Product Design and Manufacturing
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Lecture - 27
Rapid Prototyping Processes (Part 2 of 2)

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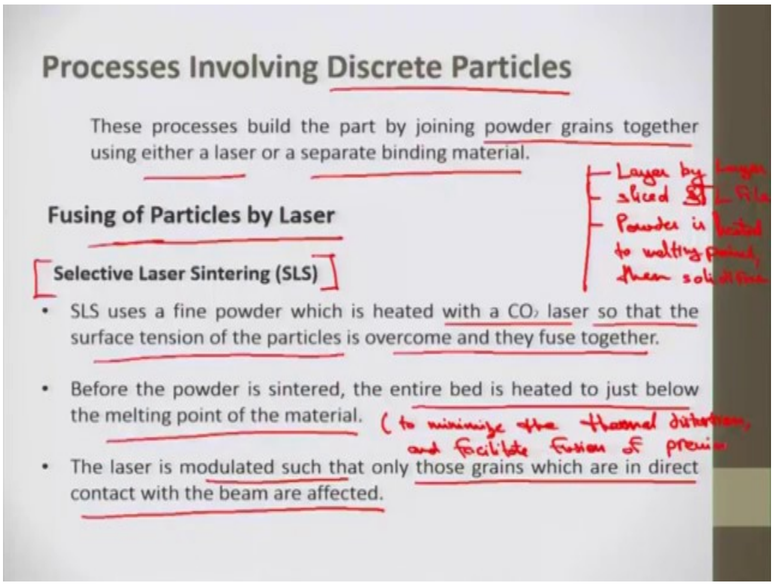

Next is processes those involve discrete particles these processes build the part by joining powder grains together using either a laser or a separate binding material. Now, fusing of particles by laser is the first way, one of the very important process series Selective Laser Sintering. A selective laser sintering uses a fine powder which is heated with a carbon dioxide laser.

So, that the surface tension of the particle is over them and they fuse together. Now this processes again I would like to recall this is layer by layer as the most processes work. Then sliced STL file is used here, then in this case the powder is heated to melting point, then solidified or it then solidifies.

In this case before the powder is sintered the entire bed is heated just below to the melting point of material before putting the powder here. The laser is modulated such that only those grains which are in direct contact with the beam are affected other powder materials other powder grains are not affected at all.

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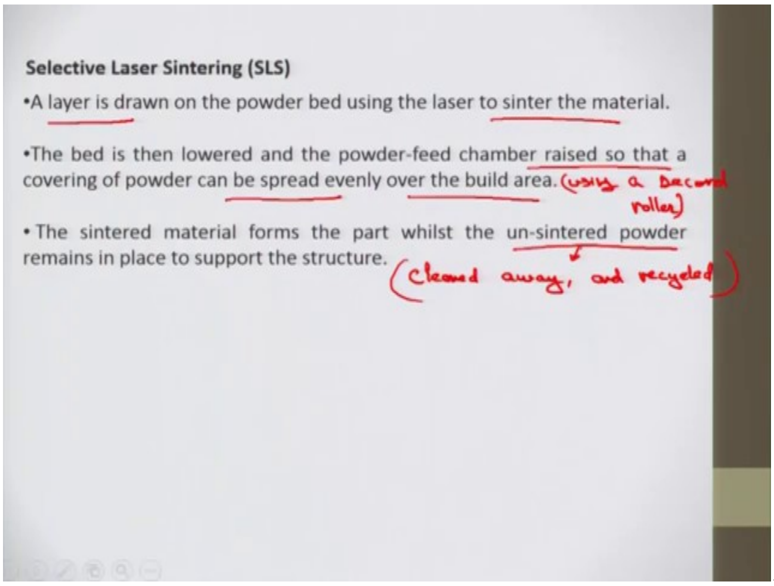

And they do not solidify. A layer is drawn to the powder bed using the laser to center the material. The bed is then lowered and the powder feed chamber is raised so, that covering of powder can be spread evenly over the build area. Now, this is raised by using a counter roller using a second roller.

The sintered material forms the part whilst the un-sintered powder remains in the place to support the structure and this is cleaned away un-sintered powder is cleaned away and recycled once the build is complete cleaned away and recycled. This is un-sintered powder.

Now, what happens before the powder is sintered the entire bed is heated just to below the melting point of the material; this is done to minimize the thermal distortion and facilitate fusion of the previous layer.

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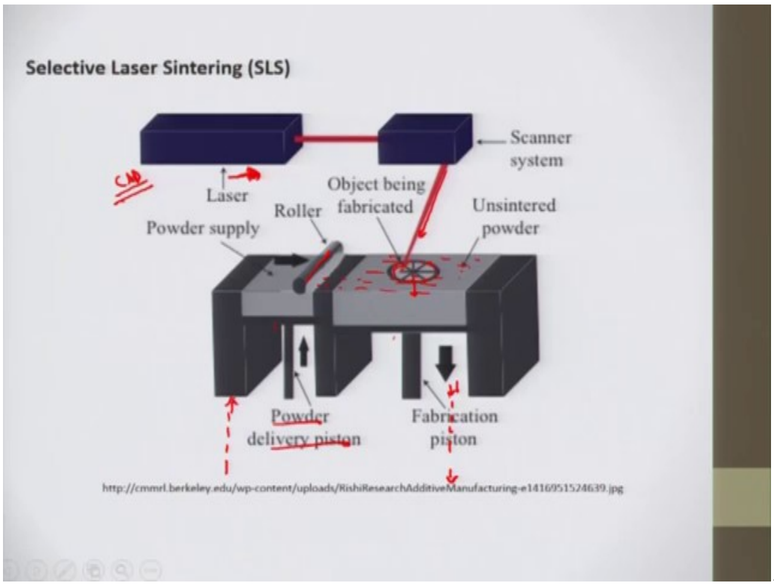

Now, let us see the equipment for selective laser sintering we have the laser here and the object in fabricated the scanner system helps to focus the laser, actually that cad model provides us the database to produce the part. So, what is happening? This is the powder material is the un-sintered powder only one layer this whatever shape is required only one layer is solidified.

Then what happens one once is it is solidified this solid part is moved down and this powder delivery piston is moved up and this role roller then disperse the powder here this roller disperse the powder here, this from the second layer. And when thus for the second layer also again the laser would solidify, here I mean would center because it heats here and the powder would then qualify the selective powder sintering is there and again it is after the secondary it would move down. So, layer by layer this will keep moving down and this would keep moving up this platform.

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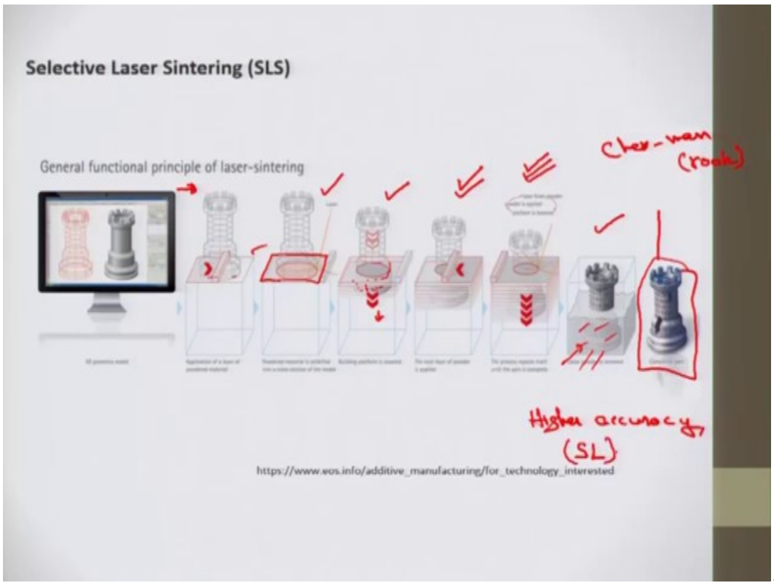

So, let us see a product here, this is actually a chessman that is rook which is being manufacturing using selective laser sintering method. What happens here is this cad model provides the data, STL file is then converted into 2D slices. Now what happens this is first this roller is dispersing the powder, the powder is dispersed over the whole area here. After the powder is spread here this is then solidified and step by step it is moving down, this is the solid material, this is the solid put up solid powder. Step by step it is moving down and once it is it is completely made this is then kept in a bath too let it cool. After cooling this whole powder is removed by soft brushes and the final product is obtained.

So, application of layer powder material is here, here we have powder material that is solidified into cross section of the model, then building up building platform is being lowered here step by step. Here the next layer of powder is applied, here the process repeat itself until the part is complete. The laser fuses the powder is applied the platform is lower 3 steps are being carried out like step by step. Now, loose powder is then removed here in this step. So, this is how selective laser sintering is carried out, now this has higher accuracy in comparison to stereo lithographic process.

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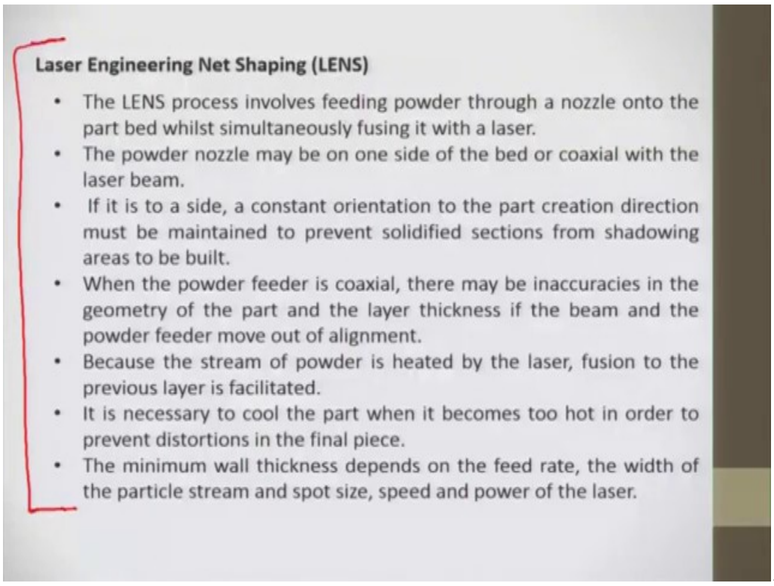

Similar to this one is Laser Engineering Net Shaping, laser engineering net shaping that the lens process involves feeding powder through a nozzle into the part bed while simultaneously fuse fusing it the laser. So, this is a similar process so, you can read this one because of the time constraint I would not cover all the processes in detail, but you can read this and you are open to ask any questions in the forum.

So, I would be happy to answer the questions, I will try my best to answer the questions and you can even ask about various other processes which we have not covered here in rapid prototyping and maybe in oral product design manufacturing.

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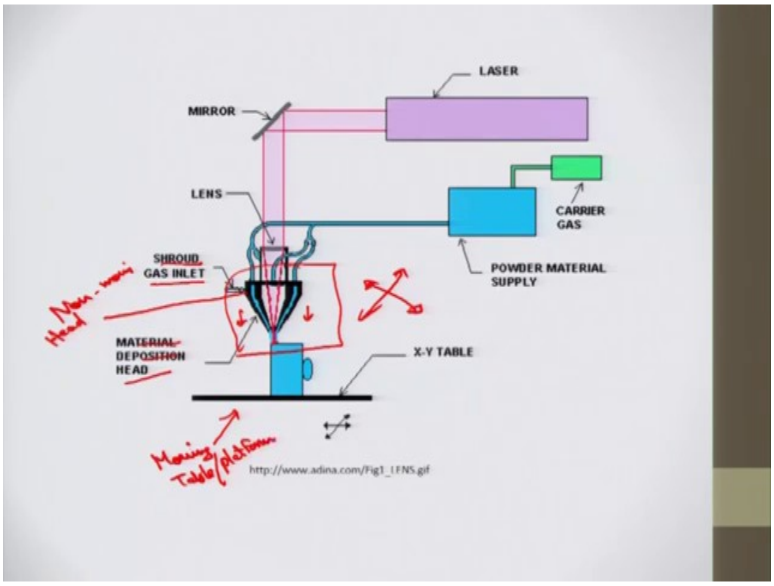

So, in this process I would just try to brief this, in this case the laser is there and the powder material is supplied, both the things are supplied simultaneously. The powder material is supplied and when the point specific point where the powder materials is supplied, the laser is simultaneously sintering the material.

So, what is happening this powder material is supplied, the may laser light is sintering this one, then this shroud gas inlet is there. The material deposition had that is having the laser and powder material supply, then X, Y table is just moving it into 2 directions X and Y. So, this is stable here this is nonmoving head and this is moving table or platform.

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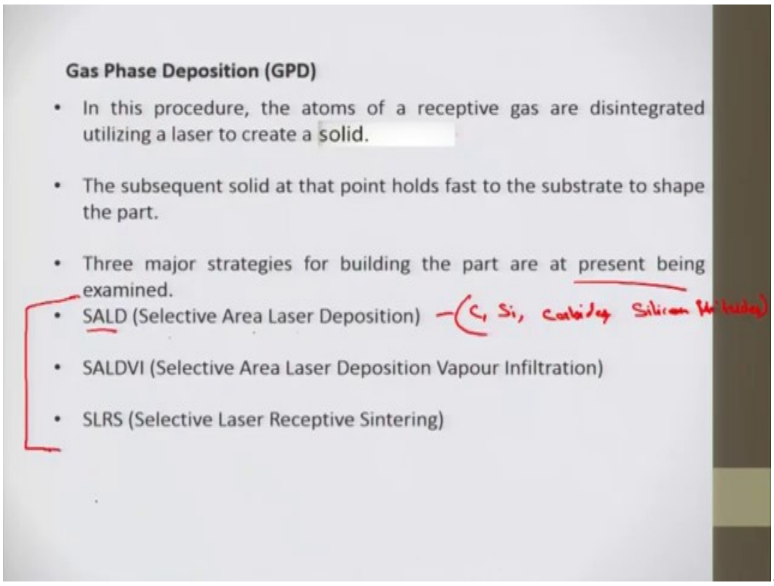

Similarly, there are the processes like Gas Phase Deposition, in this process the atoms of a receptive gas are disintegrated utilizing a laser to create a solid. The subsequent solid at this point holds fast to the substrate and to shape the part. 3 major strategies for building the part are at present being examined, one is SALD Selective Area Laser Deposition. In this the solid segments of the decayed gas is utilized to shape the part, it is convincible to build apart using carbon, silicon, carbide then silicon nitrides.

Then next is SALDVI; Selective Area Laser Deposition Vapor Infiltration. Now this spreads a thin covering of the powder for each layer and then the decade solid fill in the spaces between the grains. The next is Selective Laser Respective Sintering, in this case the laser starts a response between the gas and the layer of the powder to frame and this and a solid piece of silicon carbide and silicon nitride is produced; however, we need not to go to the tail of the processes. So, just an introduction is enough.

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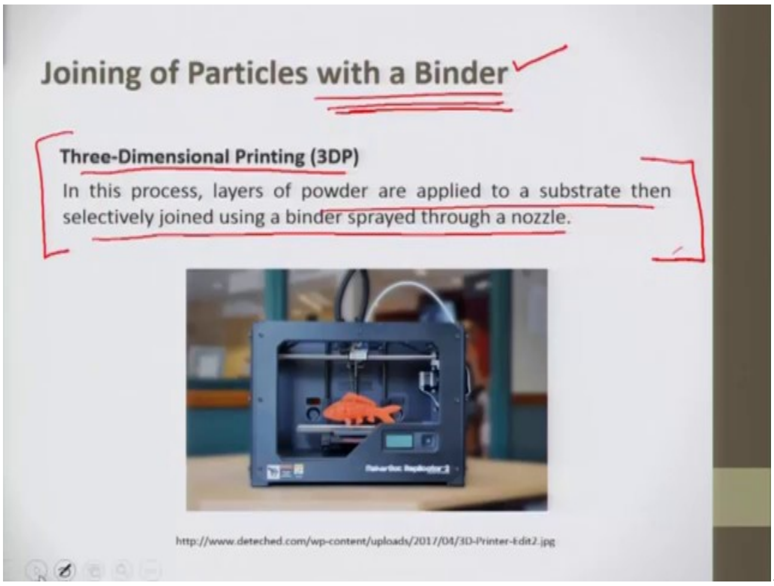

Now, next method is joining of the particles with a binder. Running the particles is the binder means we provide a powder that is the build powder then a binding material when these 2 are mixed together the part solidifies.

The very common method in the market is 3D printing, 3D printing is the process where laser powders are applied to a substrate then selectively joined using binder spread to a nozzle. I think most of you at least mechanical people and computer science people might be knowing this thing so, I would go into details of this one.

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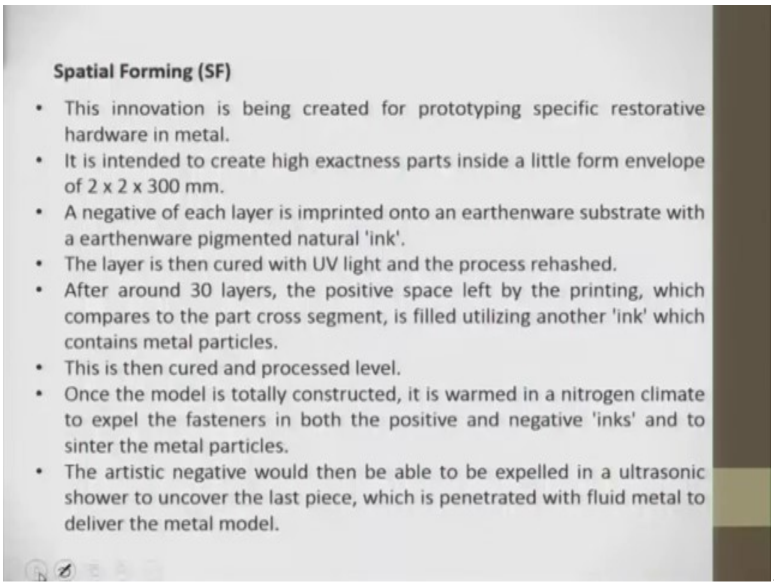

Next we will have spatial formation.

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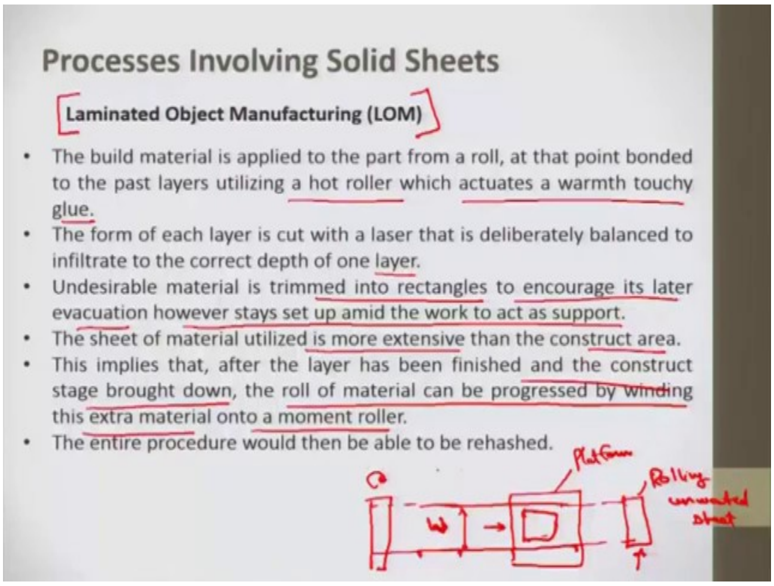

Then we have processes involving solid sheets, in this case a popular or very commonly used process is Laminated Object Manufacturing. In this case the build material is applied to the part from a roll and at that point the bonded to the it is bonded to the past layers utilizing a hot roller which actuates a warmth touchy glue. The form of each layer is cut with a laser that is deliberately balanced to infiltrate to the correct depth of one layer. The undesirable material is then trimmed into rectangles to encourage it is later evacuation; however, it stays set up amid the work to act as support unwanted material or the undesirable material, here can act as the support.

The sheets of the material utilized is more extensive or it is wider than that construct area for example, if this is the material that is to be cut the sheets would be always be wider so, this is my width of sheet. Once the part cross segment has been cut the edges of the sheet stay in place so, what happens.

So, once this is cut this part is cut by laser actually this is a roller here this is a roller on which sheet is rolled on and it is being unrolled the sheet is being unrolled and the laser is cutting this is my platform. The laser is cutting the desired shape then the set further sheet is taken forward step by step. So, this is one step one layer, second layer, third layer would come and this is kept the sheet width is more than the materials required; So, as it stays here and this is being unrolled and the unwanted sheet is being rolled here.

But, this implies that after the layer has been finished and the construct stage brought down the role of the material can be progressed by winding this extra material onto a movement roller here. The entire procedure would then be able to rehashed here. So, this is a specific laminated object manufacturing apparatus here.

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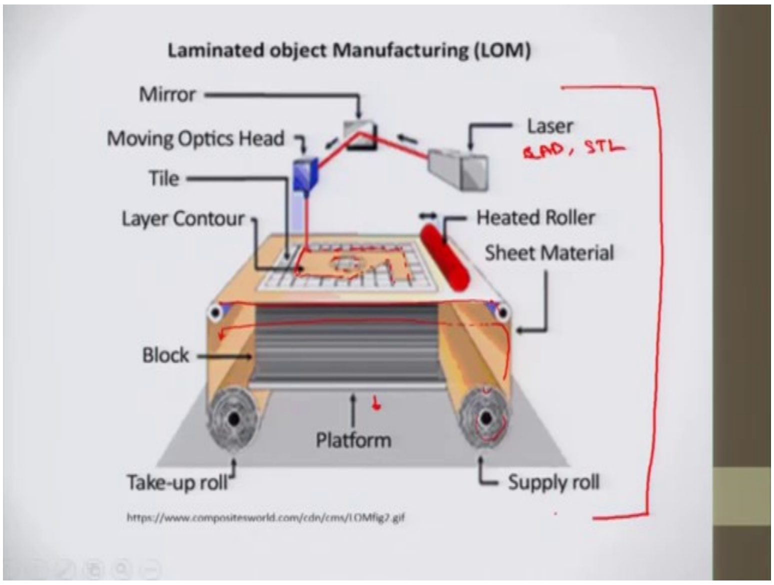

So, what we have is this is the roll this is actually take up roll, this is supplier role. Supplier role is being unrolled the this is the sheet the sheet one layer of sheet is there, the laser this is the mirror the laser that data is again provided through my CAD in a STL format.

Now this laser is cutting this specific shape, after cutting the shape the specific shape the platform is then lowered here and the second step of sheet this would be unrolled and second step of sheet or second I would say layer of sheet would come up here. And layer by layer it will keep on building this component here whatever is required. So, this is laminated object manufacturing method.

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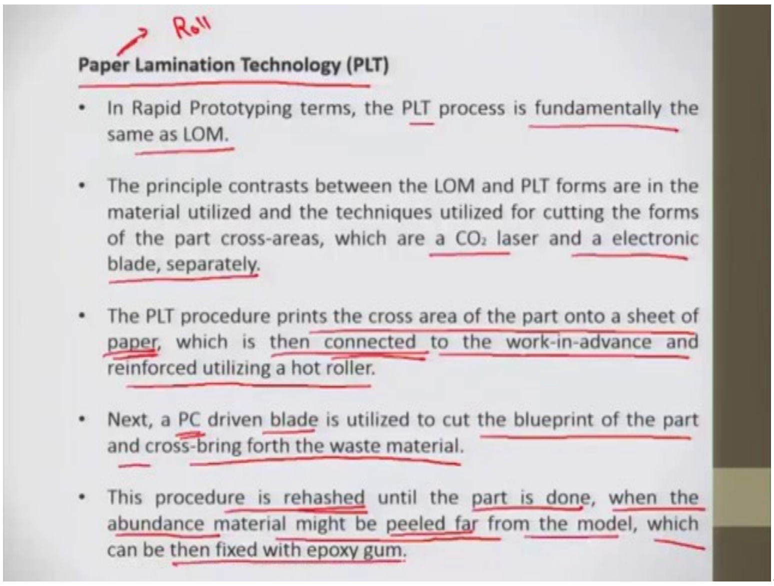

Similar to laminated object manufacturing we have Paper Lamination Technology; the major difference is that the sheet here is of the paper the paper roll is used here. In rapid prototyping terms the paper lamination technology process is fundamentally the same as laminated object manufacturing method. The principle contrasts between these 2 is that in the form of the material that is being utilized and the techniques utilized for cutting the forms of the part cross-areas here, which are carbon dioxide, laser and a electronic blade, separately.

The paper lamination technology procedure prints the cross area of the part onto a sheet of a paper, which is then applied or connected to the work-in-advance and reinforced utilizing a hot roller. Next, a PC driven blade, PC is a process computer driven blade is utilized to cut the blueprint of the part and cross bring forth the waste material. This procedure is then repeated until the part is done whole part is complete, when the abundance material or the extra material might be peeled far or cut away from the model which can then be fitted with an epoxy gum.

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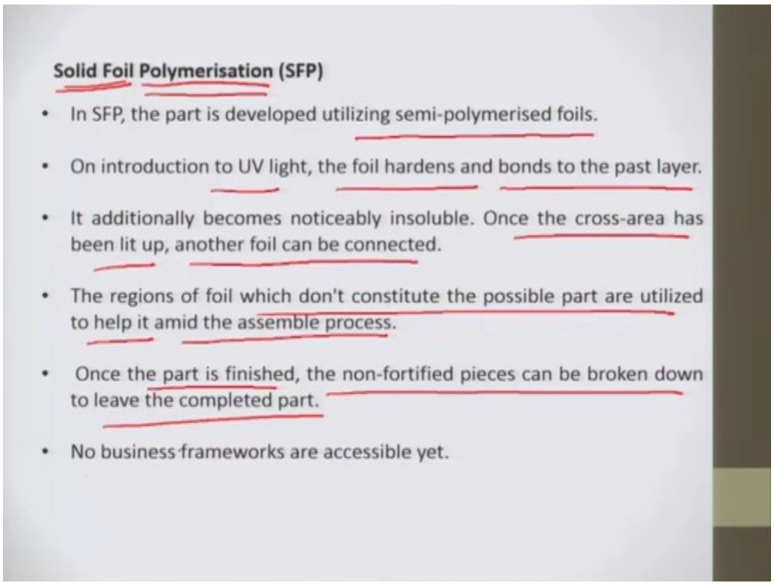

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Now, similar to this process we have Solid Foil Polymerization, solid foil polymerization, the part is developed utilizing semi-polymerized foils. On introduction to UV light, the foil hardens and the bond and bond the pass layer. It additionally becomes noticeably insoluble; once the cross-section area has been lit up or it is heated another foil can be connected.

So, in this case solid foil polymerization is being carried out. The range of foil which do not constitute the possible part are utilized to help it amid the assemble process; Once the part is finished the non-fortified pieces can be broken to leave the completed part, no business to complete part. So, these are a few very prominent processes which are being used in rapid prototyping.

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So, next we have a few applications of rapid prototyping, rapid prototyping applications can be divided majorly into 3 sections; Number 1 engineering design number 2 analysis, number 3 is tooling. In engineering design, we can consider some product that we need to (Refer Time: 17:38) feature we can just design that product and produce a prototype not designers as able to confirm the design by building the real model. We will just see a few examples here like this one.

So, this is a drill that is the final product that is required. So, a rapid prototyping product has given us a model for which we can have the feel of the product. We can see how the drill bit feel when we have that in hand, how the button filled, how could we have various like this chuck here, the drilled body we can put hand over here so, all these things.

the next is analysis and planning, analysis and planning would mean like how many products, how many components are required here how many components, what an manufacturing required. Then we can have tooling, in tooling we can think of what kind of tool, what kind of manufacturing set up all those things are required.

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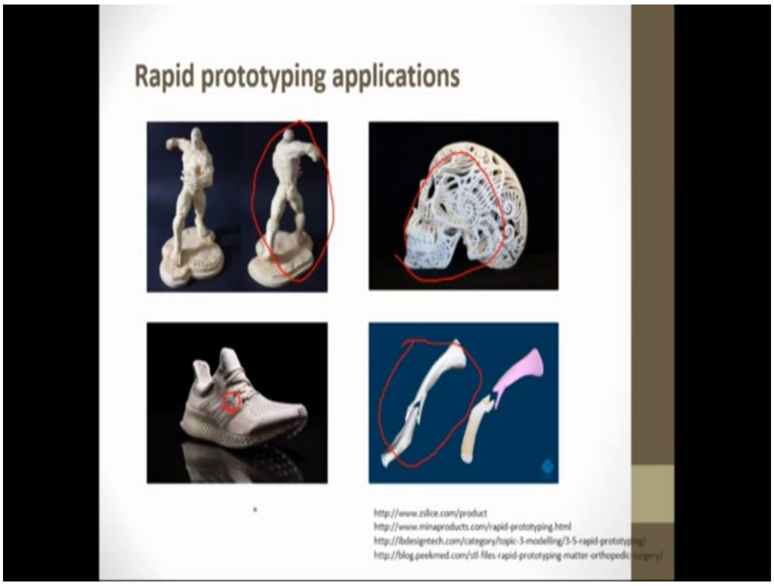

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So, you can see a few products here this is human skull a model of humans can achieve the complexity of the products he had. So, many complex features over here, these are human limbs.

So, these complex parts can be very easily manufactured using rapid prototyping or adaptive manufacturing. So, we will see few products in the 4 I lab in IIT Kanpur.

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Now, we are here in 4 I lab IIT Kanpur and few products are displayed here on the table which are manufactured using rapid prototyping technology.

So, what we can see in rapid prototyping let us see this first product this crank. This is a crank that is all that is all manufactured using fuse deposition methodology, see the kind of features it have. Also we have this cylindrical section, now this cylindrical section is produced using rapid prototyping again. So, this can be used to see if the size of the pipe which we were considering is that or not with we fit go fit no go fit with it fit properly or not.

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Next, we have this impeller, this is actually impeller it has so, many fins in it. You can see the number of fins it has number of very deep features it have, it just sucks the fluid and throws away. So, this is manufactured in one go using rapid prototyping technology in (Refer Time: 20:32) we can do the rapid prototyping is just scanning the object using 3D scanners and producing that again.

For instance, someone loses laser or limb let me say a it loses it is right leg, so right leg is lost we cannot have that again. What is the beauty of 3D printing you have? What is the beauty of rapid prototyping I would say here we can scan the left leg and using mirror command we can produce.

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So, here we have a few products like that here let me say this pen stand, this is first scan scanners all the through it will take 1 or 2 or hours to scan this then this is manufactured. So, this is the model. So, one can see the closeness of the product that is just being scanned to the original product. So, this is the beauty of rapid prototyping here.

So, next what we can have is these human models. So, if there is if you need to some human model we can just scan the face or the body of the human and produce this kind of model.

So, what you can see this bigger model this bigger size model that is. So, this is difference in these 2 models, this bigger size model it is harrow from inside and a small face that is solid from inside. But, these are a few products that can be manufactured using rapid prototyping technology. So, this is all in this week rapid prototyping.

So, we will meet in next week where we will discuss plant layout planning, conduct warmth over, will discuss managing competitiveness disk those are few important aspects in product drill and manufacturing. So, let us meet in next week.

Thank you.