Product Design and Manufacturing

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Lecture - 02
Fundamentals of Manufacturing Towards Product Development

Welcome to lecture 2, in this product design and manufacturing course. Last class when we ended I gave a small assignment asking you to do choose 4 different products; which fascinates you and then I hope you would have considered or you would have picked up 4 disassembled assembled. And then you would have written down the list of all fastening techniques was involved in that particular product.

I am sure by doing this exercise you have understood how different products try to use different technology in assembling and disassembling. So, we will continue with our lecture. So, today we will move to lecture 2 wherein, which we talk some more little bit fundamentals of manufacturing, wherein which we keep back of our mind all our focus towards product development.

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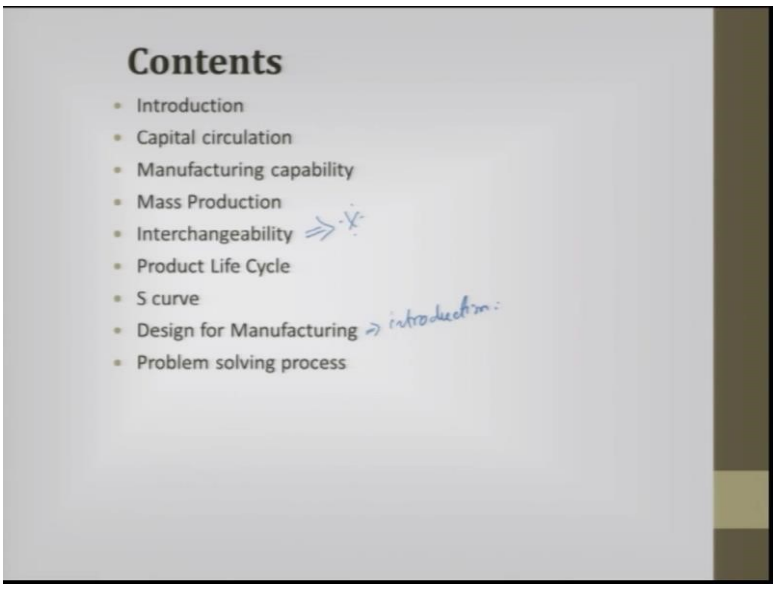

So, in this slide we will try to have an introduction then capital circulation, which is very important because when we try to do a product you should also understand what is the capital which is involved, how do I get it out or something like that. So, manufacturing capability, mass production, interchangeability which is a very, very inter important concept very important. When you talk about product interchangeability is very important and then product life cycle S curve design for manufacturing we will just have an introduction in this chapter, but later we will have a complete session discussing about it. And then last will be problem solving process.

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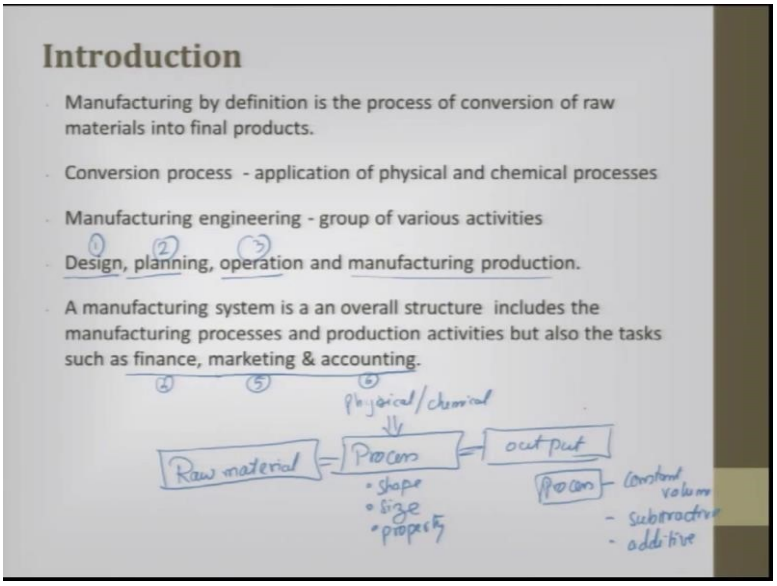

When we talk about manufacturing is nothing but I take raw material, raw material I try to do a process. And I try to get the output ok. This process can be you try to apply either physical or chemical energy try to change the raw material either raw material here you can change the shape, you can change the size or you can just only change the property to get the required output.

When I talk about shape and size you can use additive process or you can use or subtractive process. So, when you talk about processes it can be classified into 3, one is called as constant volume process. It can be subtractive process and it can be additive process ok. You can follow any of this process and then try to apply either physical or chemical energy to it and try to convert the raw material into a required output. Ok by

this process is called as manufacturing and here when we talk about manufacturing, we have to keep in mind a concept called productivity so; that means, to say with minimum input getting maximum output ok.
So, here if you see manufacturing it is a group of operations or activities involved. So, it is not only converting the physical product it is also involving other organizations or departments in developing a product wherein, which design plays a very important role planning operation and then comes manufacturing production to make a product.

You should understand all these things when you are trying to do a product design. The manufacturing system if you see as such it is a overall structure, which includes not only manufacturing process and production activities, but also the task of finance, marketing and accounting. Today I have a wonderful product I have a good set of customers for it, but if I do not have a finance to try to improvise the product or to produce the product in mass such that the economics goes down so then I am in trouble.

So, manufacturing is not only producing, but also reaching to the customer, such that you try to do it in an economical manner. So, it is now clear manufacturing is not only producing it involves design, planning, operation and then you do manufacturing process and apart from this you also try to do finance, marketing and accounting. All these departments put together in converting a raw material into raw material into a useful output is called as manufacturing. And when I do this I try to do in a highly efficient manner that is called as productivity ok.

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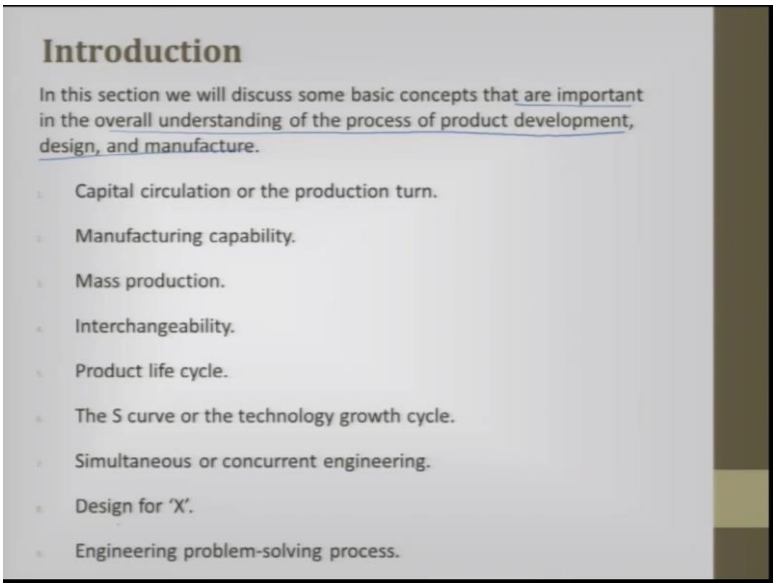

So, we will see in this section some basic concepts that are important, in the overall understanding of process of development design and manufacturing, 1 is capital circulation or production turn.

2 is manufacturing capacity 3, is manufacturing production, 4 is interchangeability, 5 is product life cycle, 6 is S curve or technology growth curve very interesting, simultaneous or concurrent engineering design for X last class, I started about design for manufacturing. So, design for X and engineering problem solving.

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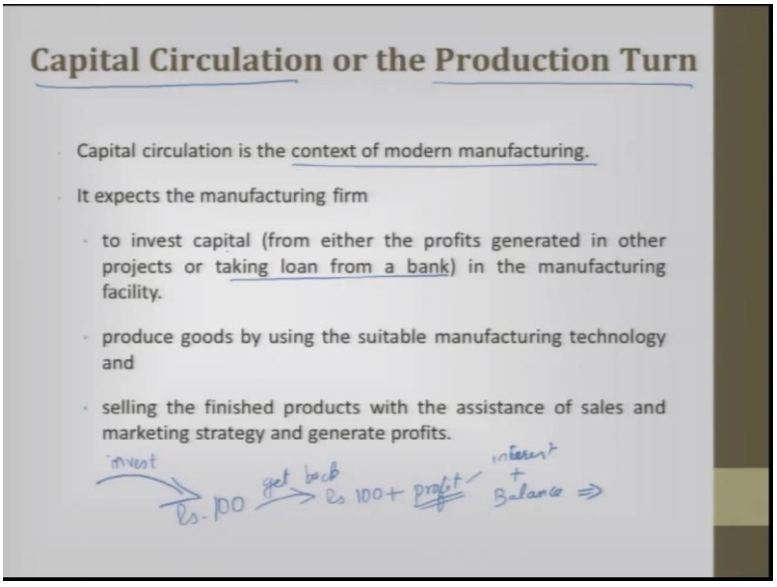

When we talk about capital circulation or production term in context of modern manufacturing to invest capital from either the profits generated in other projects or taking loan from the bank in the manufacturing facility.

So, it is to invest capital in a manufacturing facility is capital circulation. So, it is expected that the manufacturing firm to an invest capital, in the manufacturing facility to produce goods by using the suitable manufacturing technology and selling the finished product where the assistance of sales and marketing strategy and generating profits.

So, this is what is called as capital circulation so; that means, to say I invest 100 rupees, rupees 100. When do I get back my 100 rupees? So, this is investment invest and this is get back. When do I get back rupees 100? And when I get back I will always try to have a profit also with it. So, if I am fat with money I just invest whatever profit comes it is all for me.

But when I do this investment through a loan from a bank then the interest of that also has to be taken care and then I try to make my profit. So, whatever profit comes out again I will have to pay the interest component, interest and then I try to get the balance and my balance. So now, I will try to have a lesser amount as compared to if have a capital which is getting invested from some other place. This is very important when do I get back my investment whatever I do? So, why this is link to the economics of the product?

When I try to develop a product, which is 10000 rupees or 20000 rupees or a huge investment. So, I will not be able to sell that particular product to mass community. So, economics plays a very, very important role when you try to do product design, or in other ways the costing plays a very, very important role.

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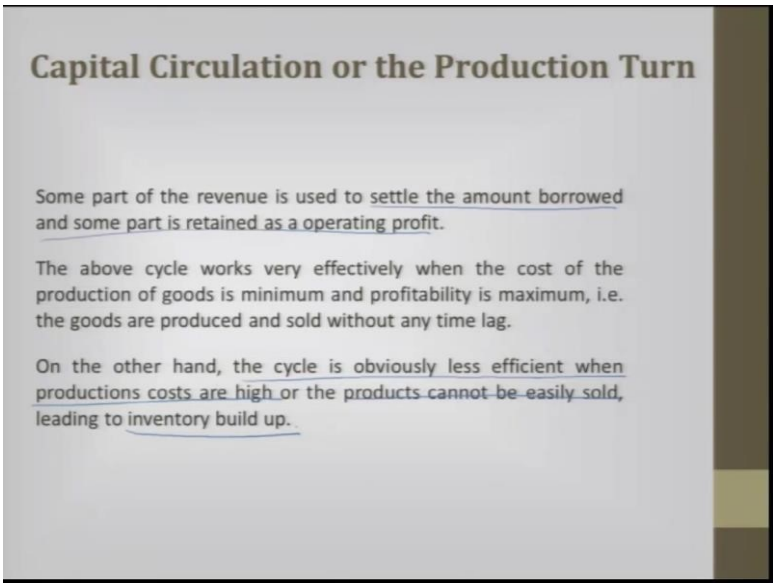

Some part of the revenue is used to settle the amount borrowed and some parts are used to retain for the operating profit.

So, the above cycle works very efficiently when the cost of the production of the good is minimum and the profit is maximum, which everybody would like to have. I invest 10 rupees if I can sell a product for 50 rupees I will be happy to do it, but unfortunately when I invest raw material 10 rupees and other things the sales component everything put together that is operational cost this 10 rupees will become 30 rupees and then I sell it at 50 rupees it is only 20 rupees profit.

So, this is very important, if I cannot make a product which is economical whatever product I do; however, good it is it will not be a successful product. On the other hand, the cycle is; obviously, less efficient when the production costs are high or the products cannot be easily sold, leading to the inventory building up. So, this inventory building up is another big thing. See in agriculture what happens when there is a mass production of vegetables perishable goods. So, then what do they do they put it in cold storage wait for a time and then they disperse it off.

So, when they try to do this they try to have to invest in the inventory storage. So, raw material plus inventory storage whatever it is and then whatever is the selling price their profit goes down because they have invested in the inventory. In the same way when I try to have a sales of textile clothes. If I cannot sell the clothes before the fashion ends or

before the season ends then naturally what I do is, I try to somehow clear my textile whatever I have as a clearance sale and try to get it. Otherwise my inventory builds up end and I do not get the return on my investment.

So, this has to be taken care when you try to develop a product. When you try to design a product try to choose in such a manner such that the product can be easily fabricated with low investment and reach out to lot of people.

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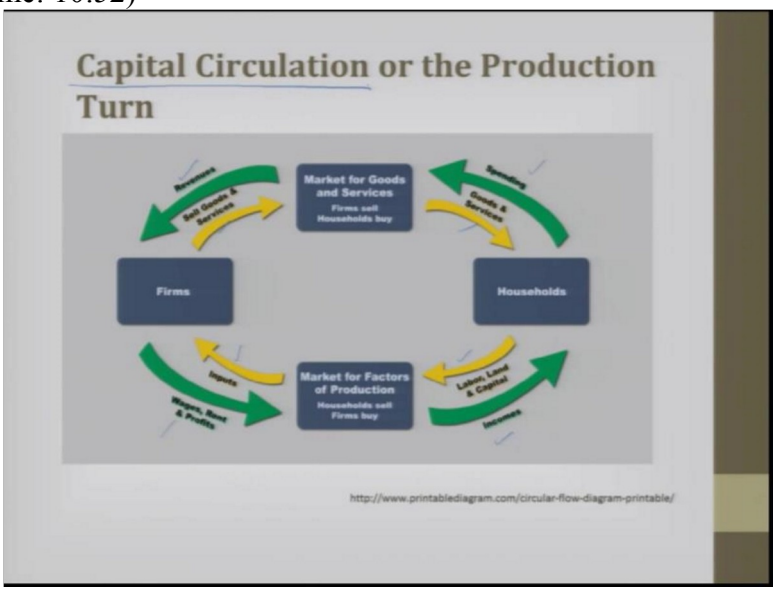

So, when you talk this is the nut shell about the capital circulation or the production turn. So, if you look at it the firm is their so sales, goods and services, market for goods and services, the firm sells household buy and from there you see that. So, you see front yellow goes in one direction and the other one green goes in the other way direction.

So, if you look at it market for goods and services, market for factory of production, right? So, if you look at it let us start from here firm. So, the firm sells goods and services and what do the company get is the revenue market for goods and services. Goods and services are sold to the house hold and this is just pending which comes by.

So, here market factory of production. So, here in the factory you will have labor, land and capital which are invested. And then this; whatever you get out is going to be income for the household. So, from here you put all the inputs to the firm and wages rent and profit. So, you have 2 circles which goes around. So, this is revenue, wage rent, income

and spending this is all financial and manufacturing if you see input, services goods, goods and service and then labor and land this are the inner circle of it. So, this is the capital circulation or the production turn which is very, very important.

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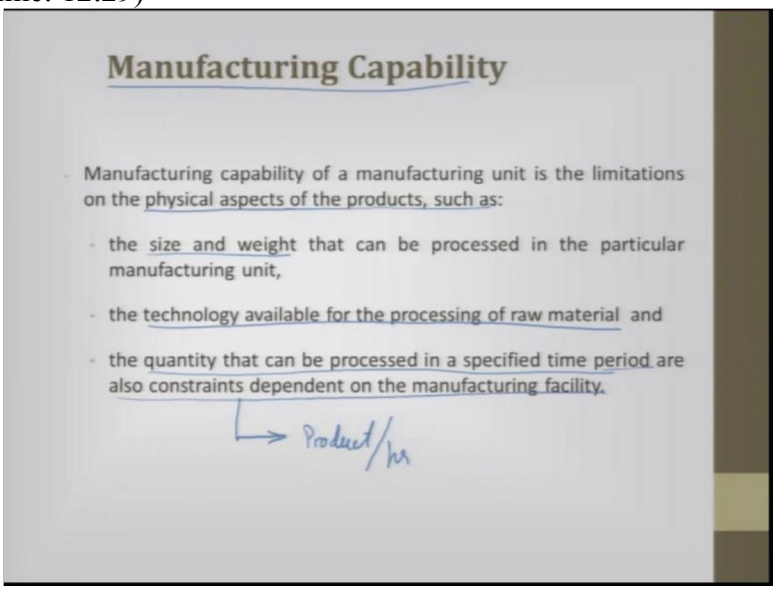

Next let us look into the next topic of manufacturing capability. So, manufacturing capability is what is the size I can have I can handle? What is the shape I can handle? What is the raw material I can handle? So, what I can produce is the manufacturing capability.

So, manufacturing capability of a manufacturing unit is the limitation of the physical aspects of the product such that the size and weight it can handle. The technology available for processing raw material and the quantity that can be process processed in a specific period of time are also constrains depending upon the manufacturing facility; that means, to say how many products can I produce in one hour?

So, that is what we are trying to say as the quantity. So, when you talk about manufacturing capability size and weight plays an important role. Technology what do I have for example, if I have plastic parts to be made. So, the technology what I have is injection molding machine and generally when I have when I talk about injection molding machine, I always have to think of producing lot many parts in one hour so; that means, to say the production rate will be very high.

When I talk about make using the same plastic and then trying to make a composite or just a hull of a ship, I hardly choose the technology which is used not injection molding, it depends on the raw material they try to do blow molding or something like that and then try to get it. So, here the number of parts produced is very less may be 1 or 2 in hand in a day to get it.

So now the manufacturing facility or the capability is to produce, how many parts? What is the technology? What is the size and weight I can handle such that I can try to decide the factory?

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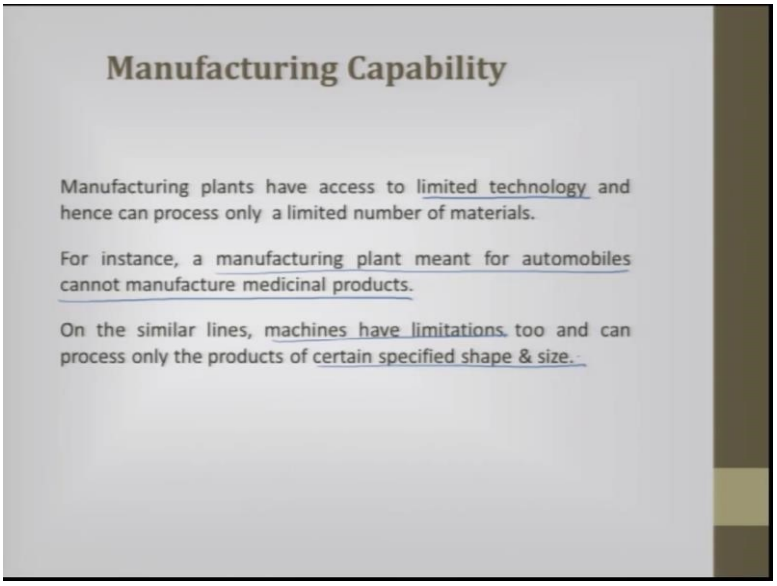

So, access by the limited technology; say for example, if somebody has a factory which is completely working on metals. So, then a plastic cannot be worked there so that there is a technological limitation. So, for instance a manufacturing plant meant for automobile cannot produce medicine. So, medicinal products need lot of clean air and it is also have to be maintained and here it is more of powder based. Automobiles are metal component means or plastic components. So, completely there is a different technology a company which makes automobile cannot make pharmaceutical. And a company which makes pharmaceutical cannot make automobile on the similar lines machine have a limitation to.

Suppose if I have an injection molding machine I have a dye for every shot I get a single piece out. Sup and if I want to make lot of outputs then I will make a dye wherein which in every shot I get 6 or 7 parts output for example, I can try to have an injection dye wherein, which I make one spoon I can have an injection dye wherein which I can make 10 spoons. So, depending upon the shape, size, pressure, what I have the raw material quantity I have? I can try to produce more in number. So, on similar lines machines have a limitation in the numbers so that depends on the shape and size producing something in large quantity mass production.

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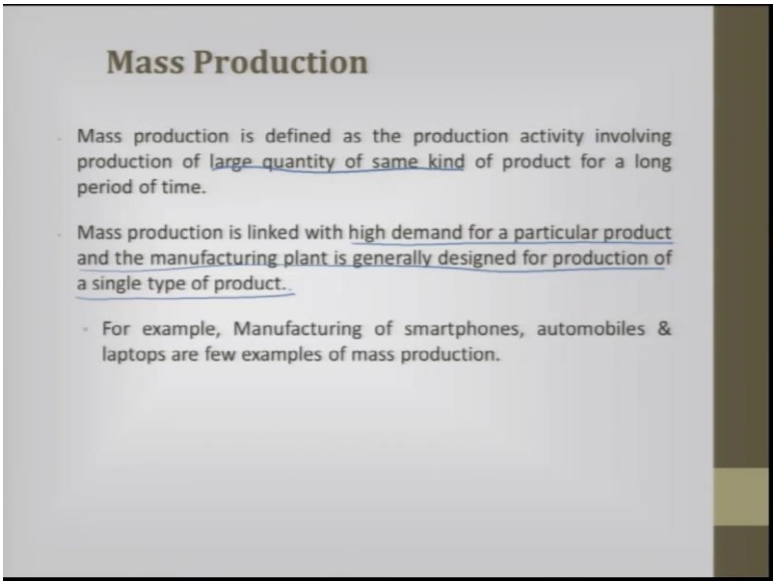

So, here in which if you decide that there is going to be a huge customer bank for your product, then you will try to choose technology wherein, which this technology is more focused towards mass. If you decide that I am going to produce Rolex watch and each watch costs 1 lakh.

So, I will not try to go for mass production here in which, I will go for batch or Jobshop production wherein which, I try to focus at a customer try to consider each customer as a prime customer and try to develop my technology and the factory whatever I have in line with the customer. Because I can produce I can give it at a cost which is on higher side. So, mass production is a concept wherein which trying to produce in large qualities of the same kind of product. Mass production is linked with high demand for a particular

product and the manufacturing plant is generally designed for production of a single type of product. For example, cement, iron and steel, pharmaceutical company, petroleum company mass requirement is there. So, they will try to tweak to their required customer and try to produce.

So, mass production is another concept which has to be considered when you try to do a product design.

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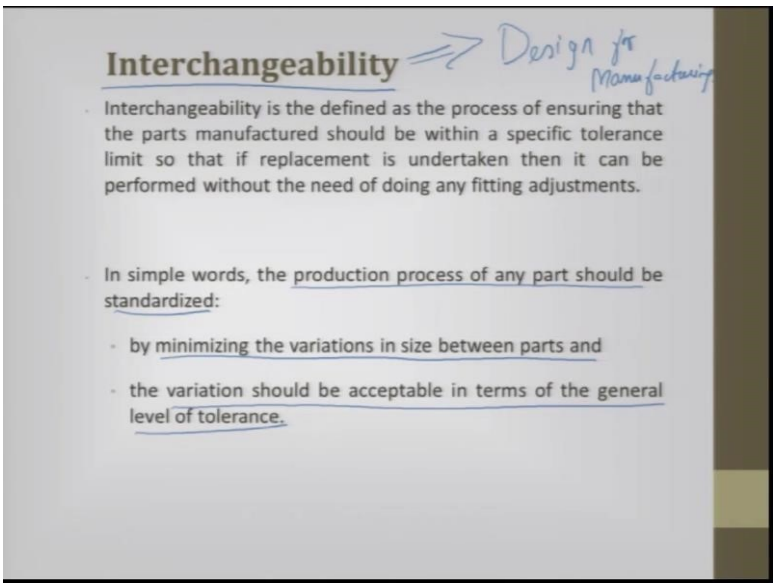


The next one is interchangeability, interchangeability is very, very important. When I try to make a product see a product can be of 2 kinds, one it a single part can be a product, multiple parts assemble together can be product. When we try to do multiple parts assembly to make a product then there comes the concept of interchangeability. The concept of interchangeability is try to use parts which are standard; so that it can be used for many applications for example, I have a nut I have a bolt ok. I have a nut I have a bolt, I pick a bolt from one box and I pick a nut from the other box wherein which both of them are try they both can match and made with each other, right?

So, if I pick anything out of the 100, I pick any one nut and a box where 100 nuts or a bolts are there I pick one, randomly I pick and if I assemble and if assembly happens. So, there is like comes the concept of interchangeability. If I do not want to do interchangeability the concept of selective assembly comes. For example, if you talk

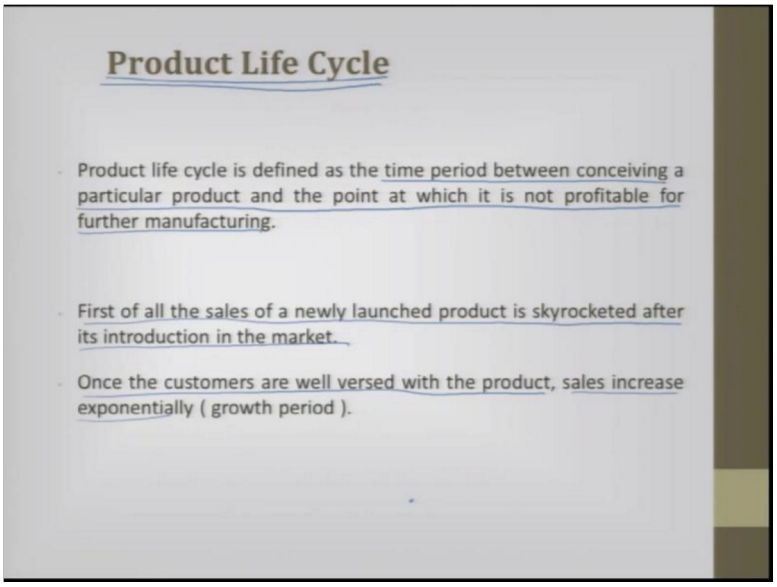
about plunger and a barrel which is used in a diesel pump. So, there we do selective assembly; that means, to say the barrel deviations are noted down and correspondingly the grinding happens on a plunger. So, here this particular plunger and this particular barrel alone can made the other things cannot made. So, basically what we are trying to say is you try to specify certain tolerance; such that the parts when they are interchanged they can still work. And this concept is very important when we talk about design for manufacturing.

As much as possible when you try to develop a product try to use standard parts, try to use standard things such that one for those standard parts you will always have vendors who will be competing and giving you at a price which is economical to, you do not have to depend upon one source you can have multiple sources. So, the advantage is. So, you can try to make your product more economical and you can try to make your product very quick ok.

So, here what you do is we try to make standard shapes and size give specific tolerance such that you can try to mix and match and make and start using it for fitting. So, in simpler words the production process of any parts should be standardize to minimize the variation in the size between the parts the break. So, the concept of interchangeability was a very big breakthrough in manufacturing, earlier what they used to do is when there were lot of requirements during world war 1 and 2 for ammunitions, they always try to do selective assembly their production rate was enormously low. When the concept of interchangeability was brought in the production of this arms and ammunition went short a very high. The Aeroplanes space parts which was been made earlier in non-standard when they could standardize the number of planes produced were enormously high during World War 1 and 2.

So, this basically interchangeability is you try to reduce the variation in size and shape, but and tolerance and try to meet out to lot of applications, the variation should be acceptable in terms of general level of tolerance. So, this is nothing but the con this is the concept of interchangeability, when you try to do a product design keep in the concept of interchangeability first what you should do? You should think in return on investment or production turnover or capital circular. So, then you will try to look at interchangeability then you will try to look at mass production, and then you will try to look at

manufacturing capacity. So, all these things are important because this will try to dictate the costing of your product. (Refer Slide Time: 21:54)



Next is product life cycle, it is a time period between conceiving a particular product and a point at which it is not profitable for further manufacturing is called as product life cycle.

I start producing a product today and how long will be the product in the market. For example, when I was young we used to buy scooters. So, the scooter which in 1980s the scooter had a were thought of and had life span of 20 years and 30 years. Today what we think of any automobile the life span is only 5 years, 7 years, 3 years. It has come to that level. So, what is product life cycle the time it enters into the market and the time when the product stops making a profit that is called as the product life cycle. And when you try to look for a product for developing to a customer always keep this concept of product life cycle in your mind. So, it is nothing but the time period between conceiving a particular product and a point at which it is not profitable for further manufacturing is called as product life cycle.

See today you can take the newspaper industry; you can take telegraph for that matter phonograms for that matter. So, they at one point of time telegram was the shortest and fastest way of communicating or transferring information from 1 place to the other. In the recent past telegram is no more existing because technology is like cell phone has

taken over. So, if you want to understand little more in detail first of all the sale of newly launched product is skyrocketed after it is introduction into the market.
Once the customers are well versed with the product sales increases exponentially and then what happens is it tries to deteriorate.

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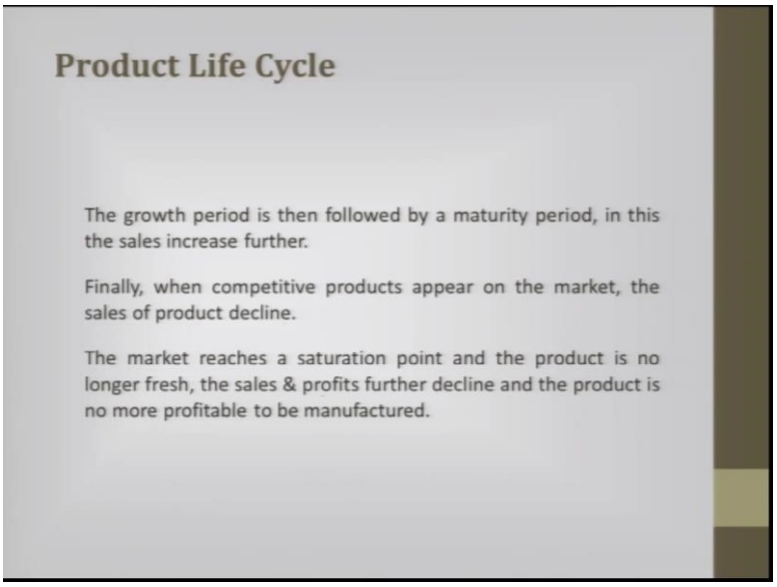

The growth is then followed by a matured period in the sales of further increase finally, when the competitive product appears on the market the sales of the product declines. The market reaches a saturation point and the product is no longer fresh, the sales and the profit further declines and the profit is no more profitable to be manufactured. I have a cycle which talks about it.

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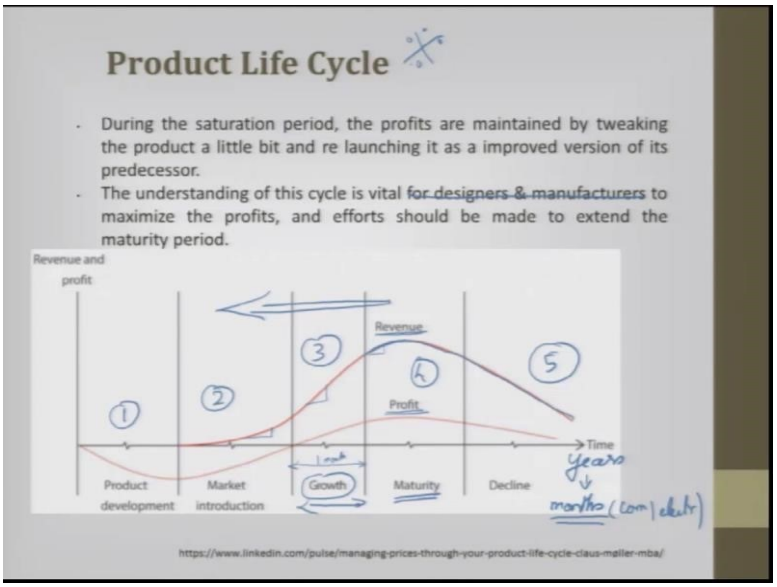

So, if I try to plot between profit revenue and profit with respect to time, you can see here I have divided into 1, 2, 3, 4 and 5 phases. So, phase 1 is the product development cycle. So, you if you look at it here, there are 2 things, one is called as revenue curve the other one is called as profit curve. When you look at it in stage 1 then revenue is absolutely 0 the profit goes in negative; that means, to say I can keep on doing investment. So, when I keep doing investment I spend lot of money with a speculation that I will win the race.

So, when it comes at the end of the product development when the product has just started selling into the market. I am recovering out of my loss and I am moving towards the 0 stage. So, as in when it is introduced into the market you always see there is a slow growth, if you take that slope of this and if you take the slope of this you see there is a big difference. At this stage when market when it is getting introduced by word of mouth by advertisements or by market requirements the product gets introduced into the market and slowly it starts moving.

When it reaches a growth state you see there is a rampant increase in the revenue; that means, to say number of products sold in the market is very high and this cannot keep continuing for a longer time. Every company would like to stretch this period, but today because of global competition. And so, many new pliers and small pliers coming into the market the growth period is now getting down to less than even 1 month, the competition is very high. So, you have to understand this and this then after this when it comes to the maturity period you see there is a slow slowly increase in slope. Like this slope value goes down and it reaches a saturation and after the saturation there is a deep decline in

the revenue. So, when there is a deep decline in the revenue the profit which was all got about it also slowly started going down.

So, this growth period is one thing a product designer should have it in his vision, before developing and getting into the market. If you try to do a very small-scale or a very small-time period growth product, then you will have you will not have more profit zone and the maturity also will happen very fast and this also will shrink down. So, earlier this life time was talked about in years today it has come down to months.

So now you see how competitive is a market and how have you to produce or what product have you to produce to sustain it for a long time ok. So, during the saturation period, during the saturation period the profit are maintained by tweaking the product a little bit and relaunching it as an improved version of it is predecessors. So, what am trying to talk about is, at this period maturity period. So, what I am trying to do I am trying to shift my curve back. I am trying to introduce a new thing for example, I try to add on some features I have a car. So, let us assume am having a car am selling the car in the market.

So, all I realize is when it reaches a revenue state. What I do is I try to add ac to the car I try to add music systems to the car, I try to add a power drive to the car. Now what has happened 3 new technology have done. So now, I have tweaked of the product little bit, I have not changed the shape of the car, I have not changed the engine of the car, I have not changed the seat of the car the volume is the same road clearing is the same, but my I have introduced small things in my product such that I tweak it and then what do I do is I re-launch into the market.

So, this goes back and starts coming out with it ok. Meanwhile, when I talk about examples for products in computer industry or in electronics industry the time span is talked about in months. Understanding of this cycle is very, very vital for a designer and a manufacturer. If I do not know the time scale of my product which will sustain in the market, no point in developing a product; this is very, very important. Today a product is developed because it has to make me economics it has to bring me some profit. If a product cannot bring me some profit no point in developing a product. We can always do for a social cause, but social cause cannot be the or the prime focus of a product design

engineering ok. To understand for understanding of this cycle is vital for designers and manufacturer to maximize the profit and the effort to be made when should they make the effort what should they tweak and how do they get it.

So, this is very, very important as far as a product is getting launched into the market.

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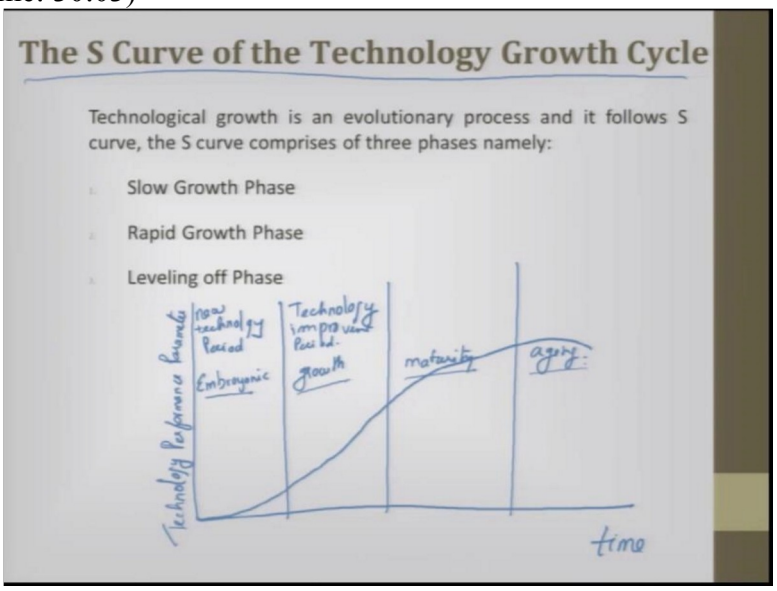

The other one is the S Type of curve of the technology growth cycle. So, the technology growth cycle a technology growth is an evolutionary process. So, let me draw a technological graph with respect to time. So, I would like to draw so this is nothing but technology performance parameter, ok? And this is which is respect to time a same curve like time with respect to the;

So, the first one I would say embryonic embryo, embryonic, then it is growth, then it is maturity and the last one is ageing ok. So, it is almost something like this ok. So, here is the new technology period, here it is the technology improvement period and here it is maturity. And here it is the ageing. So, if I the technology is so, this curve people say it is an S curve because it looks something like an S.

So, technology curve is an evolutionary process and it follows a S curve. The S comprises of 3 stages, but here I have given 4 stages one is no growth phase, rapid growth phase and levelling of the phase. So, generally what happens embryonic growth maturity and ageing. So, all these things come into existence.

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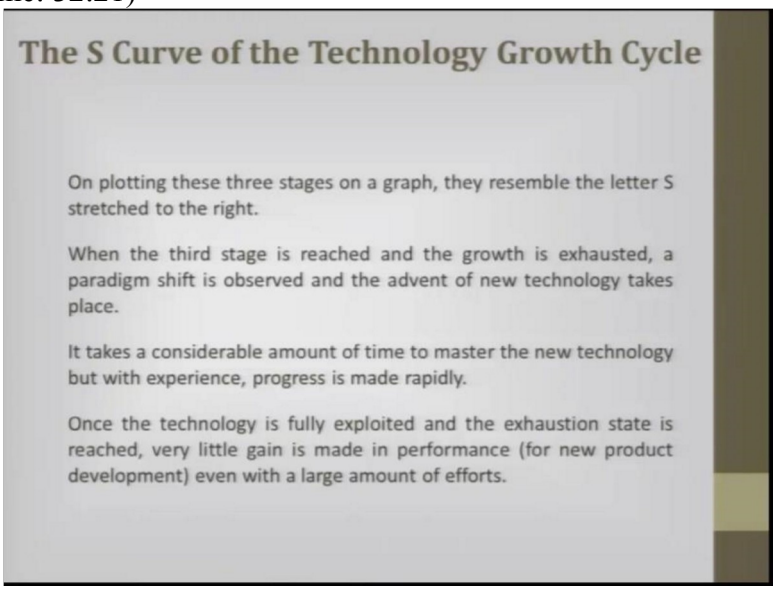

So, on this plot of 3 stages, here I have given 4 stages, but generally a maturity will be the 3 stage and we stop, they resemble the letter S a stretching from the right. When the third stage is reached and the growth is exhausted; that means, to say maturity a paradigm shift is observed and the advent of new technology takes place; that means, to say people always at this stage they try to push it back, that is what I was trying to say. Earlier it takes a considerable amount of time to master a new technology, but with experience and progress is experience progress is made.

So, improvement in technology is this rapid growth. So, this is improvement in technology once the technology is fully exploited and exhaust stage is reached, very little gain is performed. So, that the new products are developed.

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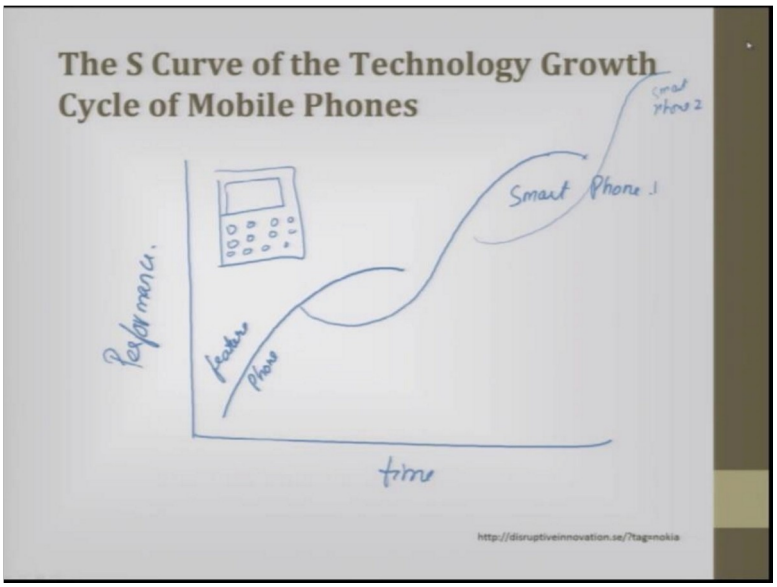

So, let me drive try to draw the S type curve of technology for the mobile phones for example, for Nokia phone alone. So, this is performance and this is the time period time, right? So, this is the curve went something like this ok.

So, this is the Smartphone usage and this is a feature phone usage. Feature phone usage is nothing but the punch type. So, you remember when we were 10, 15 years back this was the phone which came into the market wherein, which you punch the letters and so this is what is feature phone. The feature phone was going on making profit and after some point of time you see there is a slow performance decline. And by the time the company this could realize that there is a decline in the technology the Smartphone have picked up and today this is keep moving on. Today this has also come/ to a saturation. So, what is happening is now new phones come up.

So now this Smartphones comes here. So, the let us assume this is Smartphone 1. So now, they come out with a new thing called as Smartphone 2 may be a different technology, which comes out Smartphone 2 then comes smart phone 3. So, like this you see the S curve of technology in the mobile phone which keeps going for a long time. So, the feature phone came first after the feature phone came the Smartphone then.

Now, you can see there can be more advancement in the Smartphone today people are talking about watch used as a Smartphone. So, you use reach all information in your watch you talk to your watch and that gets connected with the mobile phone. And the

next generation is a; they say you try to talk without making a noise or without making sound. So, that will be the next version of the Smartphone. With this I would like to come to lecture 2 to an end.

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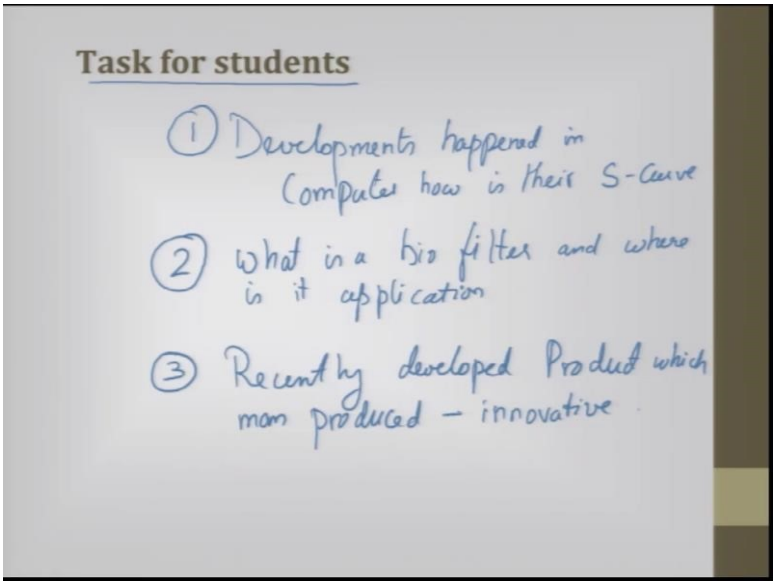

So, I have a task for the students with this is an assignment. So, here what I would request you kindly see what are all the developments which has happened developments, happened in computers and how is how is their S curve for technology. Second thing what is a bio filter which is a product and where is it is application. And the third thing what I want is I want you to look at a recently developed product, recently developed product which is mass produced , which is mass produced and when you look at the product it has to be innovative product.

So, please keep this is mind these are the small simple assignments, you try to look at you internet and try to look at books and then try to answer these questions. These questions when you start answering it you will try to realize how importance is product designer's responsibility when he does a new product development.

Thank you very much.