Product Design and Manufacturing
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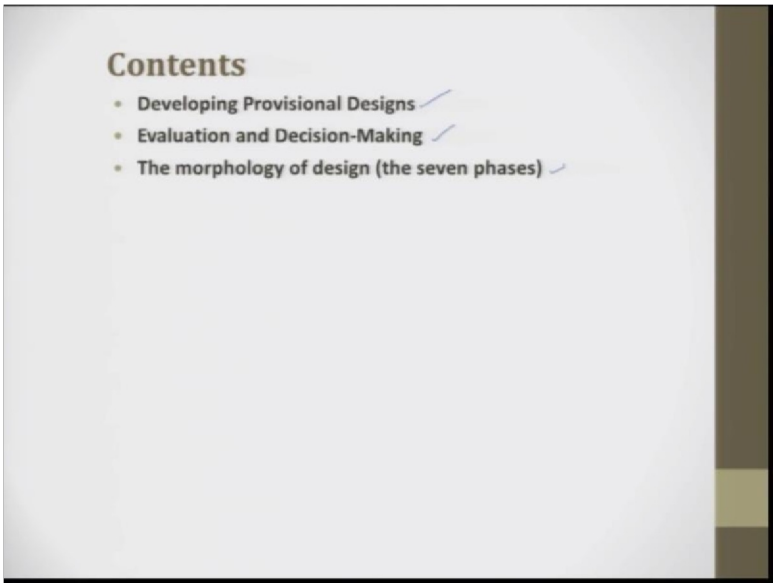
Lecture – 04
Product Design Morphology

Welcome friends. Let us move to lecture four. Today we will be more focused on product design morphologies. I am sure you would have done the last assignments which I have given at the end of the lecture. And all these assignments are only to make sure that you start enjoying this course. So, let us move onto lecture four. (Refer Slide Time: 00:37)



So, in lecture four, the content will be developing provisional designs, then evaluation and decision-making, and then morphology of design. There are seven steps; we will go through all the seven steps.
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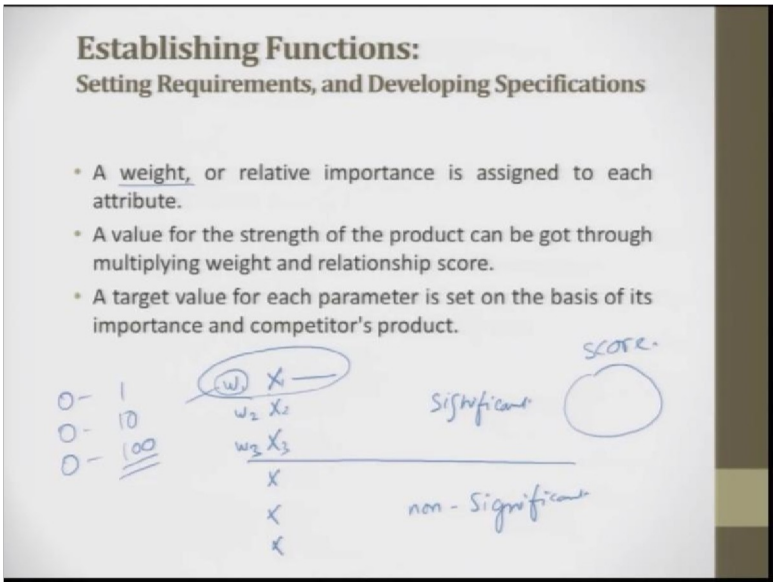


So, establishing a function that is very, very important; so here what we see is setting requirements and developing specifications. See, I was telling you last time also that I need a soft cloth. So, what is your soft requirement? So, it is very difficult for anybody to quantify the softness. For example, if you take a tea taster, there are tea tasters appointed by tea processing industry, they try to test a tea and then say this is good or bad. So, it is only they can do it. It is very difficult for you to replace them with some machine.

So, changing customer's requirement into engineering specification is a big art, many a time you will not be able to give a direct specification. So, we try to give it indirectly. For example, we will try to say the touch has to have soft as a skin of skin of an animal or it has to be as soft as a silk, silk sari. So, then what do we do is we go measure the silk sari softness, and then that we try to establish in terms of know parameters like tensile strength this and that, and then we try to indirectly give the specifications, so that is what is a big challenge in design that is a very big challenge.

So, a weight or a relative importance is assigned to each attribute, so that is what I said the indirect way of going head or you try to give a weightage. The other thing is supposed if there are ten specifications you count. So, these are the specifications of a product. So, then you will try to give in this ten specifications which are all significant and which are all non-significant, so in non-significant parameters right. So, in this nonsignificant parameters and significant parameters, again you would like to assign weightages. And you try to say which specification is more important.

For example, when you take a child's diaper the softness is very important. So, is it is it the softness important or the absorption capability the absorption capability of the water important both are important. First comes water then comes the softness. If you have a soft diaper, but not a water absorbing diaper, then it leads to the failure of the product. So, here a weight or a relative importance is assigned to each attribute. The value of the strength of the product can be got by multiplying weightages and their relationship score.

So, basically what we are trying to do is we are trying to say you multiply with x, you multiply maybe x1, x2, x3, and then what do you do is you try to have a final score here. And then what you do is you try to find out from that score what is the importance. So, generally when we try to give weightages, weightages can be given 0 to 1; it can be given 0 to 10, it can be given 0 to 100. More the weightage number more will be the demarcation which you can show. The target value of each parameter is set on the basis of the importance and the competitor's product.

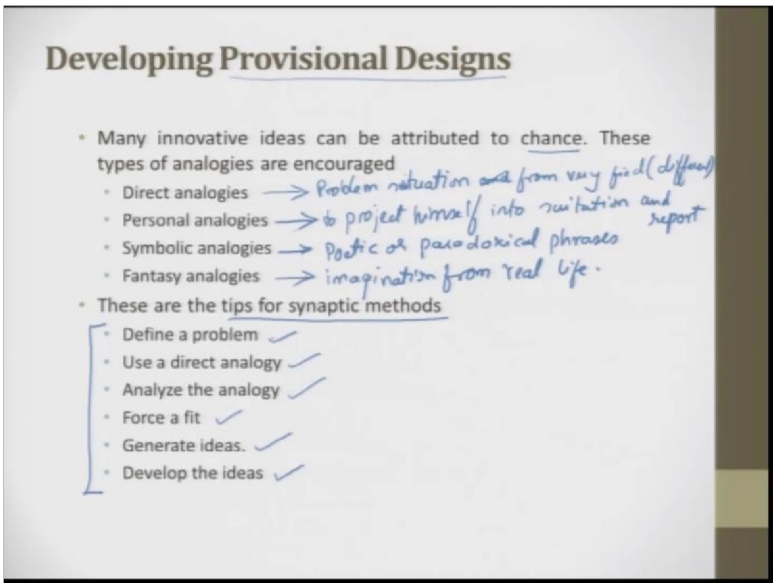
Now, what is happening you have found out the weightages now after finding the weightages what you do is you have found out that this is a very significant parameter fine. So, now, what you will do you will go to the market and find out, who else is doing a similar product. And in that similar similarity, for example, two things are there let us go back to the diaper example. So, what you do is you go around the market, and look for water absorbing products, it can be tissue paper, it can anything right. So, you will look forward, and you will try to take the best fellow.

For example, x company is producing a diaper of or it is trying to produce the cloth tissue paper which has the best absorption. So, you take that and keep it aside. Then what you do you go around the market and look at similar products for smoothening. And then you try to find out a kerchief is very smooth some x kerchief is very smooth. So, now, you take that fellow and keep it aside. So, now, what you will do is you have now done the state of the art for these two things which are a pioneer in their own domains. And now you try to take their specification, and then try to look at the current state of the art in diaper what is all available and then see where to pitch in, what to pitch in and then you decide the specification. So, deciding the specification is very important.

If somebody buys a mobile phone today, he says I would like to buy a mobile phone which need not get charged for seven days practically, yes, it should be possible, but the deciding factor is going to be the battery life. And there are two things if you say that

battery life then you should have a powerful battery. The other way round is if I have a phone which does not have so many features then still I can produce a mobile phone which can meet out to the customer requirement of not charging for seven days. So, you see how it is a contradicting thing.

So, now, you should understand what customer wants, what is competitive available and then decide your specification. If you make a mistake in assigning the specification then all the other exercise will be going futile. So, setting requirements and developing specification is a very important task. (Refer Slide Time: 06:43)



So, then what do you do is you try to develop provisional designs. So, many innovative ideas can be attributed to chance these type of analogies are encouraged to direct analogy. In direct analogy, what happens is it involves an analogy of problem situation, you try to take a situation, and or you try to take a problem situation from a very different field from a field which is different ok. So, when you try to compare, for example, you try to say the specimen or the food whatever is kept in front of me is very hot. So, what do you do is you try to put an analogy of a chili and try to increase the red colour which is given to the chili.

So, now food is something, chili is some other thing. So, now, you are trying to compare or you can try to take hot, and then you can try to put fire and say this specimen or this food item is very hot. So, you can just try to put an analogy with respect to even fire. So, here what is happening is you try to take an analogy from a problem situation from the very different field, and try to link it with your thing.

The next one is personal analogy personal analogy is here it is expected to project himself or herself into a situation and then you try to situation, and you try to report that ok. You report the experience of that particular situation back into your analogy. Say, for example, I touched some item which is very soft. So, here what did you do, you touched, you project yourself, himself or herself into a situation and then report the feelings like by seeing hearing etcetera, etcetera.

What is symbolic? Symbolic means it is something like a poetic or you try to create a paradox paradoxical phrase. So, that is a symbolic analogy. So, I was recently using a urinal in an airport there was a small phrase written. So, it said flush and rush so it is something like poetic right. So, this is and then you can also use some something like a phrase like this. And then try to bring it to your design, and then a fantasy. Fantasy is a concern is asked to here you talk more of imagination from real life.

So, what has you done is you have you have innovative ideas can attribute to chance, and there are four type of analogies which are generally encouraged. So, what you do is you try to take a direct analogy or you try to take a personal analogy, you try to take a symbolic analogy or you try to take a fantasy analogy. So, you can use analogies and then try to come to your design and try to take a design out of it. There are tips for semantic methods. First, you try to define a problem and use a direct analogy, and then analyze your analogy, force a fit to the analogy, then generate ideas then start developing ideas. So, these are the tips generally we give for developing a product.

So, define the problem. So, the definition of the problem is very very important. Then you try to put all these analogies what we just now referred. Then you try to analyze the analogies and pick what is required, and then you try to forcibly fit that with respect to your product, then you generate ideas for the conceptual ideas for your product and then you develop the ideas.

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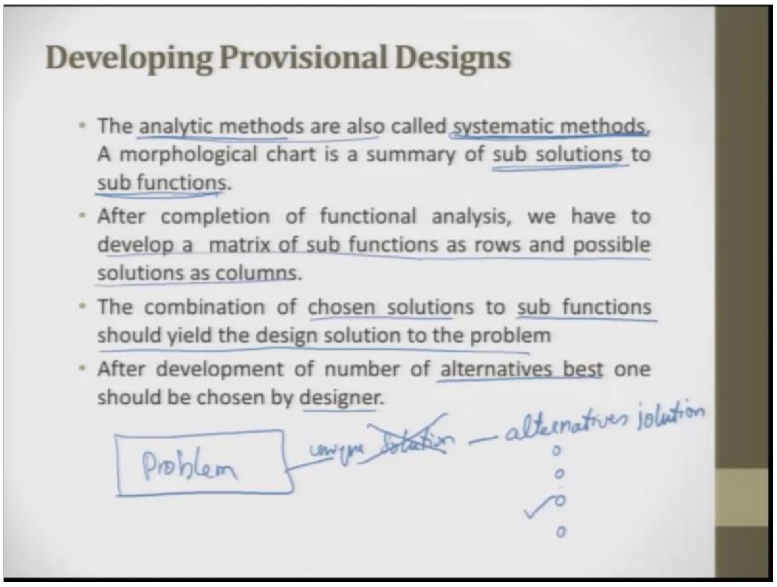

So, the analytical method is also called as a systematic method. A morphological chart is a summary of sub solutions to sub-functions. So, an analytical method is also called as a systematic method. Any product if it has to be developed, it has to be systematic thinking process has to be used in developing the product. So, analytical method means you have a logical method to try to find out or come up with the specification. For example, you can try to have summary of sub solutions to sub functions. A product can have functions and some sub functions. For example, you have a car, car is used for moving from one place to the other. The sub function is it should not produce noise or it should give you a comfort, this is a sub function, but what is your main function main function is only transportation ok. So, the morphological chart is the summary of sub solution to sub function.

**After completion of the functional analysis, we have to develop a matrix of sub functions as rows and possible solutions as columns. Then combination of a chosen solutions to a chosen sub function should yield the design solution to the problem. So, these are all part of systematic method. After developing a number of alternative best ones, you alternatives the best one is chosen by the designer. So, for example, for one particular problem, there cannot be one unique solution, unique solution is not there that is one thing which you should understand. There is always alternative solutions in design that is very important designer should understand, alternative solutions are possible. And you have to put all the alternative solutions and you pick a best solution such that you can cater to the needs.

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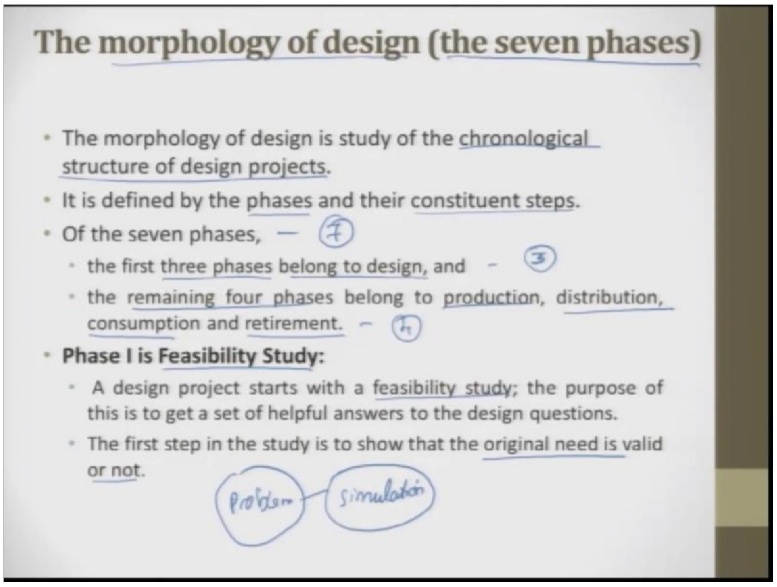

After completion of the functional analysis, we have to develop a matrix of sub-functions as rows and possible solutions as columns. The combination of a chosen solutions to a chosen sub-function should yield the design solution to the problem. So, these are all part of the systematic method. After developing a number of alternative best ones, you alternatives the best one is chosen by the designer. So, for example, for one particular problem, there cannot be one unique solution, the unique solution is not there that is one thing which you should understand. There is always alternative solutions in design that is a very important designer should understand, alternative solutions is possible. And you have to put all the alternative solutions and you pick the best solution such that you can cater to the needs.

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So, there are seven steps morphology of the design has seven steps, so that is nothing but a systematic way of solving the problem or solving or developing a product. See the morphology of the design is a study of the chronological structure of the design project. It is defined by phrases and their constituent steps. Of the seven phases, the first three phases belong to design, and the remaining four phases belong to production distribution consumption and retirement. As I told you last class retirement is also one important parameter which has to be thought of at the design stage itself. So, there are seven stages. So, out of seven three goes here and four goes here. So, the first three phases stages are belonging to design.

So, phase one is the feasibility study. A design project starts with the feasibility study; the purpose is to get a set of helpful answers to the designer's questions. For example, the designer comes to you and says can you try to find out a solution for this problem and I give you 20 rupees; or somebody comes and says I would like to have a material which is very brittle very tough and which has the very high strength and wear resistance.

So, now immediately if you go back to the databook or if you look at many materials, it becomes little difficult for you to come out. So, first then what you do is you try to pick up material a, material b, material c, material d, I tried to make an alloy of whatever it is. So, am I still able to meet out to the requirements of the customer if that is there then you can start looking at a project or start looking at a problem solution? If it is not so, then we try to scrap it at their level. So, that means, to say in engineering also we tell this the students the same you have a problem or you have a process what you do is first you try to do a simulation and then try to see whether it is feasible to develop a solution for this problem. If it is not so, we try to scrap the idea.

So, a design project starts with first a feasibility study. The purpose of this is to get a set of helpful answers to the design questions. I will take you and tell you an example of this metro rails. When metro rails were introduced at every place. People started saying that 50 rupees a ticket, so it, not a feasible model and it will not self-sustain. Please do understand when the government went for the head for these metro trains they were looking at how do people commute from place to place, how can we reduce the pollution, how can we try to ha give a better comfort life for the citizens that is where their lookout was. So, they did not think first stage financial feasibility, they looked at all other things. And over a period of time, they looked at financial feasibility. Today, Delhi metro is very successful.

So, for doing implementing this Delhi metro, they did a first feasibility study, and then they found out, yes, there is going to be a solution answer to this and our answer is giving a better result, then let us start looking at problem-solving skills. So, what are the problems as far as Delhi metro is concerned, how many trains to be put, how frequent this has to be there, what is the investment should happen. And then if you say high speeds have to be achieved, so what should be the structural stability of all those things in next. The first step in this study is to show the original need is valid or not ok, so that is the feasibility study.

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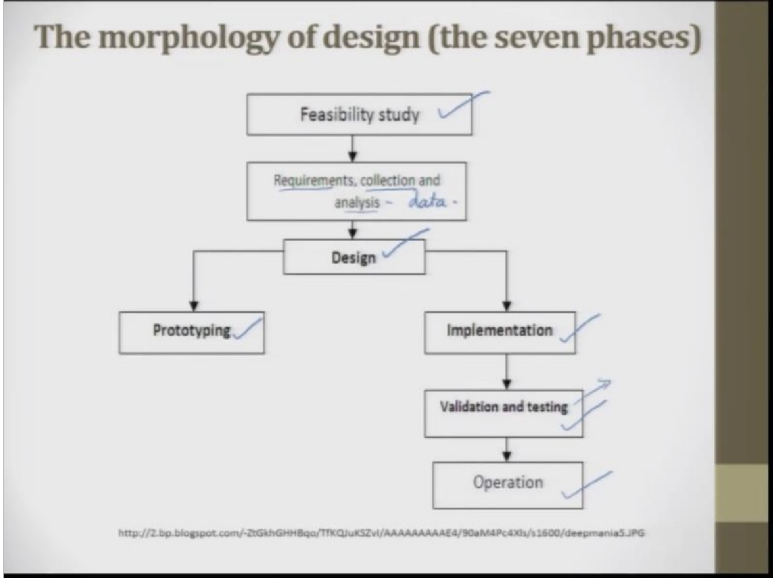
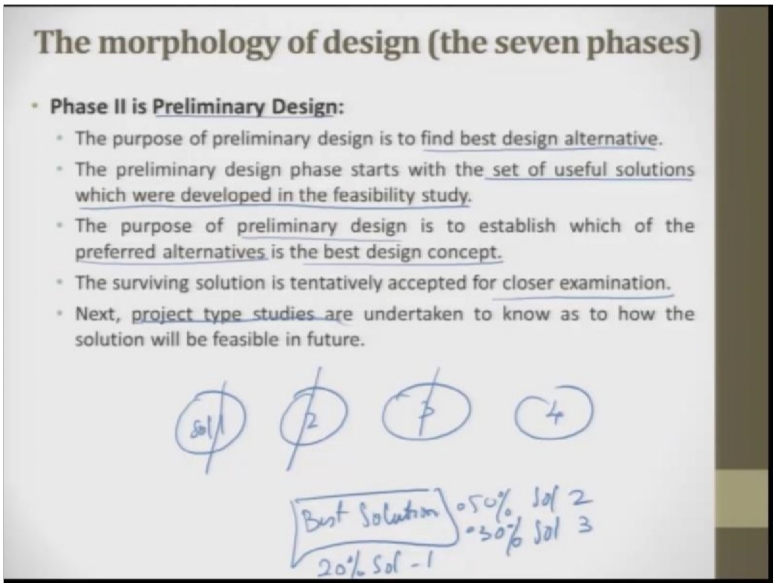


So, feasibility study first is requirements, collection and analysis have to be done. Then what we do is we try to develop a design. If it is a product then we try to develop a prototype or if it is a solution software solution other things, we try to do implementation we try to validate and test our results and then we put into operation.

So, a feasibility study is done. So, after the feasibility study, the requirements collection and analysis of data is done. And then from there comes the design, then we implement it validate it. Any design you do, it has to be validated and it has to be tested with the customer. If you take a pharmaceutical product which human health-related the testing phase takes huge time 3 years, 5 years, 10 years; they do it on a rat, then they do it on this they do it on that, but you develop an engineering one you do not have to undergo such a long time of testing. So, it depends from product to product. (Refer Slide Time: 18:58)



So, phase two is the preliminary design. We studied phase one which is a feasibility study. Then what do we do is a preliminary study. The purpose of the preliminary study is to is to find the best design alternatives. Then the preliminary designed phase starts with a set of useful solutions which were developed in the feasibility study. So, we look at alternative solutions, and we now put down all the alternative solutions ahead of us, in front of us and then look at what can we do. But now please do understand you cannot look go back and say the feasibility study I would like to relook. Now, I see in the preliminary design stage I do not see any solution. So, let me look at feasibility study, no, that is not accepted.

When you develop a product and when you are moving forward and when you move forward in putting the requirements, you have to do the requirements and you cannot now go back and start reiterating your feasibility. Please keep that in mind. You can develop a product prototype, keep revising their performance, but you cannot go back and say about the product whether this product at all is required that you cannot question, so that is what I say.

Preliminary design phase starts with a set of useful solutions which were developed in the feasibility study. The purpose of this preliminary study is to establish which of the preferred alternative is the best design solutions. So, out of the four, you now start working on which one is the better one. So, again nowhere what do we do is we do concurrent engineering today and we use the best material, the best manufacturing process, the best salesperson, the best accountability person, the best costing person all of them joined together and start picking the best solution. So, it many a time what happens in solution 1, 2, 3, 4, solution 1, 2, 3 and 4. So, the best solution is here. The best solution can be 20 percent of the solution one, 50 percent of solution two, 30 percent of solution three also can happen. So; that means, to say I do a cut here, I do a cut here, I do a cut here, I do a paste and develop the best solution possible many a times it happens in reality.

Then what do we do is surveying the solution in tentative acceptance for closer examination. So, what do we do is we try to do an evaluation of the product within our close community of friends or within the factory or within a confined zone, where I would like to test my product and see and see what is the performance of it. Then you do it in a closed examination, you do a close door evaluation whatever it is, and were very critical in telling you this is bad, this is good, this looks comfortable something like that. And then what do you do is you next project studies are undertaken to know as to how solutions will be feasible in future.

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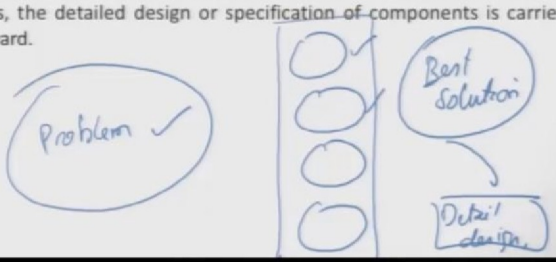
The morphology of design (the seven phases)

- **Phase III is Detailed Design:**
  - After preliminary design Other studies examine the extent to which forces from surroundings or internal forces will affect the stability of the system.
  - The goal here is to furnish the engineering description of a examined design.
  - Great flexibility is shown up to this point in designing.
  - Preliminary design is developed as a master layout. With this as a basis, the detailed design or specification of components is carried forward.



Then phase three, now what do you do if you do a detailed design. You have a problem, you have evaluated the problem needs a solution, you have developed four solutions. So, now, you have chosen the best fellow. So, one feasible solution best solution is chosen. Now, after doing the best solution, now you work on detailed design detailed design. So, you look at the best solutions and then you start working on the detailed design. When you try to look at detailed design here we try to put all our engineering knowledge right. And many a time people skip this exercise and whatever comes they just take one solution and start doing it, and they are not pretty sure whether that is the best solution ok, so that is what it is. After preliminary design, other studies examine the extent to which forces from surrounding or internal forces which affect the stability of the system.

So, now, what do you do, you do a detailed design. So, you have decided that has to be a shaft, it has to be made out of some material steel. And now what you do is what should be the dimension of the shaft, what should be the tolerance of the shaft, is that shaft matting with another gear. So, what it is all those things we will start looking at it. So, the goal here is to furnish the engineering description of the examined design. Till now you have not talked about the engineering design, engineering design helps you to move forward toward the manufacturing process decision or look forward to manufacturing feasibility ok. If this after the stage only or during the stage only when engineering descriptions are given, you try to choose the best material and other things.

Till now we did not bother about shape, size form whatever it is we thought this, this, this a crude solution was thought of. So, here we tried to do a detailed design. The great feasibility is to show up to them at this point in designing. The preliminary design is developed as a master layout with this as a basis the detailed design or the specification of the component is carried out. After the detailed design is done, now people look forward to local vendors, people look for international vendors, they try to pass on the design and then they ask them can you give the costing for it. After getting the costing they just plunge it back and see whether it is feasible or not.

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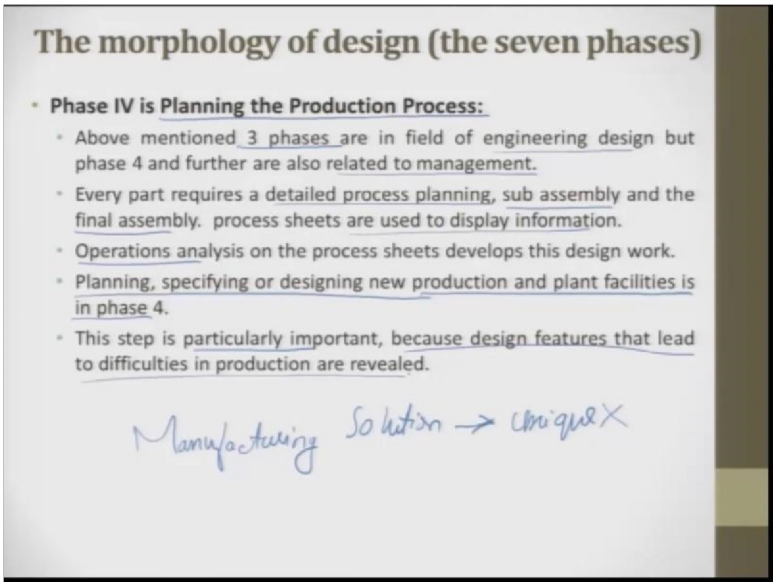


Next is as I said planning the production process. Because now that you are the fixed engineering specification, engineering design constraints, now what do you do is you look for manufacturing processes. By the way, the manufacturing process can also go back and say oh this is not possible, we cannot make this design. Can you make a oblong shaft instead of a circular shaft very difficult you cannot make a process? Can you make a square shaft instead of a circular shaft? And the design says the detailed design says square shaft has to be made, it is pretty difficult for a long for an if you want to do extrusion possible. And again in extrusion also square edges is very difficult. So, people always try to go back and say no it is not possible. So, can you convert this square into a circular one? And if they say ok, if it is possible, now you go back redo that design detailed design is relooked and then they come back and say looking into manufacturing difficulty, we have converted the square into a circular this thing.

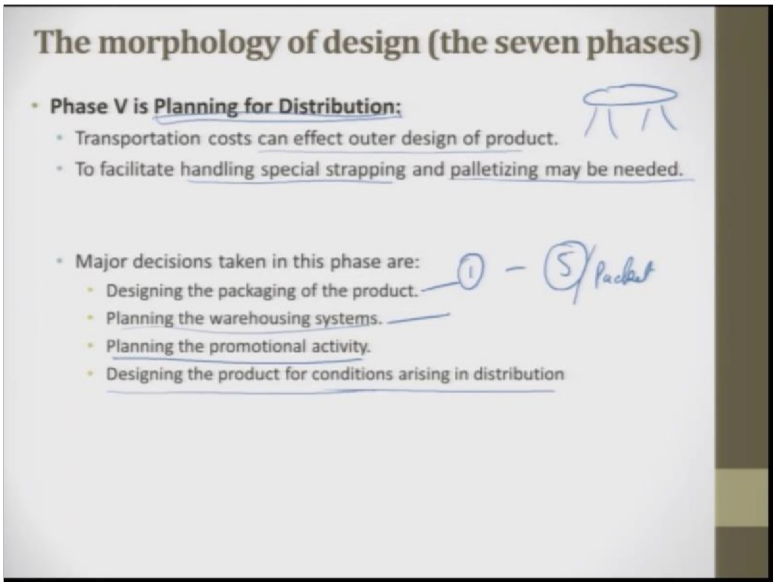
When you talk about a circular cross-section, the production cost is very economical. When you talk about a square, it is slightly expensive it is not that it is not possible. So, what we have to do is take a circular shaft, and then you have to mill the surface, index it, mill the surface and then you get a square shaft, it is possible. But it is time consuming and the sharp edges will lead to or stress concentration when you put it on mating it is prone to failure ok. So, there can be back and forth going back between detail design and the production process, but predominantly once the detailed design is fixed and during

that time itself a manufacturing expert is involved for decisions. So, whatever they take a decision there is then further taken down.

So, in phase four is planning the production process. As mentioned in the three phases or in the field of engineering design, but the fourth phase and further are related towards management. Every part requires a detail process plan. And here also I would like to bring to your kind notice manufacturing solution whatever you generate, manufacturing solution for a product. It nothing is unique, you will have several alternative solutions. You try to take the best decision keeping the time material available time cost as the constraint, and then you develop or you prefer one particular solution. A solution which worked very good in one part of the world need not work in the same way in the other part of the world ok.

So, manufacturing solution there is nothing called unique you will have to choose the best solution at given the constraints ok, so that is what we say every part requires a detail process plan, , and the final assembly as to be given. There is a process sheet which will be developed for each individual product, and then there will be more information about what is to be what all changes have to happen to the part such that it becomes a product ok. So, then the operation analysis is also performed. For example, operation means the movement, the first machine is here the second machine should I place all the machines one after each other can I place them in a (Refer Time: 28:31) manner. After this operation what is the next operation what is the total time I give in this operation? So, all this operation analysis should I do it manually, should I do it with a CNC all these things happen.

Then planning specification in a detailed new production and plant facility is in phase four. So, you establish a plant layout is done in step four. This step is particularly important because design features that lead to difficulty in production are revealed ok. So, the first three is feasibility, detail feasibility, then you look for an alternative then you produce a detailed one. The fourth one is towards lay process planning and layout. (Refer Slide Time: 29:18)



The fifth is planning for distribution. Fifth is how will I transport this part from the company or the production plant to the retailers, so that is planning. So, the transportation cost can affect the outer design of the product. Just a simple example, for example, you I said in last class itself table ok. So, today tables are made into a modular concept, they are disconnected, and then they are put they are packaged and then they are moved. Suppose, if they want to push a full fully assembled table, it might occupy a lot of volumes and the transportation cost becomes very expensive. So, to facilitate handling special strapping and palletizing may be needed.

So, for example, if I wanted to distribute milk, should I distribute milk in sachet packets of half a litre, should I do it in 1 litre, should I do it in 5 litres, should I do it in 10 litre bottles, should I do it in a 25 litre canes, should I do it at 50 litre canes, or should I do it at 1000 litre barrels. So, all are the distribution of milk, all are milk only. So, now, I have to decide what should be my packaging, so that is what we said handling special strapping and palletizing is very important, so that is decided in planning for distribution phase in phase four. So, the major decisions taken in this phase are designing the packaging for the product, should it be one piece, should it be five pieces per packet, should it be 1 litre, should it be 50 litres, so that is what it is then planning the warehouse location, very important.

Today in eBay you go ahead and book you order a particular item. So, now, this item has to be picked up from the warehouse. So, should I pick it up from the closest warehouse or slightly far away from the warehouse? The next constraint is if I pick one, one item

from this warehouse will it undergo the next ordering cycle ordering cycle, and if the next ordering cycle starts what is the costing involved. Or if I go 50 kilometres away, if there is a warehouse where there are four, four items there if I pull out one nothing big is going to happen then they can do it. And now each warehouse owner also tries to give you a discount. If you try to use my product in my space, if you take items from my space, I will give you at a lesser price. Then immediately the e bay looks for all these benefits, and then what they do is either they try to give the benefit to the customer or they try to give it to the company, they decide the warehouse locations.

Next is promotional activities; promotional activities are very important. So, if you try to leave this product, if you try to take education as a business, as a college as a business as a college as a product institution as a product. So, for this product, if the sale comes the customer comes only once in a year, so they do not have, you all people join school or college only in June, July whatever it is the season only once in a year ok. So, that is the time they join. So, for that time they generally take decisions in the month of March. Have to take a decision in month of March the college has to give a widespread and advertisement starting from January to March, and they should not start giving the advertisement after April, because after April goes in vain because the student has taken a decision in March, so that is what is planning for promotional activity ok.

Next one is designing the product for conditions arising in distribution. So, this is also very important in designing the product for conditions arising in distribution. So, for example, if I try to move ok, for example, laptops, when they are moved from Malaysia to India, many a time they are moved by ships. So, what happens when it is moved by ships in the sea, the complete container rattles it goes up and down? So, now, individual laptops have to be packed.

So, this will be packed, and then it will be done. So, should I do and when you pack it would be individual laptops packed, and then they put it inside a container, and then it moves. So, when it is individually packed properly even in the rattling if it falls down from a height of 10, 20 meters nothing happens to the product. In fact, I have physically seen a test where people drop the laptops for designing the packaging, they try to drop the laptop from the fifth floor and the sixth floor of a building to the ground, and then they see what amount of damage it has created to the laptop.

So, designing the product for conditions arising in distribution is also very important. Sometimes it can be humid climate; sometimes it may be a rainy climate. For example, e bay items are packaged in plastic covers because all in hilly regions you can have rains in the region like flat plain, the temperatures can go very high. So, all these things are part of to be considered in the planning and distribution.

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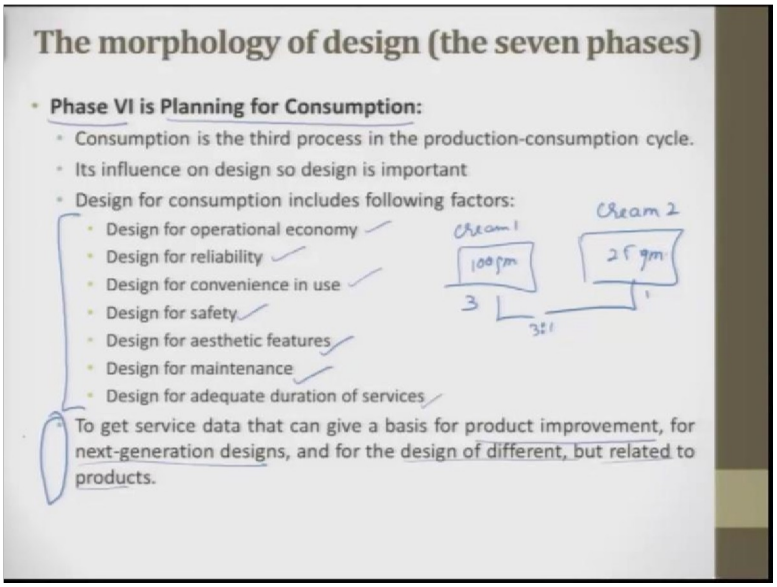


The sixth phase is planning for consumption. This is a very, very important phase. So, the consumption in is the third process in the production-consumption cycle. It influences it is influence on the designs design. So, the design it influences more on the design, and this makes design little more important. So, design for consumption includes the following factors. Design for operational economical, design for reliability, design for con convenience in use.

For example, yesterday I took my son to a doctor. The doctor suggested two creams cream one and he suggested cream two. This cream is 100 grams and this cream is 25 grams. So, he said mix these two creams at a ratio 3 is to 1. And now if I had to maintain this 3 is to 1 ratio, it is very difficult for me. I just have to pull it out and then try to randomly or more approximately assume that this is three times and this is one time, and then I put on a piece of the vessel or on a plate, then tried to mix it. When I mix it I am not pretty sure whether the mixing had happened properly, and then I have been asked to apply for my son's skin. See as a father I am more worried because if any ratio changes and if at all it affects his skin what am I going to do. So, here this is not convenient to use that is what I am saying. Design for convenience in use it is not there. And many times many of the companies sell a wonderful product, but they do not attach a good instruction manual. So, it is not convenient to use ok. So, this is one.

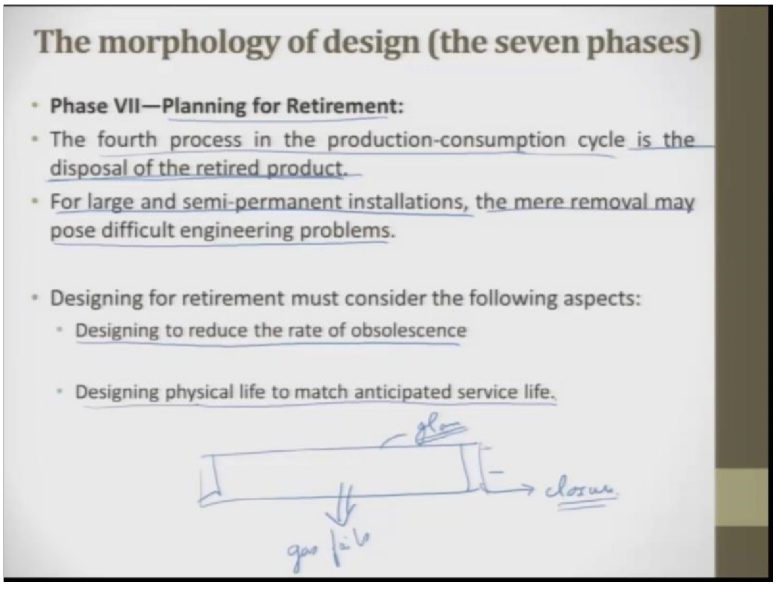
And the next time is suppose I try to take oil in a pan and then I use it for frying. And after I finish my frying I wanted to unload I wanted to remove the oil from the pan and put it into a container. So, now, if I try to tilt a pan, it spills all around. So, it is not convenient to use, so that is what I said for convenient use has to be thought off at the design stage itself.

Then design for safety. For example, batteries, after it is consumed, we discarded left and right. And now slowly people have started getting an education that it has to be discarded in an in a standard procedure, earlier it used to throw it here and there and the next thing same way for acids which are used for cleaning purpose. Hospital waste, so all these things were discarded left and right here and there and this is something which is very important which has to be thought of at the design stage itself, design for safety.

Then design for aesthetic features, design for maintenance and design for an adequate duration of service. So, you cannot say every 15 days go to a shopkeeper and get my

product serviced, my product will be wonderful, you cannot do that. So, even today when people buy bicycles the biggest problem in the bicycle is the pedal it fails or the tyre gets flattened. So, they have to produce a tyre which does not get flattened or they have to make a pedal which the screw does not fall off. So, here they do not need to go to a service engineer or a service station, they can keep continuing the product. So, all these things design for consumption when you think all these things have to be thought of and it has to be integrated into the product when you try to design a product or it has to be integrated at the design stage itself so that you try to get this right.

Then you to get service data that can give a basis for the product improvement for the next generation design, and for the design for different, but related to the products can be got can be taken, and then you can try to improvise every time. So, this is this point is more towards service data for improvising or producing the next generation of it. (Refer Slide Time: 39:10)



So, phase seven is the planning for retirement. So, after the product has finished its life or its performance, now what do I do with the product. For example, I told you the batteries the life of the battery is over. So, now, what do I do how do I discard it that is the important thing. So, the fourth process in the production-consumption cycle is the disposal of the retired product.

So, today we are we are started designing products or there is a requirement for the designer product designer that they should look for products where individual parts almost all of them fail at a reasonable time. For example, in a tube light, the glass does

not fail at all, the tube the glass does not fail, the closures do not fail the gas fails. The gas fails is only because of the gas failure which does not further go for ionization through the complete tube light. The glass can be recycled, the closures can be recycled and then now what we want is we wanted to develop a product as and when the gas degrades, the closure we choose a material that also starts degrading. And the glass whatever we use we try to make sure only it withstands for certain amount of time or a certain amount of time period and something like that. So, this is what is now talked about.

So, we were looking for a product which can all try to decompose or all try to lose their performance at a simultaneous stage. And when I throw it I throw all the products are worked to the maximum efficiency or I try to reuse the glass and the closure. So, I go to a shop and then give this tube light which is not performing, ask him to refill the gas and start using it. The disposal of the retired product is very important or reusing the product is also thought about. So, after retirement what is to be done is, is to be also thought of. So, this is the phase seven.

So, for large and semi-permanent installations the mere removal may pose difficult engineering problems. So, designing for retirement must consider the following aspect. Design to reduce the rate of obsolescence, design designing physical life to match anticipated service life, this is what I was trying to talk with respect to a tube light example.

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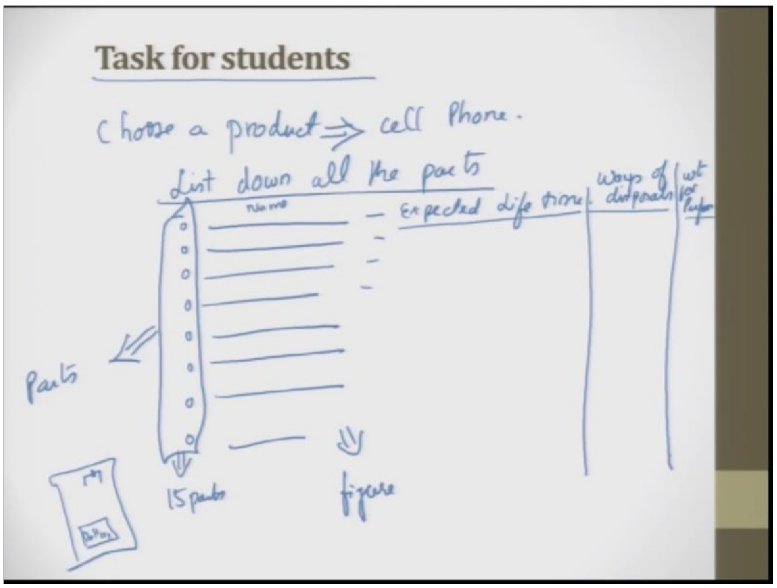

So, with this, we come to an end for lecture four. So, today's task is to try to choose a product, let us take a cell phone ok. List down list down all the parts to the best of your knowledge, list down all the parts 1, 2, 3, 4 whatever it is. And then try to write down what is their expected lifetime ok, try to write the expected lifetime for maybe 10 of this. So, this, this, these are parts these are all parts of a cell phone here you are writing the name and then expected lifetime. Then what do you do is you try to say the ways of disposal. And after that you also will say; what is the weightage for individual parts in the performance weightage of individual parts for the performance of the product.

For example, you take a cell phone, what is the weightage this for example, battery what is the weightage of the battery in the overall performance of a cell phone. Or what is the performance of the glass which is there on top of this? What is the performance of something else vibratory part whatever it is there in a cell phone with respect to its performance? So, I want you to write down the parts you have to write minimum 15 parts, let us make minimum 15, you will write down the parts; if possible you will also put their figure, then it becomes more. You put their drawings of all the figures of this then you try to write down what is the expected lifetime then if at all it fails how do I dispose it not as a total font that individual part then what is the weight of the individual part with respect to the overall performance of the cell phone. Please try to make this table and then what you do is you will see the all the phases whatever we have studied are coming into to existence

We will start with the lecture five next time, but please try to solve this solve these assignments and you do not have to submit, but solve this. So, then it gives you a confidence, it gives you what are all the problems and cell phone is today everybody has one. So, you can look at it and then start writing it ok.

Thank you very much.