Rapid Manufacturing

Prof. J. Ramkumar
Dr. Amandeep Singh Oberoi
Department of Mechanical Engineering & Design Program
Department of Mechanical Engineering
Indian Institute of Technology, Kanpur

Lecture – 16
Laboratory Demonstration, 3D Scanning (Part 1 of 2)

Good morning. Welcome back to the course on Rapid Manufacturing. We are discussing 3D measurements in this week. Today we will discuss the Laser 3D Scanners.

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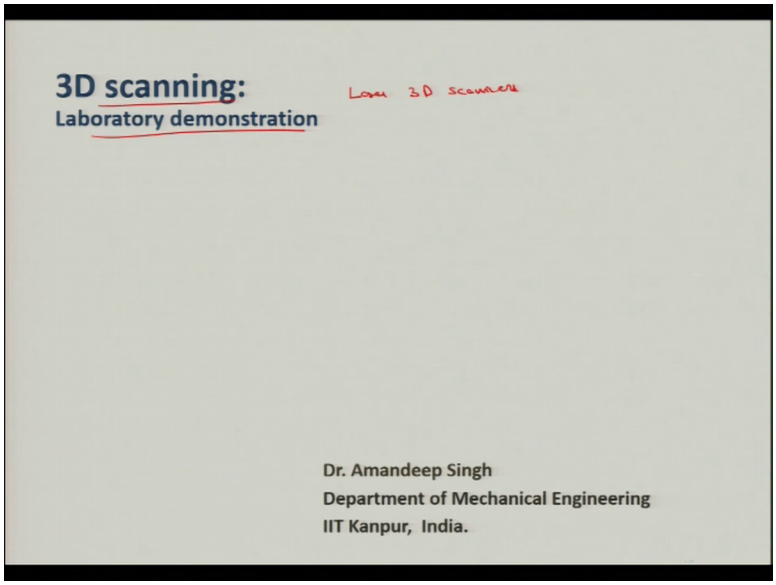

We are I have discussed the CMM 3D measurements in the previous lectures. In this lecture, we will discuss laser 3D scanners. For laser 3D scanners are required by the CAD users who required a very good precision in quality developing, quality precision accuracy high resolution equipments are there in the market.

We will discuss about one or two scanners. One is R Tech 3D scanner which is a handheld 3D scanner which uses blue light for scanning, and one is the Picza Doctor Picza 3D scanner which is there in a cabinet which is a close chamber 3D scanner. So, let us come to lab which is for lab in IIT Kanpur and have a look on this two 3D scanners.

Good morning welcome back to the course on Rapid Manufacturing. So, we are in this week and we are studying Reverse Engineering. Doctor Ramkumar has told you various

methods how do we conduct reverse engineering, what is reverse engineering is discussed first, then we had a laboratory demonstration on coordinate measuring machine.

Now, in this session we will see various other 3D scanners, coordinate by measuring machine is actually kind of a touch or contact 3D scanner.

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As this is actually hand held 3D scanner which we will discuss in detail and we will see how do we scan this specimen that is made this specimen has various profiles in it. So, this is a blue light hand held 3D scanner. Also we will have a chamber 3D scanner. Picza is the company that is the make of this 3D scanner. This is blue light and that is a red light 3D scanners, we will see the demonstration of this.

So, we are going to show you a 3D scanner. It is pretty clear that this three-dimensional scanner is the device that can scan the objects in all the three dimensions. We can scan any shape in a three dimensional orientation, especially this device is widely used in area of reverse engineering, in CAD modeling, additive manufacturing, quality control, mass production. In reverse engineering sometimes we have a component, we have a part and we need to copy that part to have mass production to have multiple products.

So, sometimes we find that we need to modify some dimension or in some shape or create some extra additional feature in that these 3D scanners are very helpful. We can

scan particular job and that scanned data can be developed in cloud form. These are the steps that we have discussed and that cloud form is then used to have surface generation and that surface generation helps to have the CAD model. Very first thing is we have point cloud that is generated from these 3D scanners. This point cloud is then used to have the mesh generation. This mesh generation is actually kind of a surface, that we have got a surface, we get surface from the mesh and from that we get the 3D models.

3D models when we have the mesh sometimes this scanning does not happen in a very accurate way at the certain noises, certain additional projections are there, certain missing areas are there, those are to be worked upon. There are certain tools in the softwares which are provided with these hardwares that we are going to discuss here.

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So, first scanner I have here is Artec 3D scanner. So, this is what we have here is two kinds of Artec 3D scanners which are Eva and 3D Spider. This is Eva, this is Spider what we have in our lab is this one.

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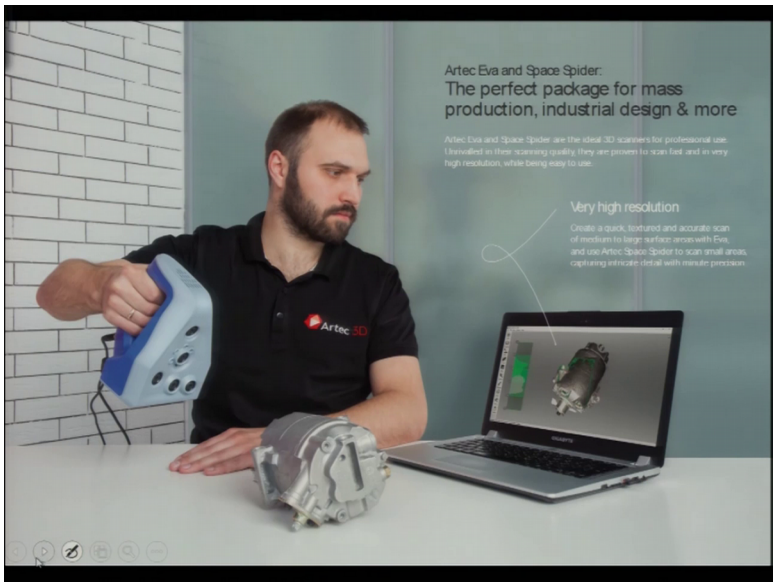

Now, these scanners can have various applications. So, this is pamphlet that I have taken from the company. So, these scanners helps to scan the objective in 3D space. So, Artec Space Spider is perfect for capturing small objects with complex geometry with sharp edges, ribs. The specific command in the software we also get the Artec 3D 11 software with this hardware, with this scanner with this equipment. So, there we have various options edges is because sometimes we need to work on edges. Edges are not very clear when we can sometimes because the orientation and we take the scanner around all those things does not happen very good.

So, those things can be worked upon. So, this is a high resolution scanner. So, Artec Eva Space Spider are both used. Artec Eva which is this one, this kind of scanner is used for the very big objects like we can scan complete bus or a complete spacecraft and this can also the spider can also be used for that, but only thing is that the working distance is different between two, that I will show you. So, Artec Eva can scan the objects and we can have high resolution objects here.

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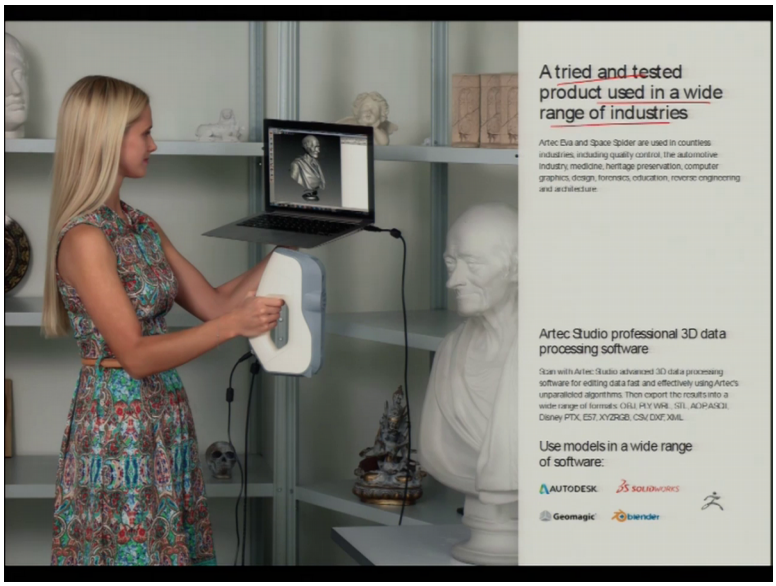

Then it is tried and tested product as the company say that is used in wide range of industries. So, these are using conference industries such as quality control, automotive, medicine, heritage preservation.

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Here they are scanning this archaeological object and they are not even having any contact with this one and see this is a portable scanner that can be taken, that can just work with your laptop or your computer or your tablet and there is a battery that is used to operate that. The battery can work for 6 hours and you can scan and create replicas of

these important objects of cultural importance. We can preserve them, digitize their collections, make them accessible to everyone in the world.

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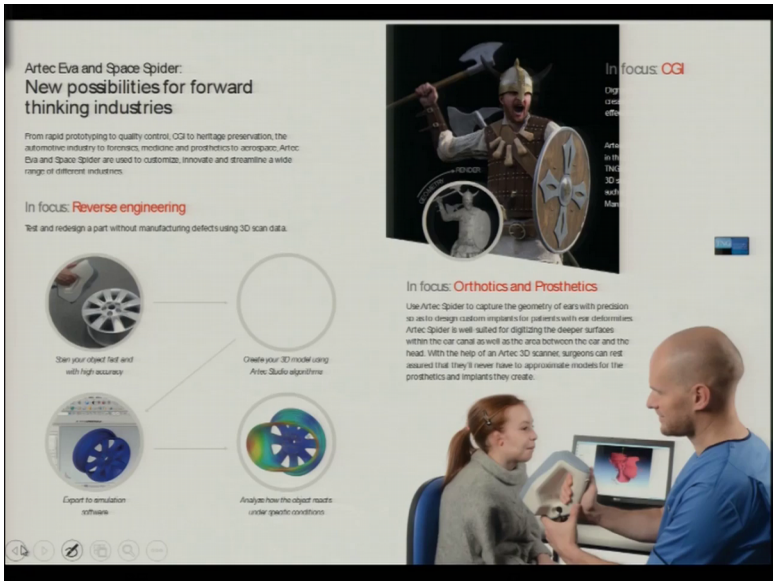

So, these things can happen. Also these scanners are compatible with many other tools.

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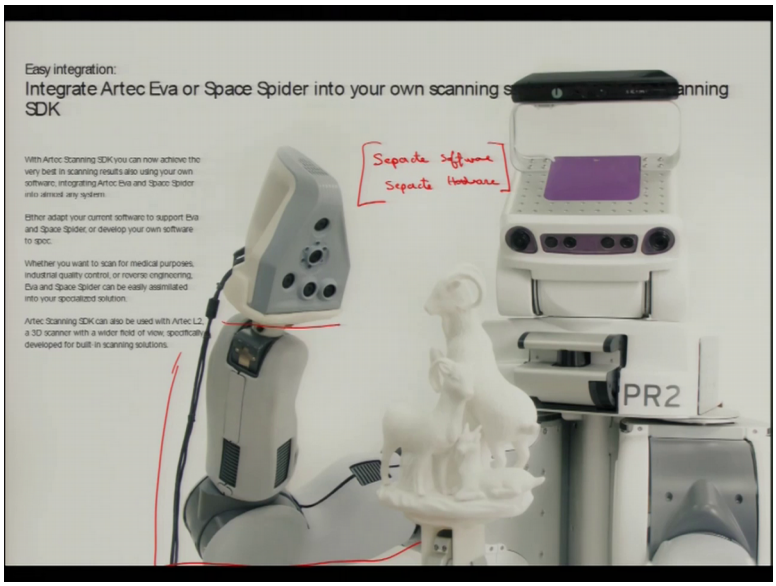

You can see a robotic arm is there. A robotic arm is holding the scanner and it can take the scanner around the object. This can be done in two ways; either we rotate the object that we need to scan, for instance I need to scan this object. I put my scanner here in a stationary position and rotate the object. This is what we will do in the lab ok. Second

way is if the object is big one and we cannot rotate and all we do not have returned table rotate the object, we can even fix the object. Object is kept stationary we can take our scanner around it.

What essentially it is doing? It is taking multiple images like we have panorama view in camera, in our mobile camera or our regular cameras. We have multiple pictures and those pictures are aligned into one. They select a rostral line, rostral line when is there is some overlapping, then select this point where the overlapping happens, then produce this object, this rostral kind of scanning is done using this scanner and the other scanner Doctor Picza that we will discuss in the next lecture.

That is a kind of a CMM machine. We have different circles different circles and those are then enclosed. There is no overlapping, no rostral line is there. So, with this it can be we can achieve best results also using our own software, our separate software and a separate hardware, right. This separate softwares can be other softwares which are having the interface with manufacturing, with additive manufacturing even with non-additive manufacturing and the hardware is like you can see this robotic arm, it is helping to support this 3D scanner.

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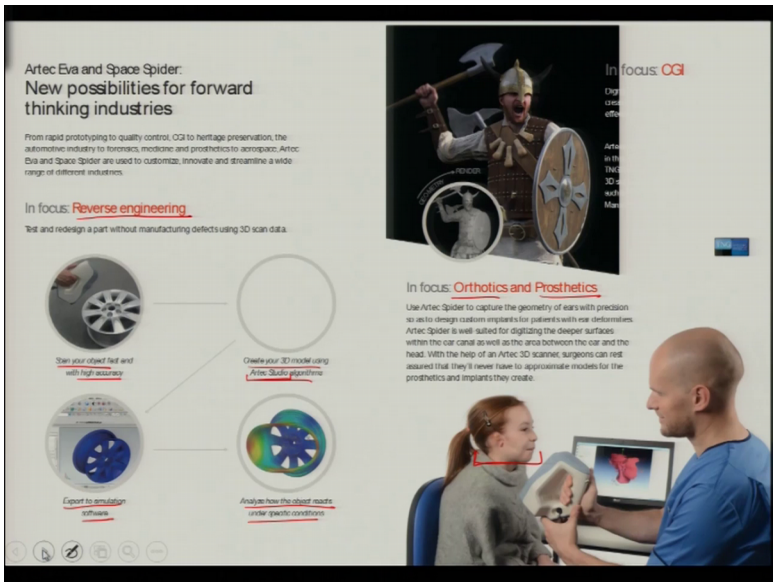

Next certain other uses it is showing that these 3D scanners can be used in orthotics and prosthetics. This is a blue light scanner and blue light is not at all harmful to human. That is why it is then opened 3D scanner, this is a closed chamber 3D scanner, Doctor Picza

3D scanner that we had here that is a red light laser which is harmful for human skin or eyes. So, that is why it is kept in a closed chamber. So, this scanner can be used to scan the face. So, this is a general scanning steps which scan the objects fast with high accuracy. We create the 3D model using Artec studio algorithm. Artec studio is the software that is supplied by the same vendor, then we export to the simulation software and also can analyze how the object react under specific conditions. This exporting can be done in various forms. We can have HTL, we can have IGS and we can work on solid works ensures cathie various softwares to do this analysis.

So, this is reverse engineering, like you might have watched the movies Man of Steel. To be light there were certain dummies their created, they used this specific scanner to scan the object and then created those dummies to use before this CGI. Before moving further let me show you the specifications of this scanner.

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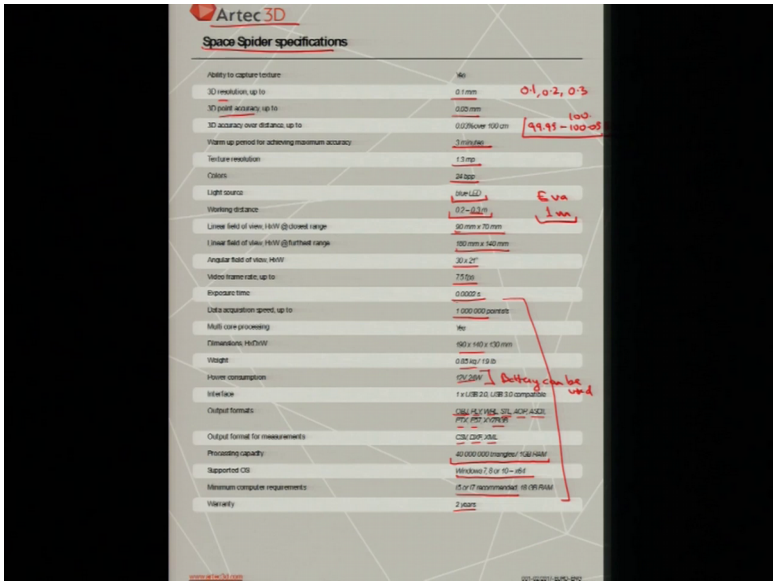

These are the specifications of this scanner that we are going to demonstrate in this lecture. Resolution is 0.21 and accuracy is 0.05, the difference between resolution and accuracy, this is engine metrology. Resolution is the minimum steps taken that we can take forward that is the first step is 0.1, second step can be 0.2 third step can be 0.3 and so on. Accuracy is closest to the results.

If the results for instance the distance is let me say 100 mm, it can show from 99.5 to 100.05 this is accuracy. So, warm up period there a small period when we just start the

equipment it has to hit up because the laser has to be laser has to be excited, that warm up period is said as 3 minutes here. In our equipment it is little larger. We have to still find out what is the glutting there or what it is around 10 minutes that it takes for the equipment to warm up.

So, this is known as soaking period. Then texture resolution is 1.3 megapixel colors. It can have 24 bpp, then light source is blue led light working distance will 0.2 to 0.3 meter. For the Eva scanner there was a difference that is why I said for a scanning large objects if we are standing around a meter away from that object, this scanner is not recommended. It can work at a maximum distance at a maximum distance of 0.3 meter that is mentioned here.

So, these are the field with 90 mm into 70 mm 180 mm into 140 mm is a linear field view. So, this is the closest field view 90 mm to 70 mm is the closest. This is the farthest 180 into 140, video frame rate is 7.5 frames per second, angular field view is 30 into 21 degrees, exposure time is 0.002 seconds.

So, these are the certain specifications. So, it can acquire around a million points per second, a million points can acquire in a second that help to get the point cloud and we can generate mesh from that, then this weight and height empowered condition is in 12. That is why we can use battery here, battery can be used. So, output format this is important it can give output or we can publish the data in this formats OBJ PLY WRL STL AOP ASEI PTX. All these formats can be used, then output formats for measurements can be CSV, DXF XML and so on. So, processing capacity is 40 million triangles per GB of RAM.

Then it can support the windows 7 8 10 and so on, in this is the computer command as this say. So, warranty all those specifications are there. There are certain differences in the specifications of this equipment with Artec Eva. We do not have Artec Eva with us, but just to let you know that what are the other scanners available in the market.

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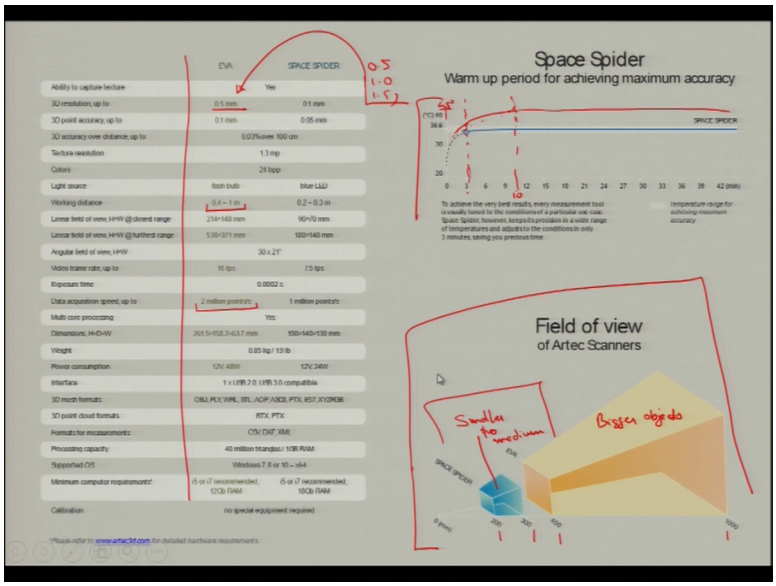

There are certain companies who do the producing these scanners in the similar range, but this is the one we have. So, this is Artec Eva it has a lower resolution. Resolution is 0.5 that is the next that it can have after 0.5 is 1.0 after that it can have 1.5.

So, this is resolution for low resolution, but it can operate from a further distance. The distance is 0.4 to 1 meter, also we can see it can develop 2 billion points per second. There are certain similarities and differences between two, but we are more concerned with our scanner. This is Space Spider, this is field view of our Artec scanner. We have this scanner here, this is the face view field view from 200 to 300 mm the field view expands and for Eva it is larger. That is why this is used for bigger objects, this is used for smaller to medium objects, but this is not a restriction.

Even if we have the Artec Space Spider model with us, this can also be used to develop the models for bigger objects. Only the thing is that it has taken more time and because this space field view is lower and second point is that we have to be a little closer to the object lesser than 0.3 meters. So, this is the warm up period that I mentioned 3 minutes is the warm up period and specified by the company, but our scanner is taking around 10 minutes. So, our warm up period is something like this and the temperature that we go up to is 45 to 50 degree. So, in our scanner the piece that we have will go up to 45 degrees and 10 minutes, right. So, this was a general overview of the specifications of the

equipment that we have in our laboratory. Now, let us get back to the laboratory and see ok.

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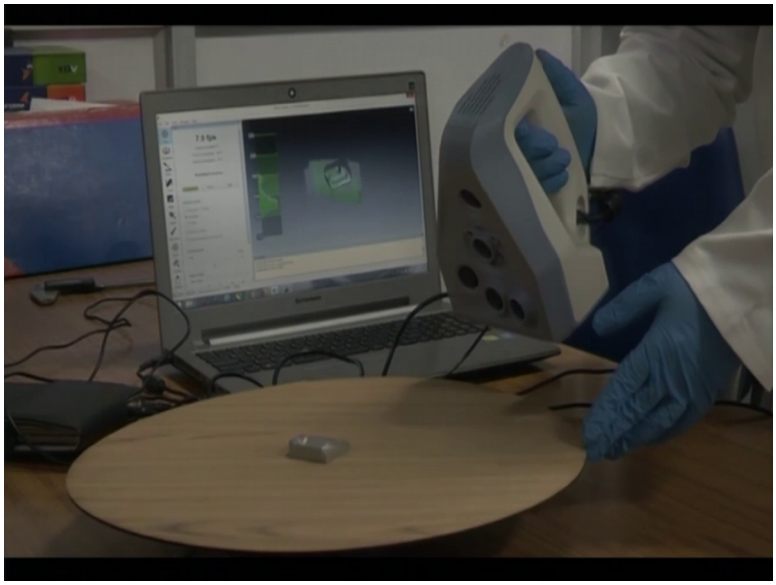

Again this is a handheld scanner, this is a light weighted handheld scanner. The weight is less than 1 kg and we can work with this. Now, we can use multiple ways as I said before we can either take a turntable and put the object over there and rotate the object or we can scan the bigger bodies by picking this scanner and just moving around and scanning the data. So, this can happen. So, because it is portable we can even use multiple scanners. We can have 2 or 3 or 4 scanners for scanning a single object that would save time, for that we can develop 2 3 different models and then, combine them in our software. So, that can also happen.

So, there are 4 cameras here which are known as receivers, this is laser generator, this is camera, camera, camera and camera, this is laser generator, right. So, this is a blue light scanner that does not harm the skin, the blue light is generated. We will show you when it flashes. When the blinking happens that you can see that when will operate this thing what happens, the receiver receive the signal from various angles and with this kind of scanner it can scan a geometry as well as texture. So, as I mentioned this scanner when we start it, it takes a few minutes to warm up which it is known as soaking time to that is happening.

So, the laser source is getting some temperature elevation. So, this is called activation of laser. Normally it is 45 degrees. So, the current temperature is around 47 degree, 47 to 50 degrees. Optimal temperature we have put 50 degrees actually, 50 degrees are the temperature put. So, this is the temperature that is required for the scanning device. As a temperature rises, the laser source is getting excited and activated properly and then, we can start the scanning. So, this is Artec Studio 11 Soft software. So, this is a software as I said is provided by the same vendor Artec 3D. This software the needs of professionals at any experience level and post numerous automated features one of the state of art features here is autopilot, this is autopilot. Autopilot the auto means it is something that is automatic.

So, in it creates a professional great 3D models of any size so, users are guided through a few simple questions related to the characteristics of the object being scanned in the type of 3D model that is desired. Then this software deletes any unwanted captured data, auto aligns the scans with one click and it selects the most effective 3D algorithms for the data that is required. So, it helps in high precision 3D module that is of same quality as those created manually by an experienced user. We will not work with autopilot mode because we will need to show you the demonstration. We will work with the manual mode here.

So, autopilot makes the process so easy as a beginner can use it without the intense formal training that was once required, however expert users preferred to use these autopilot features because they would have to work on their own. So, expert users can also leverage the intuitive feature, this intuitive feature because it provides quick pathway to achieving the highest quality model.

Sometimes they also use this one. So, very first option here is scan as a copper resistance can scans the object, when we click it this scanning happens in the same way this is autopilot second option is autopilot. So, we are in manual mode, actually we always go for the handle option manually the third one is editor, this one is editor.

So, we can edit the object, the object at which we can edit that for instance making some pockets or any kind of alteration. So, that can happen, in next tools, these are tools. Tools I believe this is clear, this is a toolbar system where we can have various options, various kinds of tools, we can remove noises, we can make some changes and so on those things can happen. Next is a align; alignment is when we align various defects scans and try to

produce a single model out of that. Next is edges: edges is an important feature and I can even say it is a special feature because we know that an object can have an edge profile textures. Edges is a special feature and here it is mentioned separately because whenever we go for scanning, when the light strike on the edge is normally it diverges in multiple ways.

So, this is known as diffraction. What is diffraction of light? Diffraction of light is the scattering of light. When it hits the edges, it is actually slight bending of light as it passes around the edges of an object. The amount of bending depends upon the relative size of the wavelength of the light to the size of the opening. So, this is diffraction, to counter that we have this edges as an option. If we click edges, it will just complete the edges by itself. In this way we can find think profile or sharp corners.

So, next we have measures for make a measure the size or the dimensions of the object. This measures whatever we have scanned this is multi though this scanner has capability to scan big objects, but we can even scan smaller objects in one shot, we can keep small small objects. Let me see small pins, all pins or small tips of the pens maybe that we can scan in one shot, then we can generate multiple models from that, that is multi this is texture; as we can scan a body or a geometry and also we can scan texture. Texture is something for some color reflection, some colored deviation or some peaks and values are there some shades in profile. So, that can be taken with the use of this feature texture.

So, we can scan geometry, we can scan texture. Now, this is publish is simple. It is nothing, but the kind of saving the file in different formats, because we can export this file into various software such as solid works cathie and says to cut conduct analysis inventors is one of the softwares. So, we can export the model with help of publish, we can save the CAD model in different extensions that I showed you in the specifications of the equipment. So, we can call different file such as dot stl dot igs and then, we open and we access the same model in some other software. We are now going to conduct this scanning.

So, as we mentioned earlier this scanner can scan big objects, but this is a small object that we have here. So, either scanner can rotate around the object or the object can rotate. This is a stand table that helps to rotate the object. So, it helps to rotate the job here. If this is job is kept stationary you can move around. So, this is this is one way we can take

it around it all depends whatever is convenient for the user to start this. There is a button at the back, green button that has to switch it on. So, this is just at the reach of the thumb of the operator who is using this scanner. When we switch this on, you can see the scanning starts, the blinking and the scanning starts. You can see on the screen it is trying to record the data.

So, there has to be some optimum distance from the object. The optimum distance as it was mentioned is between a specific range we are rotating the object, different orientations of the object are coming in contact with the lenses with the light slowly and the product is being scanned. So, you can see this green light here, this green light means the distance is good. This green light you can see the scanning and flashing is going on here. This is the optimum distance between the object and the scanner. This is very important to keep the distance see we are rotating here and we are trying to scan the object.

So, we have developed this data as per the dimensions or the features of the object. This model is generated here. You can see this object it has various features like the hemispherical, the cuboidal angle is there, edges are there, bulgy profile is there. This is actually free from geometry, but one point is that this is made up of aluminum which means that it has a shiny surface. So, you can see that this data is not developed properly at some points, the color is not green. The reason is that aluminum is a shiny metal and this is a luster that does not let the light to reflect back to the lens. So, it is deflecting from the proper way. So, we need to cover the shiny surface that is important when we scan any lustrous material.

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So, we use this developer. This is a liquid spray. So, this can has gas and powder in it. This is of a milky white color when we spray it, you can see it is developing a coating over the object. When this solidifies, it will be white. So, it has made a white thin coating of port powder here this is W1 OO3 developer.

So, it has hidden all the shiny surface and scanning can happen easily. As we know that when light strike on white color, the deflection is very less. Another contrast to this is that we cannot scan black objects. Black objects would observe the light, if you try to scan those. So, black objects are not at all scanned with this scanner if the objects are black window to provide some developer on them and then, that can be scanned because the light has to be defect deflected back. So, this development is removable. It is very easily removable with water or with the brushes as well.

So, this is the way we are using the scanning here. So, developer is here. So, these cameras will capture the data without any scattering, light scattering now, that will strike properly back to the reflector. So, this is always used, powder coating is always used when we have a shiny surface or black surface. So, this developer can be removed properly by using acetone. Acetone is a cleaner; acetone can be used to remove the developer here. So, this is W1 OO3 developer. So, this spray helps to scan the objects properly.

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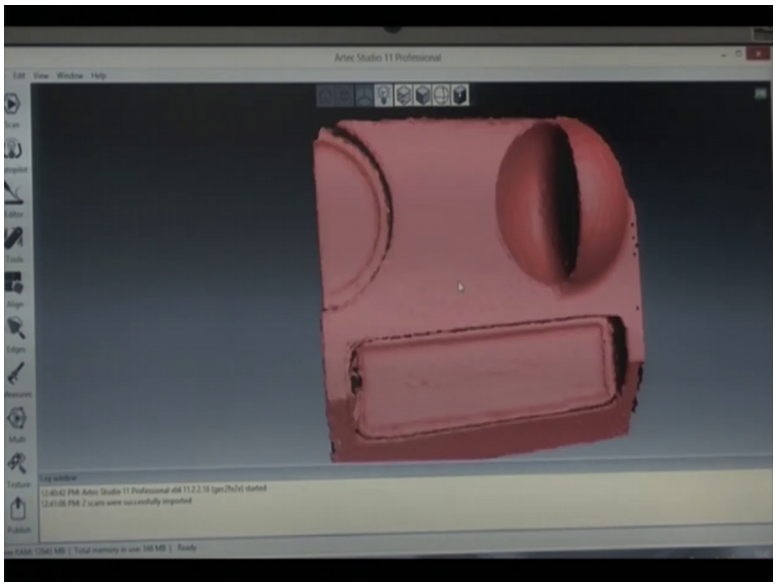

Now, this is the object that we have obtained after the complete scanning. You can see the different views of this you can learn this is this is point view point cloud, this is point cloud, this is the point data or the different point that we have found to, this point cloud helps to get the mesh and that mesh helps to develop is solid model. You can see there is a small flow here this data is not captured, but we will work what we can worked to get this corrected.

We can also see that here the edges are not found properly. So, at edge is also there are certain other errors those who were formed. These you can see here. So, we can use tools. If the tools we can use tools to rectify this, these are the tools to work on this.

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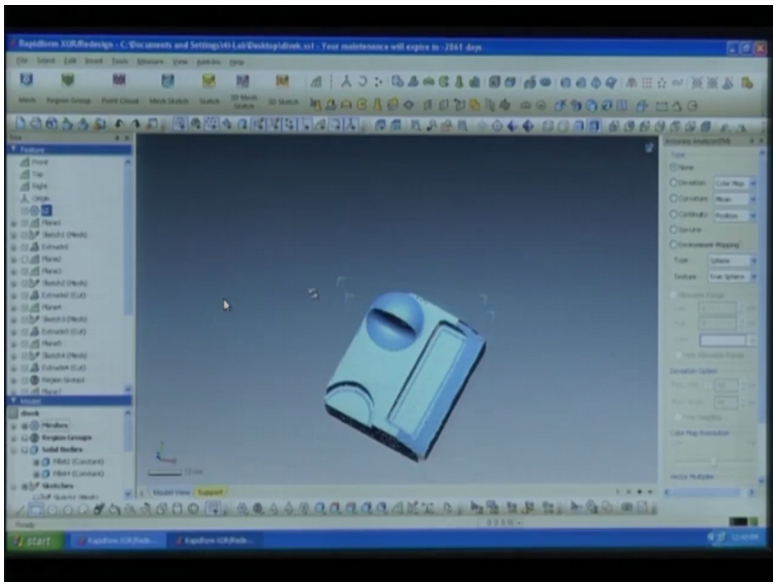

This is a software that is rapid form. The scanning devices is one which can help us to develop the data, develop the cloud data, then we need to work on this cloud data, we export the data to the softwares. This software is rapid form which has a new version geomagic. Now, this is taken over by Geomagic and these two are the same. So, we can open the same model in different softwares for work for modification, for changes, for actually implementing into manufacturing. So, we have exported into this rapid form.

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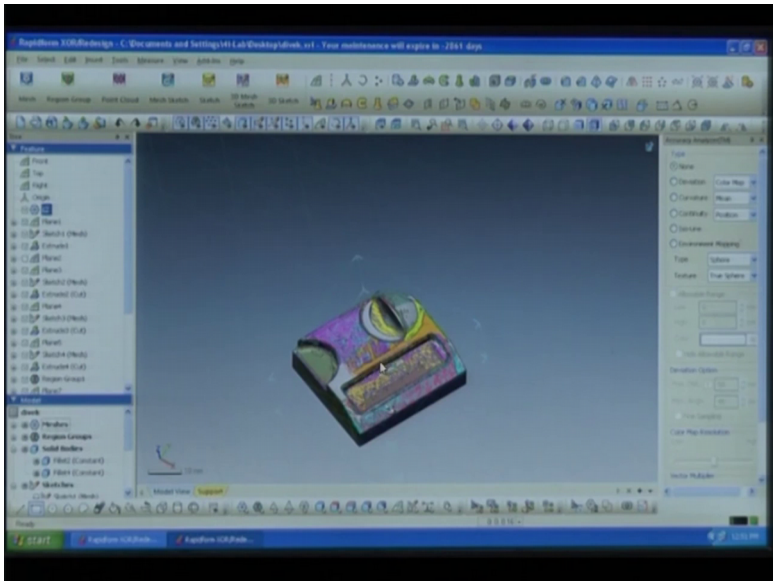

We can see the different groups here division groups. So, when we click here, we get different colors here. These colors are patches, when we do scanning. So, it develops the data in patches form this patches are hen overlapped or they help us to get the object as I said these are rostral way. So, we can also see different these are region groups, these are region groups; if I click here region groups regions groups we clicked here, we get these patches, different patches.

So, these are have been used to develop the solid model for the surface. So, we can also see this solid model, this is a solid body. We have fixed solid body here; we can see the solid body it is worked upon also. We can see the mashes because this is a solid body. We have closed the mashes this. The final body that we have generated using this now this is developed using this scanned data. So, this is the mesh data, this is the mesh data.

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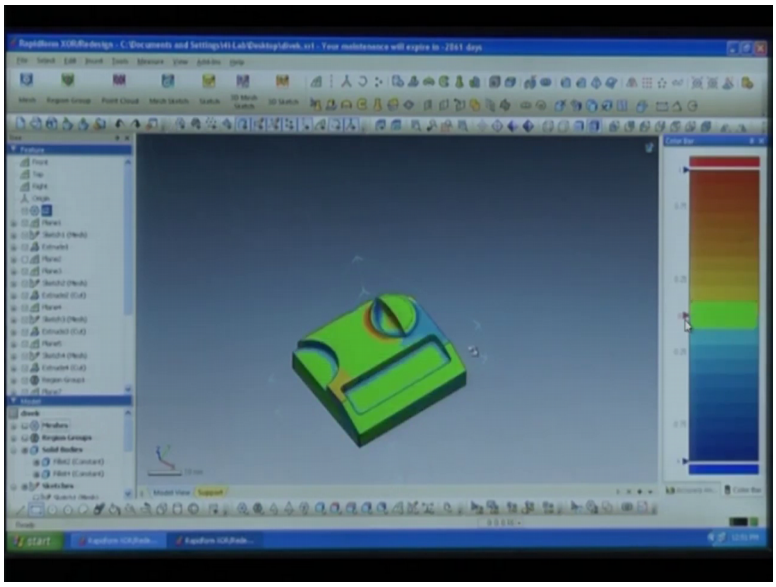

So, there is a deviation. So, this is deviation here. You can see here in colors, this green color indicates that it that it is all uniform that is there is 0 deviation. You can see deviation varies from minus 1 to plus 1.

So, this red color is positive deviation, this is blue is negative deviation. So, in our case deviation is blue and a small part that is red small part that is around 0.75. This color shows this red color shows that it is around 0.75, this green color shows that it is 0 and this is on the negative side blue color. So, it is around again 0.75 and at this point it is little darker at this point it is little darker. It can be around point 0.80-0.85 may be.

So, most of the product the surface that we have obtained is green in color. That means, we have obtained object in a precised way, but there are certain errors at these points, at these edges. So, this is the object that we have obtained using the Artec 3D scanner.

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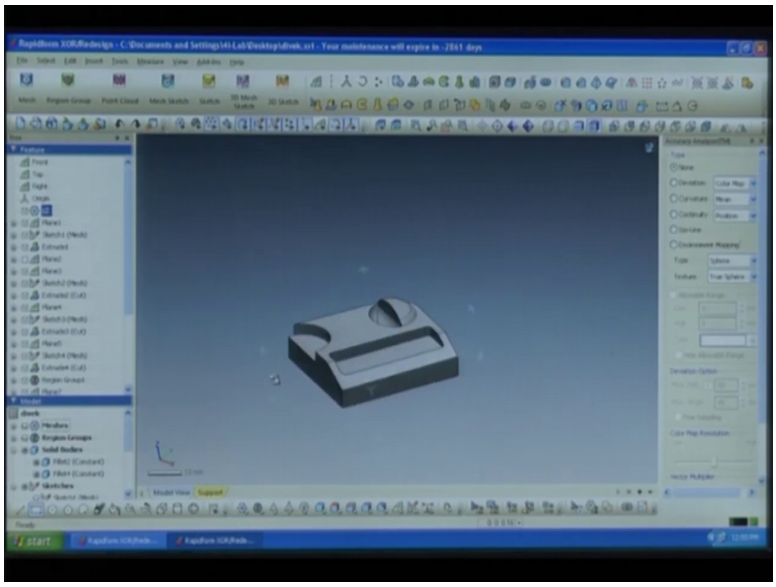

So, this is a final object that we have obtained using our Artec 3 space spider scanner and we can work on this. We have just showed you the demonstration on how to use the scanner, what is the scanner, what is the principle on which this scanner works, but we have not shown you the exact data cleaning that we call it. Data cleaning is working on the data, working on edges, working on tool that would be very extensive.

So, you are most welcome to come to IIT Kanpur to see the demonstrations on this further. So, this is all about the scanning using Artec 3D Space Spider equipment. In the next lecture I will show you the cabinet spanner that uses red light. So, let us meet in the next lecture.

Thank you.