Design Practice - 2
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Lecture - 30
Introduction to Rapid Prototyping

Hello and welcome to this design practice to module 30 another course this particular module is dedicated to rapid tooling rapid prototyping. And in the last few modules we have been extensively looking at CNC programming and processes related to the CNC machine. So, let us look at what is rapid prototyping to begin with.

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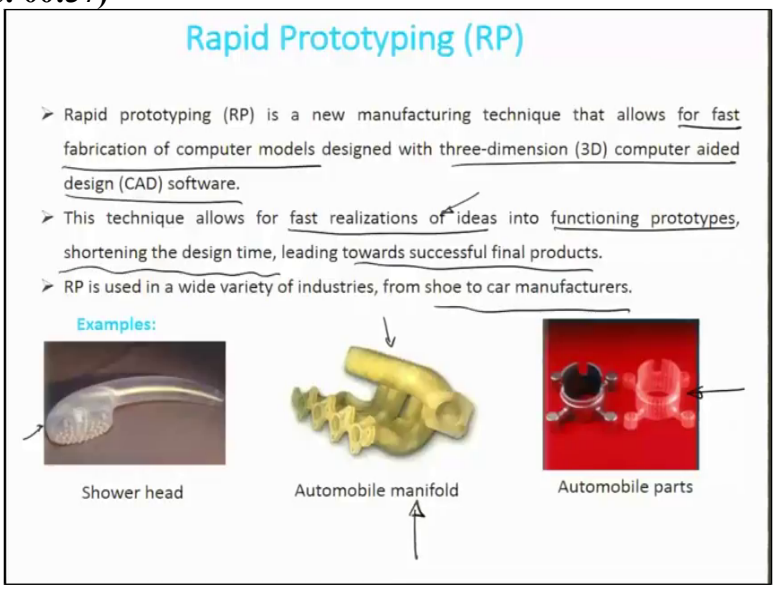

So, rapid prototyping basically is new manufacturing technique that allows for fast fabrication of computer models designated with three dimension computer-aided software CAD software. So, the idea is whatever we have done towards the beginning of this course where we have talked about lot of handling of lot of data related to surfaces more related to you know let us say 3 dimensional models. The same coordinate data can be really mapped in form of a direct you know manufacturing through this process rapid prototyping.

So, this process allows fast realization of ideas particularly it is used more as a modeling tool for the you know prototyping stage of the design. Most of the designers are have equated to visualizing 3d shapes forms etc by looking at the rapid prototyping forms because it is easily doable. So, basically the idea here is that through polymer or through metals you can actually

formulate a layer by layer manufacturing so that any complex topology any complex shape can be reproduced okay.

And you know the ideas into functional prototypes is basically the aspect of design which is covered using these rapid prototyping techniques. So, therefore because we have functioning prototypes for all the design ideas that you have already discussed and sketched and schematically drawn and you know also made the computer model. Typically shortens the design time because a lot of time otherwise is spent in visualization and thinking about what will happen to the final product out layer.

So, if you have something in hand where you are actually looking that which is maybe a demo maybe a scaled-down version but it just gives you an idea of the whole 3d shape or size or form. So, this really is a step towards successful final products. So, RP today is used in a wide variety of industries from shoe makers to car manufacturers I would say. This is the level and complexity in which our RP is used some examples could be for example can look at the shower head which has been 3d printed using polymer.

As an extremely complex shape but you know the the form of this particular object how convenient it is to hold by a user what is the extent of water pressure that can be dwelled. How well the water can be split? All these things all these aspects are shown by the shower head this again a 3d print of an automotive manifold. Just prior to the final designing ok it is important that you develop this intermediate step to look at aspects related to flow and other fitment aspects this part gets into an automotive and fits along with the engine.

There are other automotive parts where 3d prototyping is used quite a bit you know in order to visualize how the prototype would really look like from design stage to a product you know to a prototype stage or a component stage.

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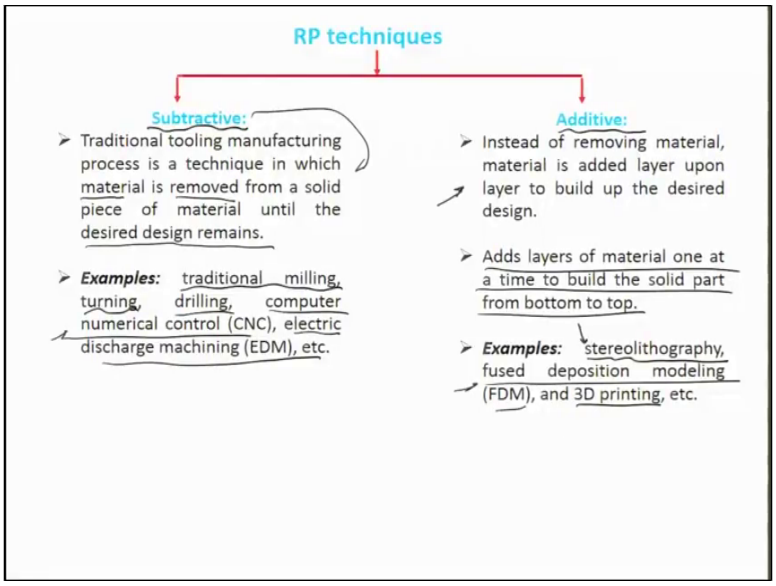

So, these are some examples of rapid prototyping if I looked broadly into what are the kind of techniques which are involved in doing this rapid prototyping there are either subtractive techniques where you take out material or there are additive techniques where you remove instead of removing the material you add layer by layer and build up the desired design. So, when we talk about traditional tooling and manufacturing processes it is a technique which involves mostly the material removal processes from solid piece of material until the desired design or shape or form is realized.

There many such examples okay one could be traditional milling turning drilling computer numeric control CNC machines. You looked at a lot of aspects of CNC in the last few lectures electric discharge machining so on so forth. These are all subtractive techniques you know and you can say that if you want to use these processor for you know prototyping your design ideas they could be subtractive techniques for prototyping the design ideas.

On the other hand additive manufacturing or additive machining is probably the new pot in the industry principle in principle reasons for thinking your deposition rather than removal is the prevention of wastage which otherwise would be when you are trying to machine an otherwise solid block or shape and removing material as chips. So, that gets eliminated in this case once you are adding on because you can add the deposited amount the desired amount you know rather than extra amount and taking it off okay.

So that is one principle reason for going the additive way in the manufacturing domain. So, it adds layers of materials one at a time to build the solid part from bottom to top. The many

examples one of them which was widely used in the earlier years and still in the electronics industry is used quite rapidly is the micro nano manufacturing techniques you know used as a micro nano manufacturing technique is a stereo lithography.

Then you have fuel deposit in modeling FTM which uses single or two-phase polymer systems and the polymers are otherwise fed in as wires you know obtained from Pellets and then they are extruded so that there can be the deposition of the extruded polymer on to a bed using a track which is very well defined through a computer design it a design process. So, 3d printing in metals is another area where you know you are talking about a manufacturing for rapid prototyping of performing that it rapid prototyping.

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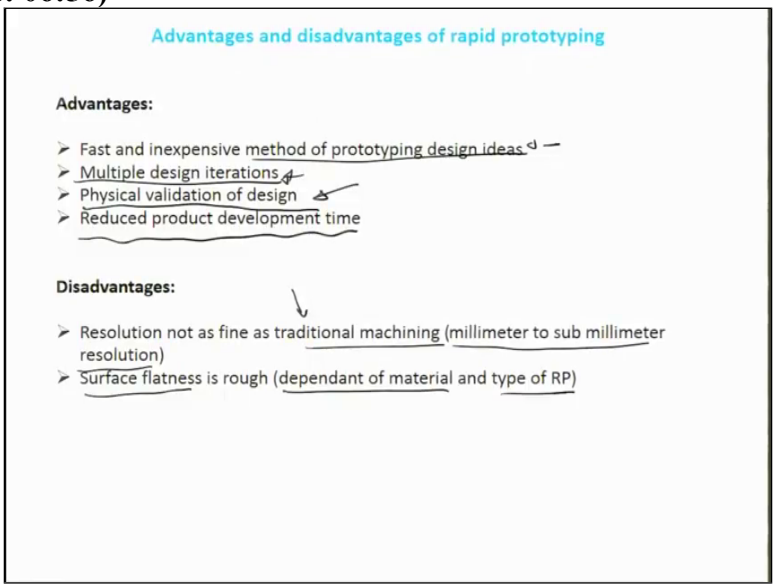

There are several advantages and disadvantages of rapid prototyping as such the advantages could be that the fast and inexpensive method of prototyping the design ideas you could have multiple design iterations and try to creatively visualize it and visualization becomes much easier if you have a model in hand rather than mental form of visualization. And then you have physical validation of the design sometimes.

Sometimes you are doing reverse engineering and trying to see how the design would come out okay in terms of the CAD geometry that has been plotted in space. And so this gives you a quite a bit of you know validation of how a manufacturing method would work on the CAD data. For example a CNC operation would work on the CAD data. So, there is an in-between step here which is less expensive and does not cater to the complete re-prototyping of the final form once there is an error.

So, then there is a reduced product development time again which is another very important advantage for the rapid prototyping techniques. There are several disadvantages also one of the most important disadvantages is the resolution it is not as fine as the traditional machining process. You know traditional machining typically goes to millimeters or even sub millimeter domain resolution.

Rapid prototyping may not be able to give this much kind of a surface finish but there is a way out you can think of a hybrid strategy where you add and remove and that may lead to a reasonable amount of surface finishing. Some of the tools like electrochemical machining an electro deposition used in synergism used in with some synergy would be able to realize as fine surfaces is about 100 nanometers plus minus average roughness values, as pointed out in the literature many times.

So, surface flatness is inappropriate when you talk about RP techniques obviously dependent the material and the way it flows or extrudes and there may not be much control unless you use another strategy of subtractively also machining as well as adding so that the final formulation of the roughness can happen.

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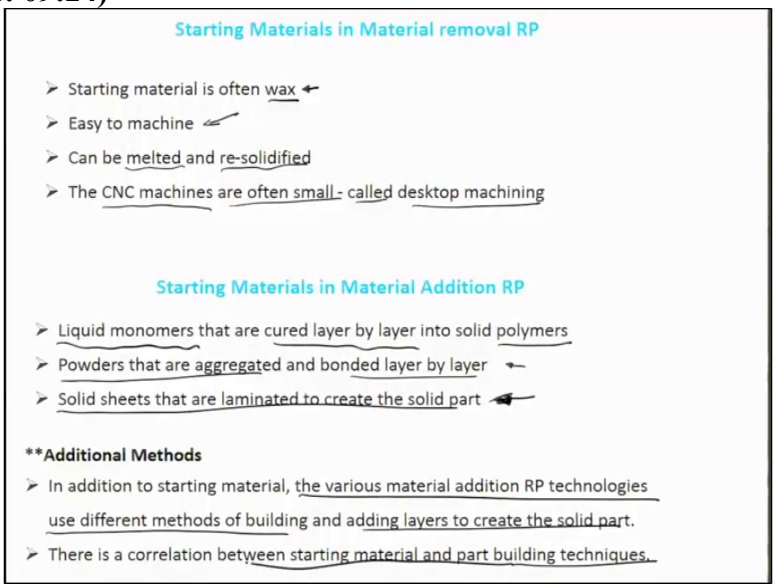

So, what are some of the starting materials in the rapid prototyping domain obviously the first material that would come to view is wax which is easily meltable, flowable is easy to machine. You know it can be re-solidified quickly it can be melted quickly and in fact there are Desktop

CNC machines which would actually build models using wax which was one of the first generation RP tools that started within the industry.

Then there are polymers which are mostly very widely used particularly solid polymers which are formulated through curing layer by layer of liquid monomers then there are powders that are aggregated and bonded layer by layer this process also known as the selective laser sintering process SLS process. There can be solid sheets that are laminated to create solid parts together the only catch here is the layer by layer construction of a certain shape or form or size that has been designed through the carry interface.

There are some additional methods in additional in addition to starting material the various material addition RP technologies use different methods to build and add layers to create solid parts. And there is a correlation between the starting material and the part building techniques which leads to the realization of the final rapid prototype product.

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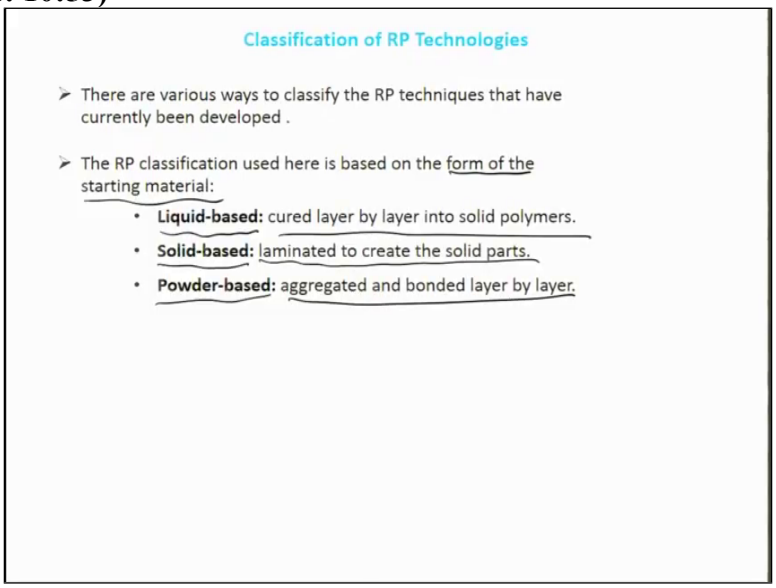

So, how do we classify the different RP technologies which exists so you can have one form of classification based on the starting material for example there could be liquid based 3d printing process which when cured layer by layer into solid polymers develop the solid shape or form of size or the final 3d product. There can be solid based materials particularly I mean it is which are bonded to each other to create the solid parts.

And it could be powder based where it is still solid but then granules and these granules can be sintered to each other very in a focused manner using laser and other you know light forms and

this aggregated and bonded layers can be again built up layer in a layer by layer manner so that the final 3d shape or form can be realized. So, these are some of the classifications of RP tools based on the starting materials.

We will go into the details of each of these probably looking into some of the aspects associated with stereo lithography which is actually a liquid based 3d printing process you know FDM which is again based on a solid extruded polymer and then para based which is again based on lazing action and sintering action. So, I think I will close this particular module because this was a shorter module to plug the gap which was created in the last week's lectures of about 10 minutes or so. So, the next module will start some of the detailed discussion about these individual techniques as of now, thank you very much.