Product Design and Manufacturing
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Lecture - 01 Continued.
Introduction to Product Design and Manufacturing

Last class we just completed or we were just trying to understand the concept of production and consumption cycle. I said four important parameters are there. One is how to produce; second one is distribute; the third one is consumption, and fourth one was recovery. So, all the four things are very important because today we talk about socio ecological system for every product to be developed.

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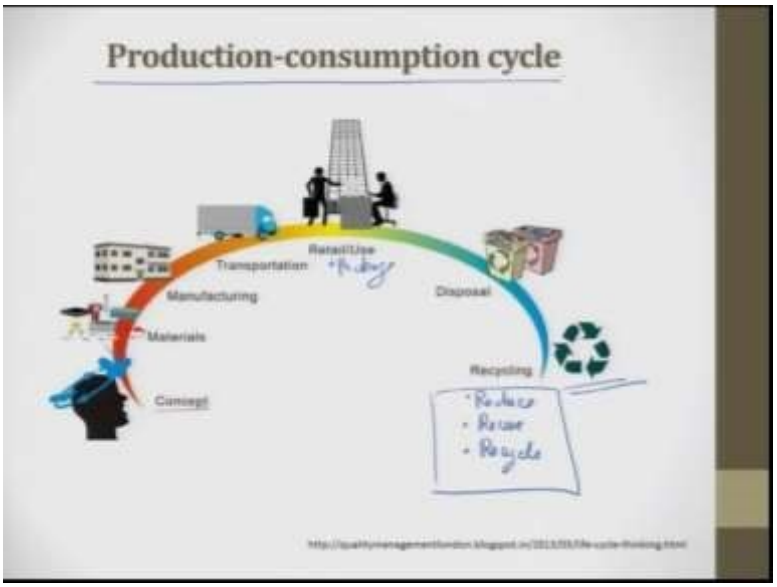

So, getting continuing with that topic, so can see this is how the cycle entire cycle goes by. So, the first one is concept which is getting developed, and then the designer responsibility is to look at all the different varieties of material which is available. And then what he does is he tries to choose material from different part of the world; earlier it was thought of only try to pick from within the country or within the zone, now it has

become competitive market, global competition has come into existence. So, we get parts and products and subassemblies at a very competitive price from across the globe.

So, then after that manufacturing is a next phase which happens in this cycle; so two types of manufacturing are done. One you try to produce some parts within your in house; and some bought out items you get and then you do assembly and then you develop a product. The next model which many companies are following today is they try to get everything from different vendors, and they do only assembly and sell it as a product. So, once you manufacture, then you try to transport. So, here the transportation can be done in multiple ways. For example, look depending upon the size, the volume of your product that can be two one is the volume of the product is very large or number of parts which you keep inside the particular packages also it depending upon the size; that means, to say a lot sizing will be done.

So, it is decided and then they try look for transportation. For example, if you try to produce a continuous product continuous product in terms of cement. So, now, here they try to move by train. So, in train you can have the raw material can be the material can be moved as a complete container of powder or several small bags of cement can be put and then moved. It can be moved in trucks, it can be moved in train. So, you decide which is optimum. And then which is again keeping sustainability and cost into your consideration you try to move the transportation.

Then you try to do retailing. And in retailing, what you do is this whatever product you have sent it in a package it is discretized further, you sell it as individual piece or you sell it as a batch of ten or a complete whatever is a commodity you do it retailing. And here you try to add some packaging material to it, so that you can try to attract customers and then from there it goes to disposal, and then recycling comes into use.

So, today we talk about reduce, reuse and recycle. So, whatever this is very common thing which is being thought right from school, when you develop a product we should always try to keep this in mind. So, first of all we should try to tell the customers though they buy our product, but try to tell them that you reduce it and use it or try to give them the required amount of dosage of whatever it is, and then try to tell them that you reduce it and use it.

Next thing is you reuse and use it. So, reuses something like I gave you an example of compressor. So, I use took of the compressor from one refrigerator take the compressor fit into the other guy and you start running another compressor, so that is reuse right. Recycle is completely change the product and then you try to develop a new one from the scrap. So, for example, all the chips scrap which is manufactured are now used for recycling, and then trying to get billets developed or rods developed, so that is recycle. So, I recycle plastic are recycled today ok. This is the complete production consumption cycle which is very very important for a product designer to understand this. At every phase, he has to involve, he has to be creative, he has to be innovative in developing a product before releasing to the society.

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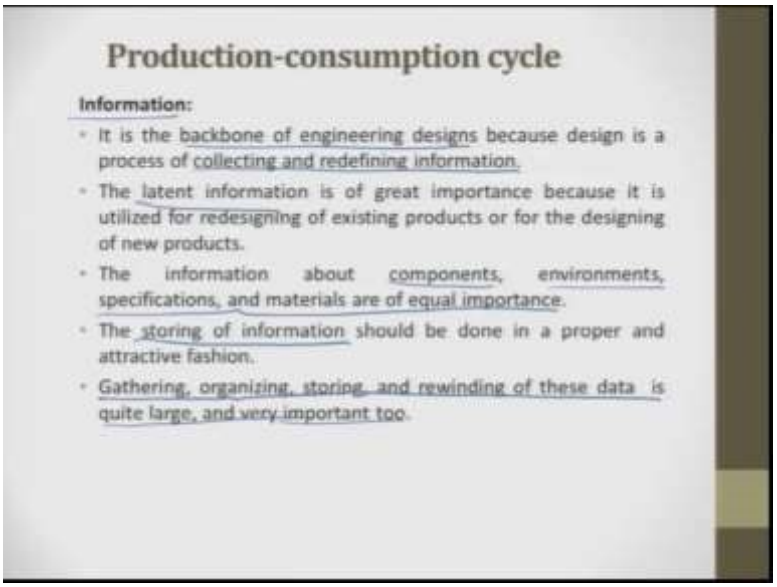

So, in this production consumption cycle first thing is information. Today the biggest resource is data. People everybody wants to have data. Information is something which is very costly, data. From data you put a filter and what you develop is information. Information is precious. If I have to understand the cross section of the society of people I would look forward for information. So, information can be static; information can be dynamic. In information can be got when you personally meet the people do interview and acquire data. Information is very, very important. Without information, you cannot develop a product.

So, it is the back bone of engineering design information is collection and redefining of information is the biggest thing which a product designer must do. He should collect

data. He should process the data put filters, remove noise, rearrange the data such that he can assimilate and develop knowledge and concept for a about a product.

The latent information is of great importance. When you are looking for contemporary design or a concurrent design or when you are looking at up when you are trying to develop a shoe. Today earlier shoe was just thought of for trying to protect your foot. Today the same shoe is looked at for evaluating the status of a person. People say when you try to wear latest trend shoes, they say you are techno savage same thing which goes to a mobile phone. If I have a mobile phone which is of old type which is punch type, that means, to say you punch the numbers and use. So, people try to have an estimate about you right. So, today people look at Smartphones, Smartphones are integral part of life today because so many apps so many things happening in the society is being well transmitted or communicated using a Smartphone.

So, you should have latent information which is very important. When you try to develop your product it has to be integrated with the latest technology which is around. The information about the component environment specification and material are very very important, you should look for this before developing the product. Do not go by here say, do not go by some senior said some boss said, do not go by that look for standard data which is available process those data and then try to convert. So, today lot of companies come out with manuals wherein which they say these are the components which we develop, please look at our brochure.

So, when you look at our brochure, we try to give you lot of other specification about the product. See when I was talking to my son he said I would like to have a spoon which is which could just go very close to my mouth and it just tries to attract my tongue outside, so that it can meet dispersed inside, but what does he want I do not understand. So, now, if am a designer, if I am a product designer what I should do is I should now convert whatever he said into a specification such that an engineering knowledge can be applied on top of it. People say I would like to have a very beautiful house, how do you quantify. There is no engineering specification for it. So, now, if we convert that into some engineering specification then for a product designer, it becomes easy to work.
I would like to have a phone which is very sleek very smart which attracts everybody's eye. So, it is a statement which is all qualitative, you have to convert it into quantitative statement, so that is nothing but information. And whatever information you collect you

have to start storing it. Generating information every time is very very expensive. Doing experiments every time and then trying to generate data is pretty expensive. So, whatever information you have collected, please do not thrash it, try to store it, logically store it such that you can revive it and reuse it at any point of time as it is required. Gathering, organizing, storing, rewinding of the data is quite large and very important aspect as far as far as product development is concerned.

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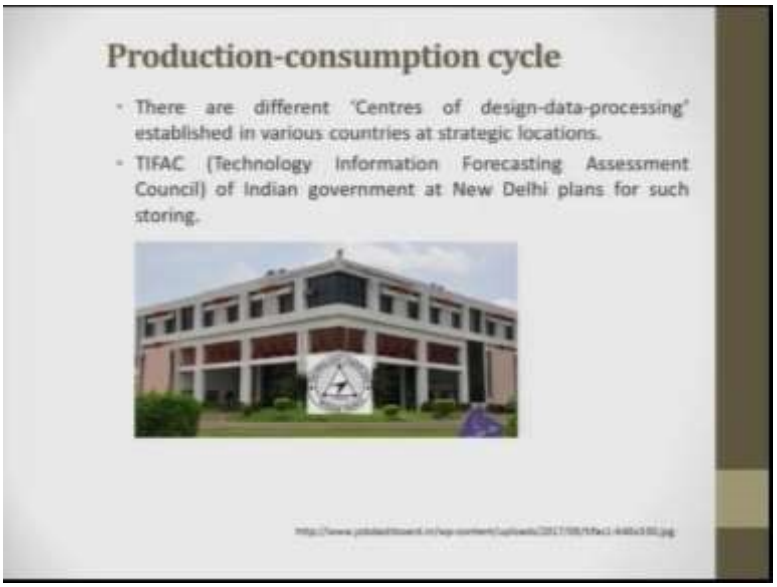

So, in India, we have something called as we have a council which is called as TIFAC. TIFAC is nothing but technological information forecast assessment council ok. So, here what they have done they have several centers wherein which there is design data processing. So, which is established you can go pull out the data and you can try to develop that products very fast.

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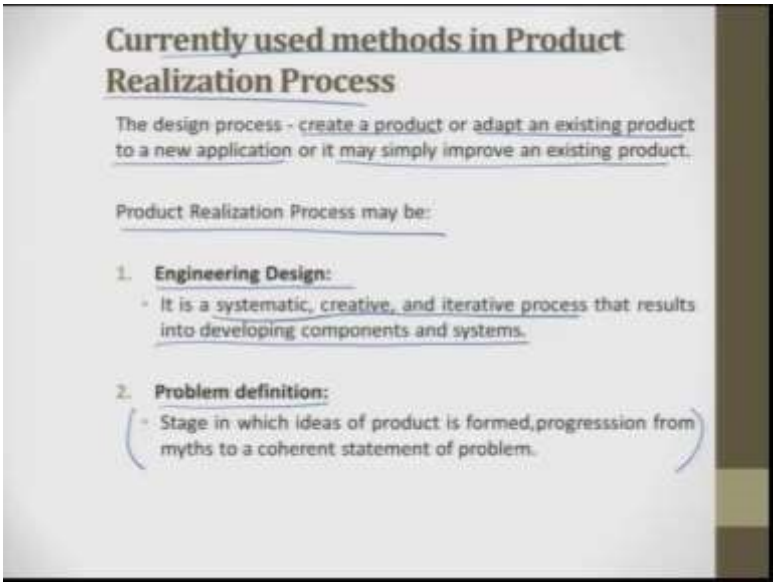

So, let us see some of the currently used methods and product realization process ok. So, design process is to create, adapt an existing product to meet out the application or simply improve the existing product. All the things are to be done it is part of process. One is creating a product completely new taking other one is trying to taking an existing product and trying to add new applications for example, a Smartphone. Today, a Smartphone initially phone mobile phone was thought for talking only. Today if you ask any customer talking has become one of the lowest priority in his big list of choosing a Smartphone. He looks at a camera, he looks at the battery size, he looks at the screen clarity, he looks at how many apps can I store, and he looks at so many other things and finally, talking, talking becomes the last priority.

So, now you see existing product which can completely you took the product and which can be completely tuned to a new application. Today banking can be done on a mobile phone which I never thought of. I used to stand in queue for depositing money; today there are e-counters which has some which is called as green e counters. You go deposit money, you get a receipt; you deposit cheque you get a receipt. So, this existing thing modified right.

And the third one is just try slightly improving the existing product wherein which the efficiency can be can be improved. So, all these things are part of design developing, adopting new existing one and giving a new application and the third one is slightly modifying for the existing product. So, the product realization process may be engineering design what is engineering design it is nothing, but collection of data

logically arranging the data and then trying to get a knowledge out of the data is engineering design.

So, now it is nothing but systematic, creative, iterative process that results in developing a component or a component or a system is nothing but engineering design. In all these things, the first important thing is problem definition. Problem definition is one of the biggest challenge. A product designer has a big challenge to identify the requirements of a customer. This is the first and foremost thing. And once you identify a problem then half of your product development is done.

We are we see when you think of a child, and you want to develop a product, there are humpty number of things which a child cannot even explain. So, how do you identify what is the problem and then for that problem you have to come out with an engineering aspect for that aspect you have to look up down for a technology and then come out with the product. And again you have to try your product on to a child, who are he or she cannot give any feedback, you would try to develop a product look at the challenge which is there. Problem definition is the first major challenge as far as product design is concerned. It is a stage in which the idea of the product is formed, progression from myth to a coherent statement of problem this is problem definition; in a whatever problem definition you do then you try to do the engineering design of it and then develop it.
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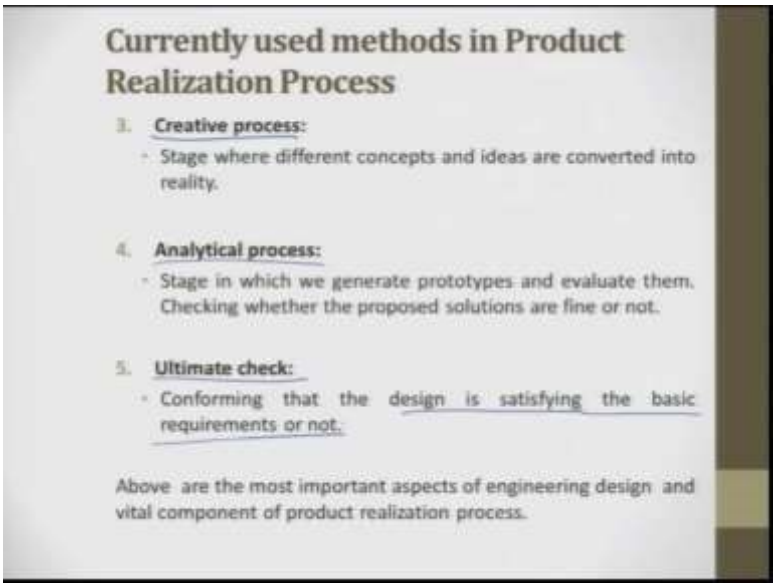

Next one is creating process. Today there is a mixed opinion people say you cannot be creative and some people say there are some tools wherein which they can try if you follow those tools you will be led to creative thinking, creative process is something which leads to innovation. So, stage where different concepts and ideas are converted into reality is part of creative process.

Then analytical process this is a stage wherein which we generate prototypes and evaluate the prototypes, and check whether it is accepted, what modification has to be done, and go back to your desk, reiterate the product and keep repeating the step and keep repeating the step so analytical process is that.

An ultimate check is before finally, the product gets into mass production you do a final check you do a final confirmation, and then you start producing it. Confirming the design is satisfied the basic requirements or not this is what is the ultimate check we do. So, when we talk about any process or any product, we see all this steps products realization process may be engineering design, problem definition, creative process, analytical process, ultimate check is done and then we finally, release the product to the customer.

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The design can be of several type. So, here I have put the aesthetic design a camera right at there are several cameras available, several webcams available how do I have a niche how do I hit the market. So, people here have given more important to aesthetics as compared along with it is not that only aesthetics, aesthetics along with other things. For example, if you go to Taj Mahal, it is more of aesthetics right. If you go to some other fort in India, or if you go to castles somewhere the aesthetics is given a very important look. Many a times recently I have visited a building a hotel wherein which the hotel had a very good aesthetic appearance from outside. But when I started staying in the rooms I found out some strange thing because their roofs were all tapered in order to give castle like look what they have done is the roofs all in every room have made it a this taper.

So, when they make this roof as taper the when you try to put an air condition, we try to have several areas as dead zones which are of no use. For example, if I am going to stay in a room, my comfort zone is this area, but if you look at it all this zone where AC is not even required has been full filled just because of keeping aesthetics. So, there has to be a tradeoff between aesthetic and the functional look.

So, here there are aesthetic design is referred to creating action of fashioning an object without consigning with how or even if it can be made, so that is aesthetics. But aesthetics are also important because giving color, giving shape, plays a very important

role to appeal a public. Aesthetic design has now become an important part of the product realization process and companies are looking for professional so integrate engineering with aesthetics. So, today engineering is integrated with aesthetics such that you can produce good products to appeal.

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The other thing is industrial design. In industrial design more and more functionality is given importance rather than aesthetics right. They emphasize those aspects of the product or a system that relate most directly to human characteristics needs or interest such as visual, tactile, safety and convenience. And they do not give more importance towards the shape or the color. So, here it is called as industrial design, but earlier it was thought about exclusively industrial design, exclusively aesthetic design; today the two compartments are getting merged. So, there is a thin line between aesthetic design and industrial design. So, any product you develop has to have aesthetic design as well as industrial design if you have to be successful in the market.

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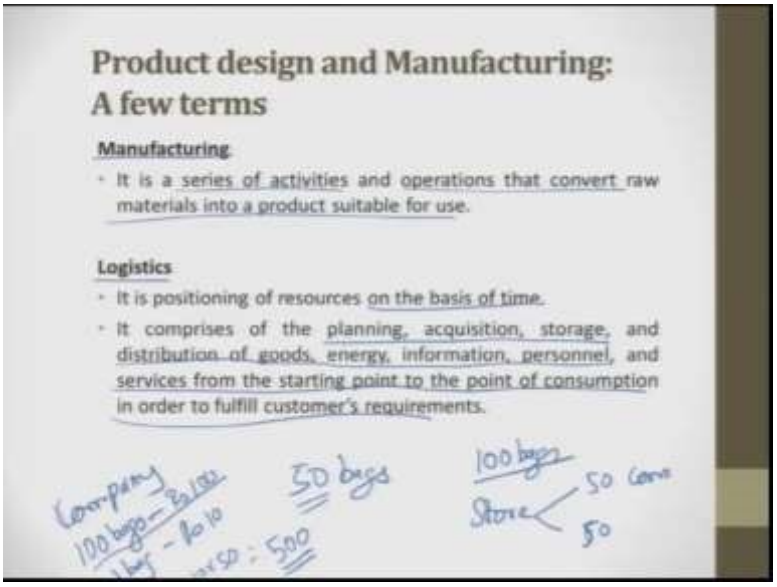

So, some more terms for before getting into the course I thought I should explain the other important term is manufacturing. So, manufacturing means it is a series of activities and operations that convert a raw material into a product such that it can be useable. So, basically converting a raw material into a finished product, you do value addition. This value addition is nothing but manufacturing ok. So, converting raw material into finished product in a most productive manner such that the energy, cost, material is all minimized and then you do value addition to it such that it can be to the customer requirement. And it can be one step it can be multiple steps, so that is what is manufacturing.

Next important terminology is logistics today there is a concept or a challenge which is given to the designer is please try to use the local resources what you have at your location in developing a product. Government of India is now pushing very hard to construct houses from the locally available materials such that they can reduce the costing of the house. For example, use raw materials available in and around your location, so that is a big challenge great challenge. How do you make bricks currently suppose if you do not have bricks, for example, constructing a house at Rajasthan or Thar Desert, you do not have water at all how do you construct a house. So, still you need to construct a house at that location were where you have to take cement brick or sand and though go mix it with water or can you take hollow blocks and go there just assemble everything and then construct it, within no time, so that is logistics.

So, logistics it is nothing but resources and these resources dictate the cost these resources dictate the time for movements, so transportation. So, logistics is another

important thing which you should always look for when you think a product design ok. It is the positioning of resources on the basis of time. It comprises of planning, acquisition, storage, distribution of goods, energy, information, personnel and services from the starting point of the point of consumption in order to full fill the customer requirement.

So, this is very, very important. See, if you have to take resources from some other place will I buy it say for example, if am constructing a house. So, if I am constructing a house, my house needs only fifty bags ok, but the company says, if you buy hundred bags of cement I will give you at just for example, rupees 10 a bag; if you buy the other option I have is you buy 1 bag I give you at rupees 10 just for a fictitious condition.

So, now there are only two options he says either you buy as individual bags or you buy it as 100 bags, if you buy it as 100, I give you at 10 rupees or let us make it as 100 rupees; and if I buy 1 bag, I give it as 10 rupees. So, if I have to construct my house, I need fifty bags now what do I do is I try to buy it as individual bags. So, if you see that it will be 10×50 which is around about, I pay 500 rupees to buy 50 bags, whereas, the same company has upper slabs saying that 100 bags at 100 rupees. So, now, what I do is I try to buy 100 bags and then I try to store it right. I consume 50 and then I keep 50. So, tomorrow if any of my friend wants to construct I give it, because it looks to be much cheaper right.

So, this is what I am talking about is planning, acquisition, storage, distribution of goods energy information, but if I store 50 bags, I occupy a space for that space I have to have a storage space which I have to construct. So, then I have to maintain the humidity, third thing that room the product should not be lost or the shelf life should not be lost for the product. So, all those things get into that and then also have to store information, I have to have person to maintain that 50 bags. So, it is all expensive. So, you have to logistics is a very important thing which you have to control.

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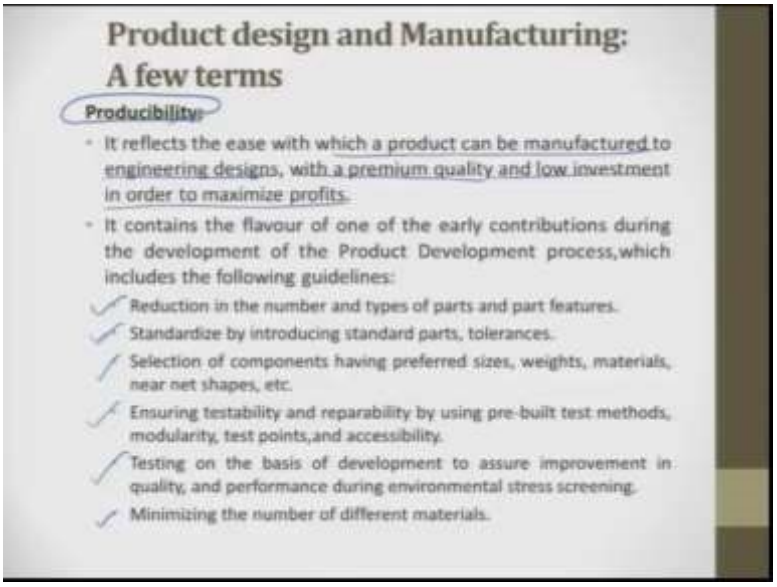

So, the other thing is the tracking of the resources is main part in the logistics. For example, in my own home I have six, seven keys one for my office, one for my research lab. So, tracking of all the keys, where do I keep, how do I keep my everyday spent twenty minutes of time searching for my keys placing in here and there which is inside my house or inside an existing location. Tracking of resources is very important. So, tracking of this logistics is also very important. So, barcodes today are available, lasers have come up in a big way. RFID have come up in a big way to help so, but using all those things we do is we try to have a logistics in a better controlled fashions, but logistics is very important.

So, as I told today people look at building products with a locally available thing for example, if I wanted to build a product or a pen, I should not say for this pen, everything I do it India, but nib I will get it only from Japan. So, now, it is completely makes a costing very high ok. So, you should be very careful about it.

Then the next important thing is producibility, producibility or in other terms it is called as manufacturability with minimum cost how do I manufacture. So, for this there is in engineering terms, we call it as design for manufacturing. When we talk about design for manufacturing, the first important thing is how have I standardized the parts which I have standardized the parts that is one. And second thing using of standardized parts is the other thing.

For example, if I say go pick a green color paint for my house, so that is pretty easy because you go to any shop and then pick a green color paint and then come and start doing it. So, if I say get me a paint, which has a blue tint slightly reddish like apple with a green touch in it. So, then it becomes very complex because I have to go to a shop wherein which he has all the three, he tries to manufacture in front of me or I order it to a company tell I wait for a long time to get it. So, it is not a standard thing right.

So, what people are saying is try to use standardized parts and whatever design you do try to follow some standards such that you can try to use parts which are already available in the market. So, there are certain guidelines which are given. So, this man producibility is which tries to produce a par product or a manufacture and engineering design with a premium quality with low investment in order to maximize the profit. So, how do I use first of all reduce the number of parts, try to use part features which are common.

Next is try to use standardized parts which is as far as possible. For example, M6 screw, M3 screw, M4, M5, M6 rather than choosing a screw which does not fall in this two then it becomes very difficult, then selection of components which have preferred size, weight and shape. For example, cross section, I cross section, rectangle cross section which is used for doors whatever it is. Then ensure testability and reparability by using pre built test methods. Then testing on the basis of development to assure improvement in the quality, and performance during environmental stress screening. And minimize the number of using a different materials. So, all these things if you try to rationalize your producibility for a product goes extremely high.

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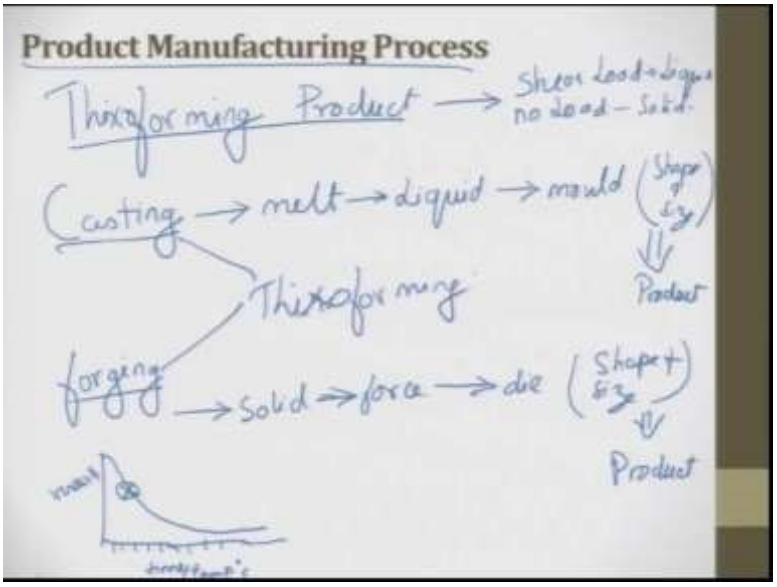

So, let us take one simple example of product manufacturing process. So, let us take a something called as thixoforming, thixoforming-products. Let us take that as an example. So, what is thixoforming, before getting into thixoforming lets try to look at casting and forging, two different processes which are very commonly used in metal based products. What is casting? I try to melt the product, I will try to melt the raw material, take it to a liquid form ok, liquid form or super heed whatever it is, try to pour it into a mould where it gives shape and size. So, we make a product out. Forging is a process wherein which I do not melt I try to take a solid apply a huge force and place it inside a die, again which is like a mould give a shape and size, so I get a required product.

So, here if I see it always depends upon the charge. How much what is quantity and I have to use for making this product. Again never I will do one product at a time. So, I will try to use many products in the starting go. So, when you talk about this casting in casting, we never do one product except for something like a big church bell or very heavy product where we have always one, but generally what we do is we try to have multiple products that means, to say number of products. So, here the charge whatever we use will be in huge charge we always use a crucible, and this crucible will try to take thousand kilos, and we try to melt we apply lot of energy it gets converted into heed into liquid, so solid into liquid. Solid into liquid then we pour it when we pour it we have lot of losses and then we try to get.

So, today what has happened is they have developed something called as thixoforming. Thixoforming means when you apply a shear load, the solid becomes a liquid. And if you

do not apply no load condition, it is a solid. So, what is that they have done is they have taken rather than trying to take say for example, this is the melting, this is temperature melting temperature whatever it is. And this is the time or what do you say. So, instead of melting what I will do is I will try to put it into viscosity change or something viscosity.

So, now, what happens is viscosity we see initially when it is a solid you will have very high viscosity or it will not even move. So, as and when the time goes up a very trend I'm just putting. So, here time or you can try to take even temperature whatever it is you can take so degree celsius this is just schematic. So, so you have a trend which goes down. So, now as in when you want to apply very high temperature, what happens is the viscosity goes down so that you can flow and so when you have long time or temperature, it is huge amount of energy which is spent.

So, what people have come out is they say and here when you go for the other way around when I use a huge force, so you need to have a very heavy machine tool such that you apply so much of tonnage of loads that you produce the output. So, here what they say is let us not take it to the liquid state let us take it somewhere to the semi solid state. Wherein which when you apply shear load it is liquid when you do not apply load it is a solid you take it to that stage, and then try to push it inside a mould and you try to get the output. So, what is that here is a tradeoff between casting and forging you try to get this is somewhere energy efficient.

So, people today talk about thixoforming, thixoforming, and using this process today the wheel rims are made out of it. It is just an offset of or an announcement of die-casting pressure die-casting. So, this is a process which has got evolved and now this is proved to be energy efficient a quality product is got. So, why am I telling you is this is a product which is manufacturing process wherein which they have started using thixoforming such that the innovation is brought in and because of the technology they are able to develop new products.

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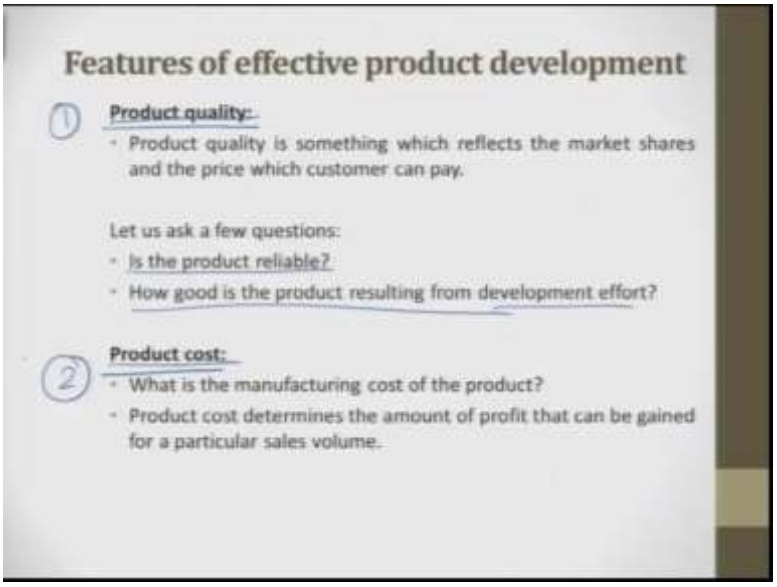

So, the features which effect the product development is one is always the product quality. See, whatever you buy today you say that I will try to get the best product and then you will try to say always ok, there is a cost which I would like to as minimum as possible. So, for just for a discussion sake, I would like to buy a Rolls Royce car for 1000 rupees if somebody could give why not. My expectation is I have to buy a car which is equivalent to know if you do not give Rolls Royce you give some other car x or y or z car, but I will pay only 1000 rupees. So quality is very important. Pro if the cost is very high, and if the quality is high people do not mind buying it, but today people have become cost conscious. So, they say I would like to have a high quality product, but I would like to give as minimum cost as possible.

Quality is very, very important why because quality in turn is linked with reliability. I buy a car, using this car I go a 200 kilometers per hour the engine cylinder piston moves at such a high frequency. If the quality is poor I will be never able to go at that. And second thing is if somebody says oh here is a product which I am not sure about the quality, you use it if it works all is yours, then it becomes lot of pressure on you stress on you to use the product. So, whenever you try to develop a product, you keep it mind quality is the first thing which you have to satisfy.

So, quality in terms of customer satisfaction, customer satisfaction can be like reliability repeatability long time durability whatever it is, so that is all quality. So, quality is one

thing which is very important you have to keep it in mind while developing a product is something which reflects the market share and the price which customer can pay.

There are few questions we asked is the product reliable, how good is the product resulting from the developed efforts. Next one comes the cost. So, first is quality next is cost. So, what is the manufacturing cost for the product. If why are we talking about this if I can change the manufacturing process, if I can produce use it in bulk, will that cost become low? But it is not necessary I produce it in bulk and if I cannot sell it what do I do at some point of time I have to scrap it or discard it salvage it, so that is also costly, so this there has to be tradeoff.

Next one is what is the developing time. See developing time is how much time does the company or a group of members spend in evolving the product. Suppose, let us say there has to be a product which has to come to a market, and the development time for this product is 15 years. Sorry nobody will even think of that product today. So, developing time is very, very important.

Next one is developing cost is very important why because this developing time and cost are inter related these two will get into product cost. Because when you try to develop a product what happens is all the developmental cost the number of person the number of time everything gets integrated into the product cost that is why you see I make a product for 10 rupees, when I why is the company selling at 50 rupees because they have invested their developing time, developing cost their IP there, so that is why it is very expensive.

So, developing time is another important thing developing cost is the next important factor. Then development capability is the last important thing. All these things are inter related as features to for an effective product development; developing capability talks about the team which is involved in developing a product.

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So, a successful product development research it is like this. Developed ideas it is like this. So, when you talk about prototyping, it is like seal seeding and then when you talk about production it, it goes to this ways to this life. And when it goes to market it is it goes it goes in to a plant in market it becomes a tree. So, a successful product development from idea to implementation, just if you try to give analogy with respect to seed it is like this. You are a seed when you are in research. When you are in market you see how big you grow and how is your development. And this is how this sale also goes high when you try to look about successful product in the market.

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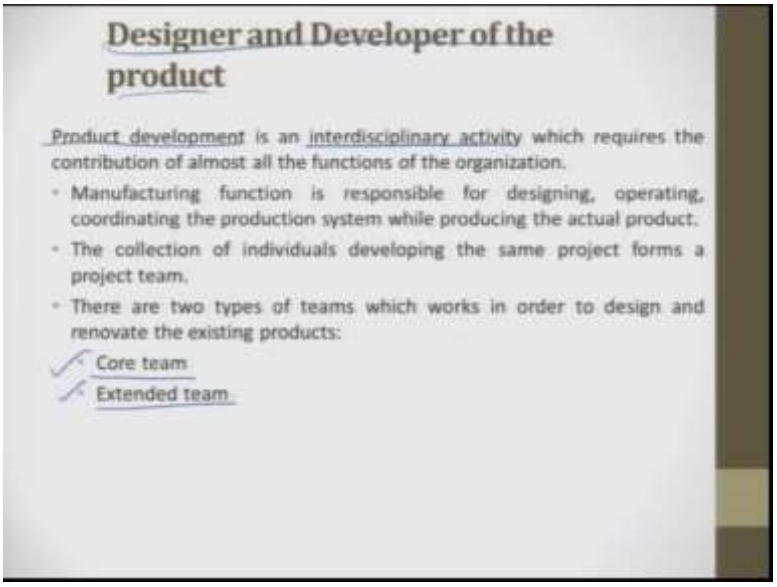

So, next look at designer and the developer of the product. So, first thing you should understand is today product development is not individual based, it is team based. And when you are talking about team also it is interdisciplinary team which is involved in developing a product. Product development is an interdisciplinary activity you will have hardware, you will have software, hardware in terms of giving physical shape, hardware in electronics all these things get integrated together to develop a product. So, it is an interdisciplinary activity where multiple functions are there to develop a product.

When you talk about individual, when you talk about a team which is involved in developing a product, there are two teams which are there, one is called as the core team, the other one is called as the extended team. So, for developing any product please keep it in mind it is not I developed it is we developed. Gone those days when individual terms in this I have developed a product, it is we have developed a product we leads to more leads to more success than I. So, in product development there has to be a team which is involved even for developing a very small product. The team there are two types of team one is called as core team, the other one is called as the extended team. (Refer Slide Time: 39:30)

The core team is a small group of people who are involved in trying to understand how this mission statement can be reached. For example, there ISRO launches rockets every now and then, it rocket today ISRO has gone into a business module. So, earlier it was one in three years, today it has become one in every month. So, they have learned the

skill. So, this they have there is a team which is involved, team of may be thousand people, ten thousand people involved in developing this. DRDO are now have now mastered the missile technology, they talk about surface to surface, surface to water, land to land, land to water whatever it is they keep talking of so many missiles. They have they have understood the technology they have developed a technology.

When you talk about car it is also the same. When you talk about even prototypes like this it is also the same. So, in all these things, there is not a single man involved. It is a team which is involved. The team has a core team this core team is they are only few number of members who understand what is mission statement. They try to take up in to small modules like they try to convert a product or disassociate a product into or disassociate the product into four modules. These team leaders of this core take that four modules and then go back form a big team extended team which has been for hundred people, five hundred people, ten people, twenty people and disseminate their problems statement, such that the idea can be reached.

In the core team they try to report what is the development, they try to reiterate their developments and then make sure that they reach the final goal. For all these products which have displayed here it is a team effort it has a core member, it has an extended member. So, a group of people contribute for this success.

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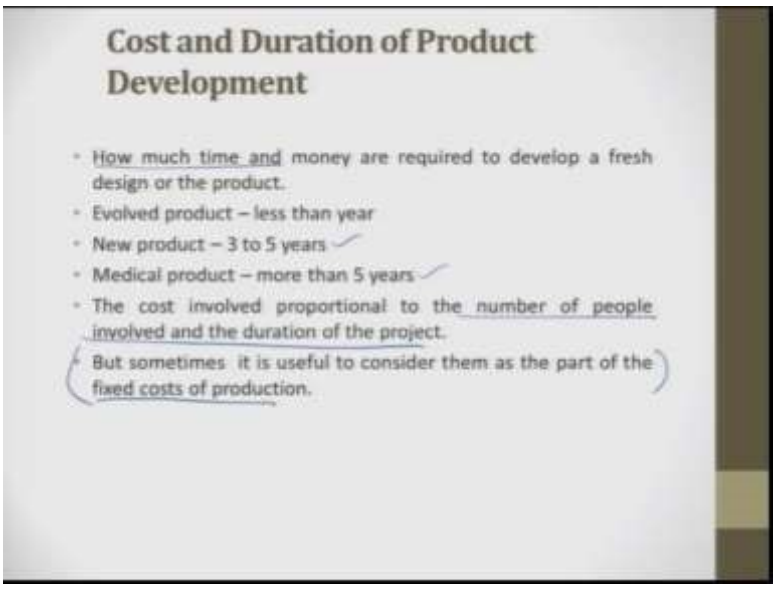

So, when you talk about cost and duration of a product, so we always ask how much time and how much money are required. There are evolved products or design of evolution a product might come to the market within less than one year, new product which can come within 5 years. When we talk about big technology a new technology it might take more than even 5 years medical industry always takes a longer time because they try to do testing on at several phases, and until and unless they get enough of confidence they do not release the drug or the product to the into the market. So, the cost involved in developing a product is directly proportional to the number of people involved, and the time duration which you have said.

And generally this cost is put under as a fixed cost in the product in the production development.

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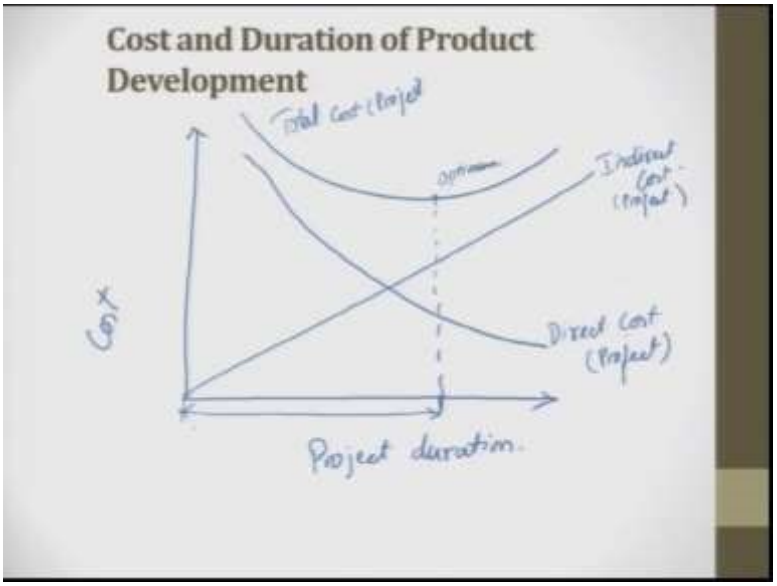

So, let us see a graph, wherein which we talk about cost verses project duration. So, this is something here is a trend which is called as a direct cost ok. And I have one thing which goes as an indirect cost ok. And you see here this is called as a total cost ok. So, when we try to do optimum, this is the optimum for the cost ok. This is the optimum. So, here we have indirect costs ok. Indirect cost which keeps increasing over a period of time; direct cost which keeps reducing over a period of time, and this is the total project

cost they have all what am talking about is the indirect cost of project all are with respect to project, direct cost with respect to project, and total cost with respect to project.
So, if you see here the optimum falls somewhere in this zone, but whereas these two lines cris-cross line which can happen before or it can have after. So, this is how a typical cost goes like. For example, if you want to construct a bridge, if you want to construct a rocket, so they do all this costing and then they try to find out where is the optimum and makes your product should come into the market before this optimum or at least with this optimum. So, that you try to get the best out of the project.

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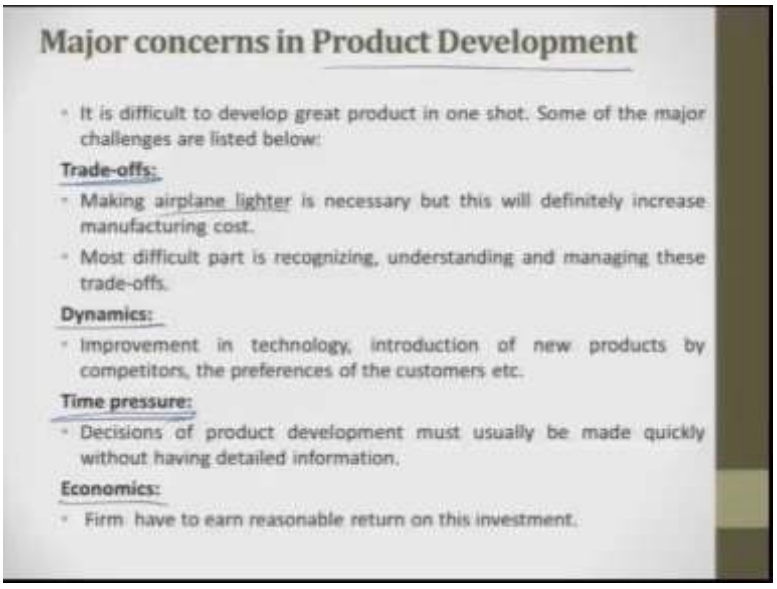

So, the other some other concerns in project development is first you have to always have a tradeoff. See if you start taking a long time, and by the time you come out with a product, you will have other competitors who are around you to come and release the same product. So, so first thing what you have to do is you have to look at tradeoff. Tradeoff is nothing but for example, here I have taken an example of aeroplane.

So, aeroplane you need to have a lighter and lighter and lighter aeroplane, but when you make it lighter and lighter and lighter, you should also keep it in mind it has to be stiffer and stiffer and stiffer right. Because lighter aeroplane then when you start making lighter and lighter and lighter, the cost also goes higher and higher and higher. So, somewhere you should try to have an engineering requirement and as well as your costing

requirement you have to have a tradeoff between these two take a point and then start developing products. And when you develop product please keep in mind the tradeoff should be cost with respect to performance ok. So, there has to be a tradeoff when you try to develop any product.

Next thing is dynamics you should always look around and see who are the other competitors what are they doing, and when are they going to release, am I ahead of them, am I late. Suppose, if today if I come and and release a car which is just four wheel and has a efficiency of 10 kilometers per liter, nobody will buy that car, maybe the car is very fabulous, but nobody will buy. Because today I have cars which are completely different which are tend the cars which gives you 25 kilometers per hour. And second thing today there is also a lot of push by several countries for this electric cars. So, today what is happen they are they have made it in several European countries by 2020, 2030, you will have only electric cars on the road.

So, what is the point in releasing the new car which works on diesel cycle and Otto cycle or which uses petrol and diesel has a fuel for in the car. So, anyhow in the next couple of years I am pretty sure your car is going to get outdated. So, what is a point you should be very careful look around what is a technology, look around what is a government policy try to understand that and try to release a product which is competing with others, so you so you have to improve your technology.

And the next thing is time pressure. So, when you try to develop products, time is very very important. People today talk about releasing products in a month, in a week, in a day; and I do not know tomorrow they might come and say in a hour every hour we release a new product it is not too far off to think today. So, people are gone there is lot of competitor in the market there is a global competition. So, people when they work on product development, they are supposed to take time pressure and take a decision and what to work how to work whether to do innovative, whether to do evolving whether to tweak the existing one or whether to add something to the existing products such that it can meet out to a customer requirement. Next is economics which plays a very very important role.

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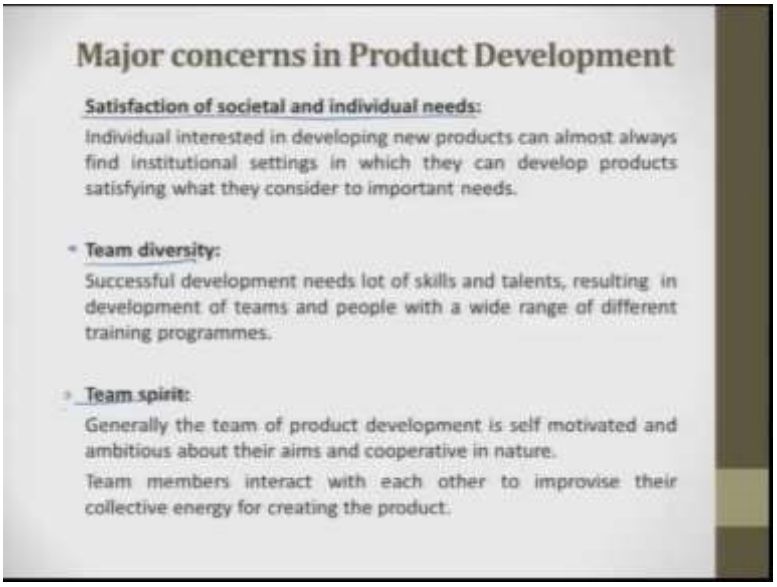


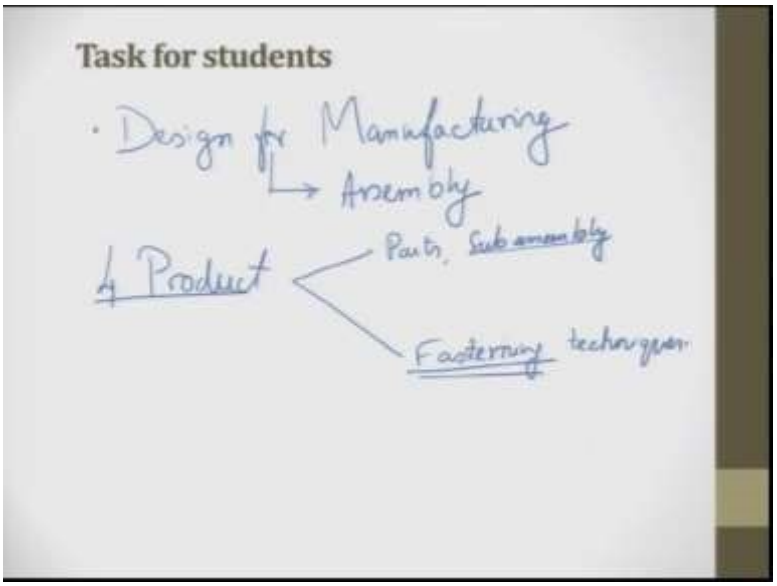
And the next one is satisfaction to the societal and individual needs whether you are able to do it. This is an important point of concern when you are trying to do a product development. And in product development there are two important things, which we always have to give lot of importance. I said any product to develop it needs a team, when you are working as a team you should have diversified people in your team. So, generally what people say as a thumb rule, when I work on product development I always try to choose two of my colleagues or friends who are completely contradicting to me, whatever I say contradict to me. Because what happens when I start listening to all the contradiction may be there are few points, which I miss they try to add it and my product becomes more reliable.

So, it cannot be always controversy, but you should try to have people who are critical about your style, your liking. And they should if all the team members are all saying yes to you, so then the problem is you will miss out many things which a customer wants from the product.

And the last thing is when you try to do a product development you should always have a team spirit team spirit is we have to win not I have to win. And every team member should be self motivated, choose a team wherein which every member is self motivated. 8 o clock is the office opening, come what may let it be cold, let it be dry, let it be rain 8 o clock if the team member gets into his office when you start something at 8, it will end perfectly at whatever time you want. So, there has to be a team spirit it has to be a bottom

of approach rather than a top down approach, but every individual should feel that they have to win rather than a team leader coming and saying let us win. So, there has to be a team spirit. So, this is also a major concern in the product development.

So, I end my lecture here and I would like to give task for students. So, every lecture whatever I do I would try to finish by giving a task to the students. So, these task is for yourself learning, you do not have to submit apart from this you will also have assignment and quizzes which will be conducted during the course, but this is for we have gone through a one topic, so one full topic. So, now, we will have to see what have you understood, can you cross correlate or can you link it with the real time used. (Refer Slide Time: 50:15)



So, in this entire presentation I have talked about something which I did not cover much which is called as design for manufacturing ok. In this design for manufacturing, I would like to make it more specific design for assembly. I would like every students to take four products which they like or which they use daily, and try to disassemble the product into parts, sub assembly ok, and then try to bring out their fastening techniques ok. So, take only four products which are detachable or disassemble. So, try to bring all the parts separately sub assembly separately will make a list write down make a list. And then you try to also write down what are the fastening techniques they have used to attach the parts into sub assembly, and see how you link this sub assembly with a product such that they make a very successful product. You can choose any cycle anything of your choice

ok. And try to do this what happens is. By doing this you will try to say how designers have involved in making the design for assembly in as part of the product so and this makes the product very successful.

Thank you very much.