So, many things that can be done before 3D printing that is infill is there, then the brim or raft to support those who report and slicing time, then the moment of the extruder that also can control the filament dia that is to be selected depending on the material that is being selected.

Those things were discussed in the previous lecture. I will just quickly go through the making of one of the components. This was actually the reverse engineer we imported a component and tried to repair and print. Now, I will try to make a CAD model. How do we just make the component, and try to print that or set the parameter right for 3D printing? Now, that part is here. So, I am going to make this hinge here now.

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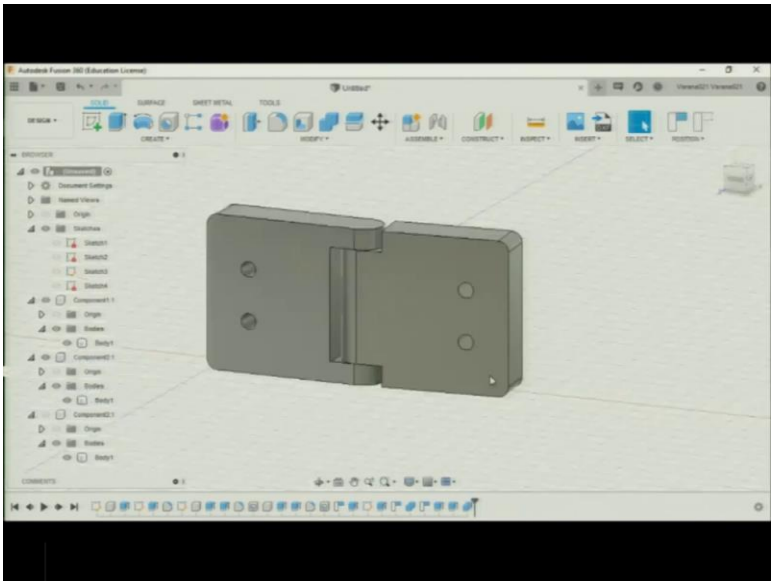

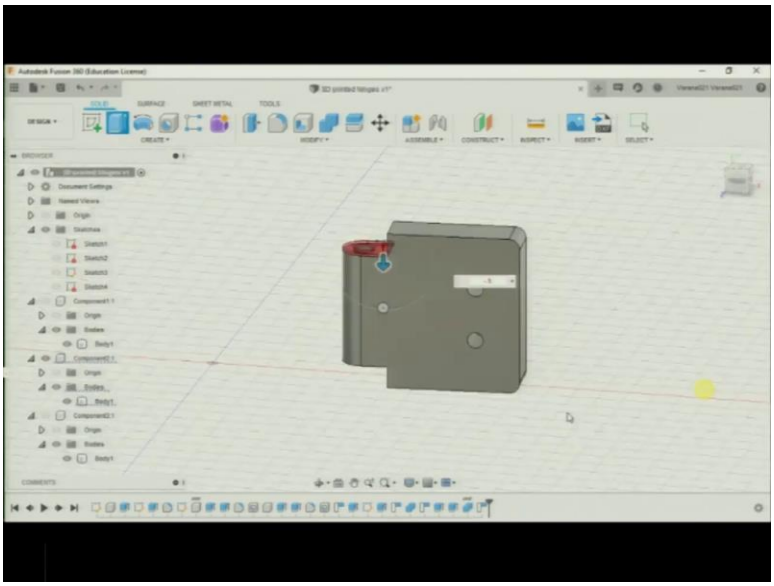

This is hinge, you can see this is the hinge, this component one, and the second component is also there, and this has to be assembled, it is printed in this way, they printed in a way so that the hinge,

there is one, or one connector in the hinge, is one connector here and this is one part that is see, this is1 connector, the other part of the hinge is held like this. So, if a printed separately, I could not put this here, this is not a separate pin.

This is the part of the component. So, it has to be printed in a one go. So, how do we do that? We put some tolerances here, and we have to print them in as a single component. How do we do that? So, for that, I will just make a model for this, for making this model. I have gone through drawing already. I will just run the history for them immediately or very fast. This was selected, I am running it very fast you can make this component if you would like to.

So, so, this one component is made, and we have to copy and paste. So, this one sketch is made I am not trying to now copy Ctrl C and Ctrl V could copy and paste or this is a second component that is being pasted here. So, this is being done here. These are 2 components, can see, then all this the joint is made assemblies made everything is done as we know this is joined here. The pivot option pivoting has been done, and we are going to rotate this.

An important point or the only important point which I like to discuss in this is how to save the component both the components as one body? That is very important to do, see what we can do. So, this is a nice 3D component is it is produced, or what we generally do we save the component separately hinge 1 and hinge 2 and I am going to import this in my repertoire environment. Now, we need to 3D print this body that is produced.

So, last time we sent it to the mesh mixer now this time I will send it to repertoire, for that I will I do right click on the component and save it, select component, right click on it you save as STL. See, this is what I am something that is doing that is not the correct way for this kind of component. I am saving it separately component 1 as hinge 1, I just named it as hinge 1, and save, ok.

Similarly, the second component and remember these 2 are again components on the bodies. We can also refine the mesh because this will become a STL file, so, small triangles are there. So, we can refine it to some extent for simple geometry we need not even to find this this is too simple geometry. I am just taking binary format here. So, for professional 3D printers, we can pick the

advanced options as well I am also saving this geometry now, on this is being saved as hinge 2 at h i n g e 2, now the assembly is saved.

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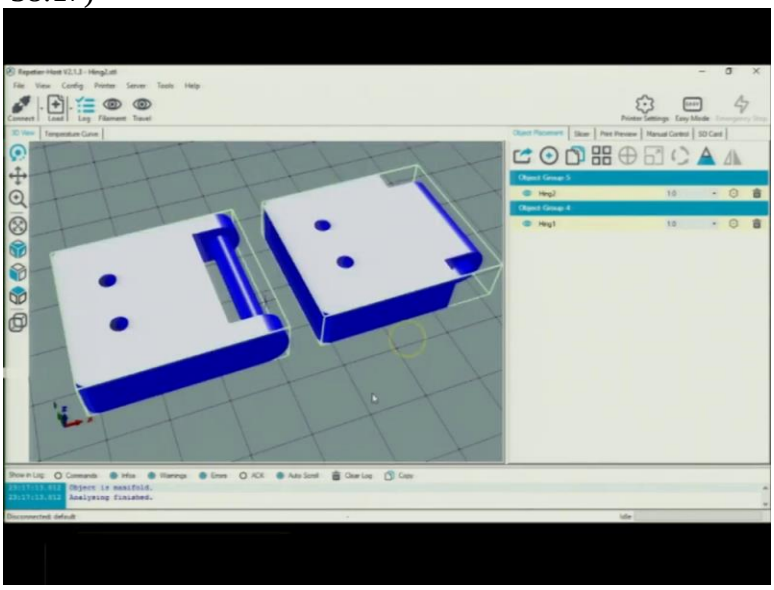

Now, this is a repeater environment. So, I will just open my file here. So, I load my file and one by one I have to select these files, both of them are not possible to select in one go, one object at a time is selected. So, hinge 1 would come here, it is being loaded here, hinge1 is loaded. Now, importing hinge 2, now this has come in our repertoire environment. Now the interesting part is if print them in this way, how would this movement.

Now, the interesting part here is that if it is printed in this way, how would this part, this joint work? So, in this case, this both has to be printed in a way these tolerances, this dimension, and this dimension has a gap of 1 mm spacing. 1 mm spacing is there that will be taken care of. It has to come as if 1 part here so, that is important. So, how do we do that? So, let us see. So, this is how it looks like if I imported like this only, this is an now two different components, it is going to be printed separately here it is it has come on our printer environment.

So, for that purpose, we have to make or select them and combine them. So, we have tolerances in between them in the joints. So, we end using combine command to just make the object as a single body now, this is single body. So, now this combined has to be saved as an STL file. It has to be

saved, save 1 file per body, save 1 file, 1 file per body would again saving or against save it as separate files I have to save it as 1 file.

Save it, saving it as 1 file as it is, I will save hinge, simple hinge. Now again loading the body, setup file, now this is being imported here.

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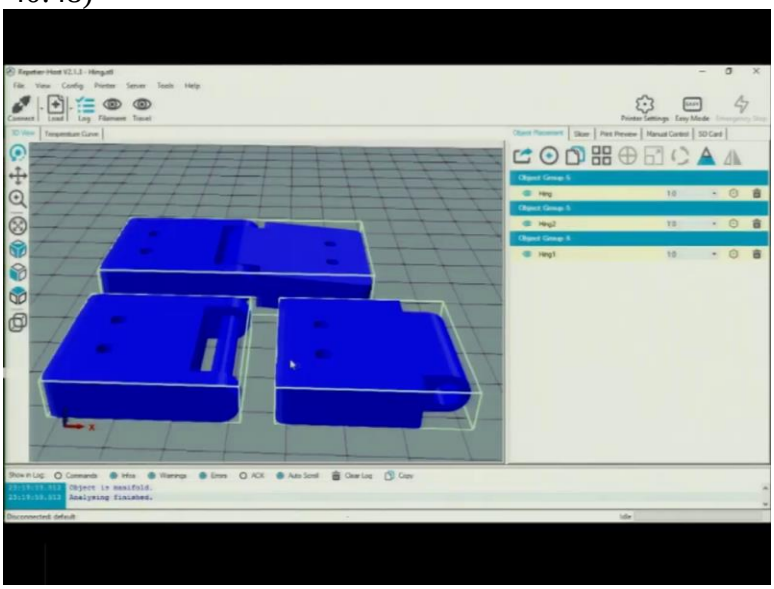

So, here we can see the file is now assembled in a single body. Now we can delete the unwanted files here. I am just selecting and pressing DEL button to delete them. But this is a file that is to be created there is so many options that we can use here.

The similar options that we have selected that we have chosen in the previous video, we can rotate the object we can see the orientation for them, we can choose the slicing, we can chose the filament dia. So, so many options can be selected here. So, we can choose include or in engine again says so there is so many options. I am not trying to repeat the things that we did in the previous lecture and these things they said thickness etc. can be selected.

So, raft and brim can be selected skirt and brim. So, all these options can be selected and this component can be printed. So, let me try to finish this quickly. With the parameters set. I will just

put a slicing, slice with Cura engine. Now slicing is happening. So, with the set parameters, the slicing software is slicing this object into multiple layers of 100 micron, it was a fit parameter here.

So, it is showing the values it will show 299 layers it will take 58 minutes, and the component slicer we can see here it is a similar thing. So, this we can also again select here whether to put brim or raft, what kind of adhesion we need to put here support has to be of reverse speed low or high the infill density is important to be put here. It is also the beauty of 3D printing that is with respect to the injection molding.

Injection molding is generally used where high quantity is required. Very high quantities required for the dies to be made as a little expensive. 3D printing can be hollow from inside injection molding it is very difficult to produce all of our plots from inside. Here, we can just select the infill density and we can opt to choose the hollow or the completely filled component.

So, this was a small demonstration on 3D printing, this was on demand, I have just used 2 platforms repertoire and mesh mixer which are very widely used, and these are 2 we have these have taken from the Fusion 360 platform through that. So, with this 3D printing, rapid prototyping part of the course is over. We will meet next week next week, where we will discuss the recent or the future technologies like virtual reality, big data, augmented reality, Internet of Things, Industry 4.0, and overall we will discuss and then we will conclude this course. See you next week.
Thank you.