System Design for Sustainability
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Week - 04
Lecture – 03
Design for Product Life Cycle

Hello everyone. So, today we are going to discuss about how to Design for Product Life Cycle. So, what we are trying to do in this particular lecture is there is a concept called as eco design concepts of we will marry the lifecycle assessment that we have learned with eco design. And this can become an important tool for people who are interested in designing products and achieve the product innovation level of sustainability as we had discussed in our previous module.

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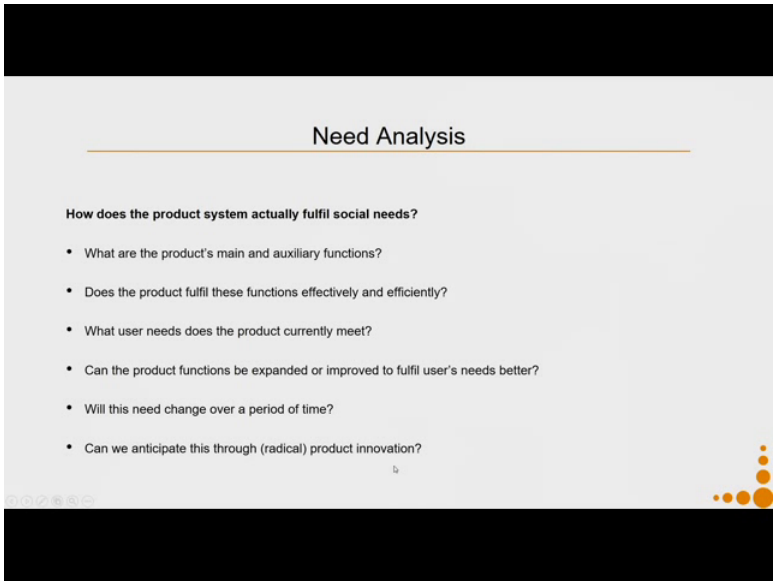

So, we will be talking about this eco design checklist. It has been developed by Doctor Brezet. So, what this checklist talks about is it gives you a checklist it since when you begin with doing a lifecycle assessment you are also not very proficient in trying to understand what all categories in which you need to seek information and so on So, this checklist is helpful for doing design for product lifecycle analysis as well as you can use it in order to think of what are the different processes which you might be missing of the materials which you might be missing when you are doing a lifecycle assessment.

So, the need analysis it ask the first question how does the product system actually fulfil social needs. By social needs what we mean over here is needs of people, the needs of the consumers. So, the question starts what are the products mean and auxiliary functions. So, say for example, if I take a water bottle its main function is to drink water. The water bottle might be made in a manner that it is easy to carry in your bag. So, in that case its main function is that it is a bottle from which you can drink water and you can carried in your bag. Similarly if you design a kind of a water bottle you can also design a bottle which you cannot carry with you in a bag because the lid has been designed in a particular manner, you can also design the water bottle in a manner that the main purpose of it is to keep it in the freezer to get cool water. So that becomes the main function of the product.

Now, what all can be the auxiliary functions? See for example, the kids water bottles they also sometimes have a small game piece of game into it. So, there will be a maze with a small ball into it and kids can play around and put the ball through the maze to the bring to the centre of it. So that is not at all the main function of that particular bottle so that is an auxiliary function usually we try to add auxiliary functions because they increases the appeal of a product to the consumer. So, first you need to understand what are the products mean, and auxiliary functions.

Does the product fulfil these functions effectively and efficiently? So, effectiveness means what is the degree to which it fulfils those functions and efficiently, in terms of material usage, in terms of energy usage in terms of waste generation, in terms of life of the product and so on.

What user needs does the product currently meet? Can the product functions be expanded or improved to fulfil user's needs better? So, say for example, I want to have this water bottle which should be very good to cool the water when I put it very efficient in cooling the water inside it when I keep it in the freezer. But when I bring it outside the freezer and I want to carry it to my office it should also maintain its temperature. Now, if I design my water bottle with an insulation all around it and I put this water bottle in the freezer because of the insulation it is going to take way much more long time to cool the water inside, so which means it is not efficient in cooling. But yes when it is cool it is efficient in carrying the bottle to my office.

But my aim over here right now is have a water bottle which can cool efficiently inside the freezer the water and it can also keep water cool. So, maybe I will have some detachable components into it. So, the insulation is detachable and it comes into the bottle as and when required. So, it is a very important question can the product functions be expanded or improved to fulfil users needs better. So, what environmental benefit you can bring in this cases? The user does not have to buy two watches one for keeping in the freezer and one for keeping the cold water cold when he or she takes it to office. So, and also this makes the bottle more attractive because the number of functions increase drastically in it. So, hence you can check out can you expand the functions so that it fulfils the needs of the users much better.

Will this need change over a period of time? That is a very important question say for example, a bottle that we were discussing it is helpful only during summers. Say for example, there is a in our country we have decent number of summer days, decent number of winter days and decent number of days in which we really do not want to dink drink water which is coming out of the freezer. Or say for example, there is a trend in employee welfares and as a result many companies are installing water coolers in their office itself. So, does these factors have the potential to change the needs over a period of time. So, maybe then nobody needs a bottle of that kind anymore.

Say for example, the cool cages those huge water reserve water containers which used to be very popular and very common in every household during the 90s. So, anybody who wants to travel a long distance they have to carry a lot of water with them because drinking packaged, drinking water was so not commonly available. So, the family would always carry this huge cool cages where they will put in cold water they will put in all the ice and the water will stay cold for a long time. But we hardly have a demand for that product in today's context because cold packaged water is very easily available almost anywhere and everywhere.

Then can we anticipate this through radical product innovation? Say for example, I anticipate that requirement for reduction in energy consumption due to lighting used in building spaces is going to be a mandatory aspect. So, can I come up with a radical product? So, say for example, from incandescent bulb to CFL lighting was a radical product innovation, from CFL lighting to LED lighting was a radical product innovation

which helped to meet this requirement that power consumption due to lighting sources has to be reduced.

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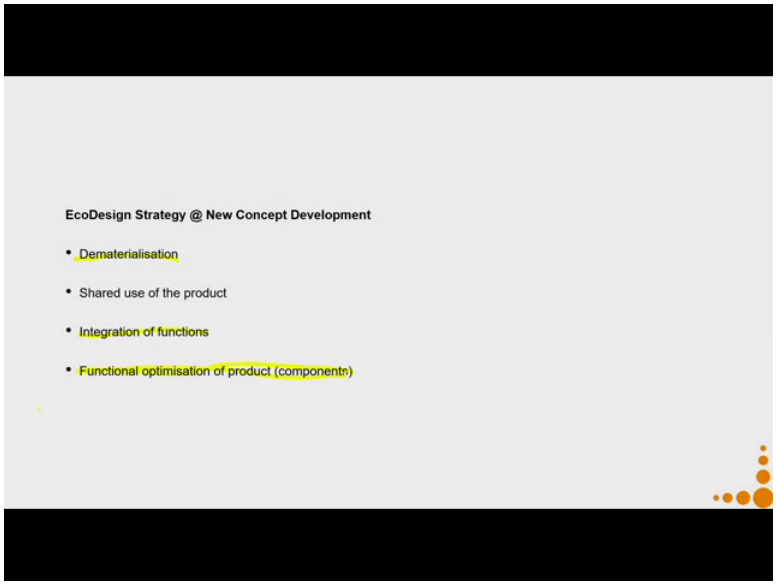

So, once we have done a need analysis of the design context that we have at hand our next step is to use this eco design strategy which is meant for new concept development. It consists of dematerialization, shared use of the product, integration of functions and functional optimization of product components. So, what does this imply? If you look at the dimensions dematerialization, integration of functions, functional optimization of product components in all these 3 we are talking about product innovation level related in intervention. Only when we are talking about shared use of the product then we are talking to certain extent on the consumption side as well. But the main focus of this eco design strategy is product level innovation which helps in bringing environmental improvement.

Let us see some examples of how to do each one of these.

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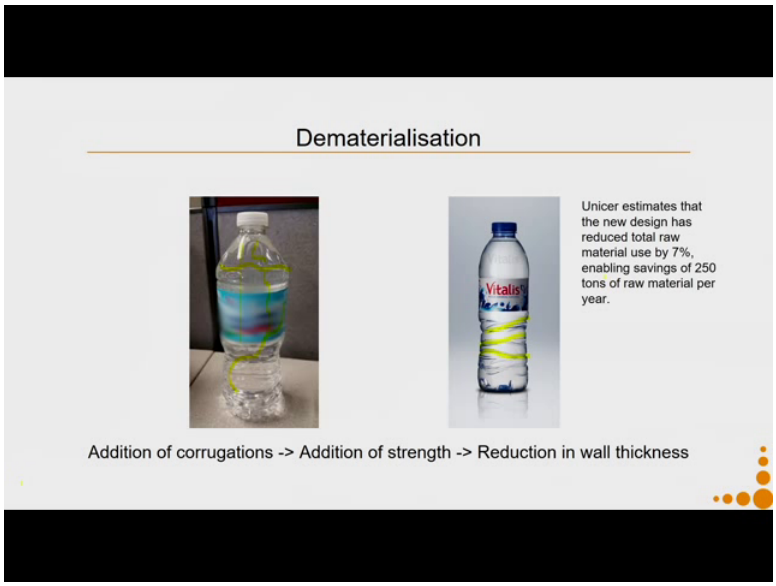

So, if you remember from our previous lectures we were talking about. So, if in this water bottle because this is a disposable water bottle if I can add certain corrugations, so corrugations can be added in this direction can be added in, this direction can be added in then this direction. So, by addition of corrugations I can add strength to this structural strength to this bottle as a result I can achieve reduction in wall thickness of the bottle material. So, what I am trying to do over here is dematerialization. So, if we see an example of the same so that is what the company unicerted with it is water bottle called vitalis.

So, with the structural design, so the structural design we already discussed about this how they came up with this kind of a structural design. So, with this structural design they have reduced total raw material used by 7 percent and as a result they estimate that they will be able to save 250 tons of raw material per year. So, this is an example of achieving dematerialization.

Now, let us go to the next strategy shared use of products.

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So, this was another example that we discussed. Why shared use of product can reduce the environmental impact? Because this much amount of material can be shared and used by many people, hence we can try to conceptualize products which can be you can have certain amount of shared usage.

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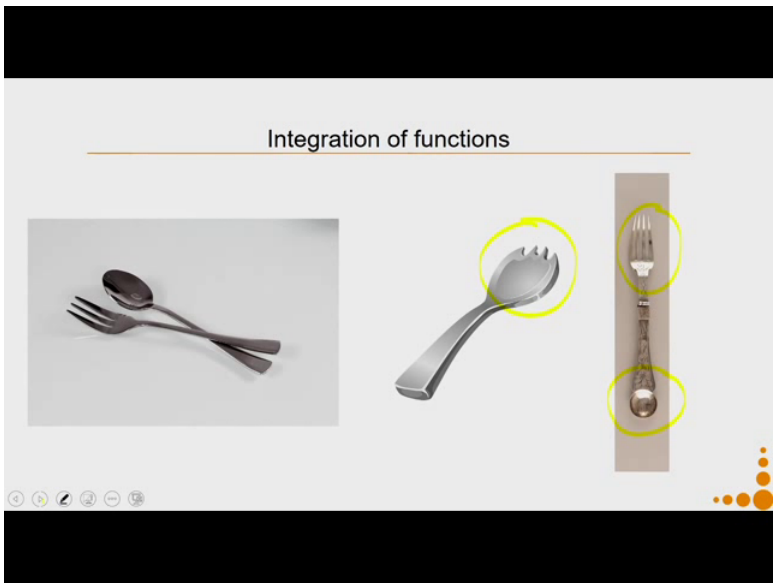

Integration of function so say for example, I can have a separate folk a separate spoon in this particular example the spoon and the fork arc are combined. This is another way of achieving it. In the same steam the spoon and the fork are on the two opposite sides.

Now, you have to see whether this integration of function makes the product equally usable or whether it has damaging effect on the usability aspect of it, but this is also a viable alternative.

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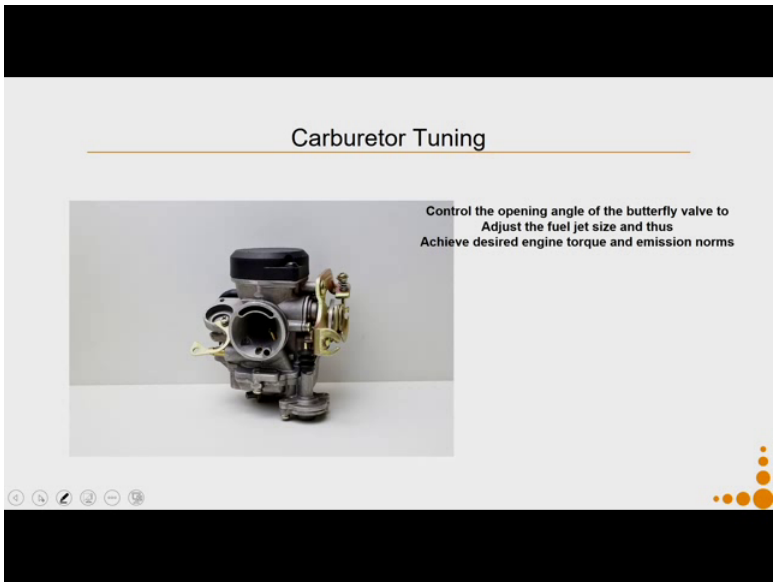

Then comes functional optimization of product components. Say for example, by control so this is a carburettor used in vehicles. So, by controlling the opening angle of the butterfly wall you can adjust the fuel jet size and thus achieve desired engine torque and emission knobs. So, all this can be done using this eco design strategy. So, let us see how to use them and how do I integrate my LCA tool while I am trying to do this activity.

So, LCA will help you in do and doing an assessment as well as it will help you in, say when you want to do dematerialization, you want to know about the material strengths, you want to substitute that material with another material where which can be used in lesser wall thicknesses. So, let us see how we will use the tool.

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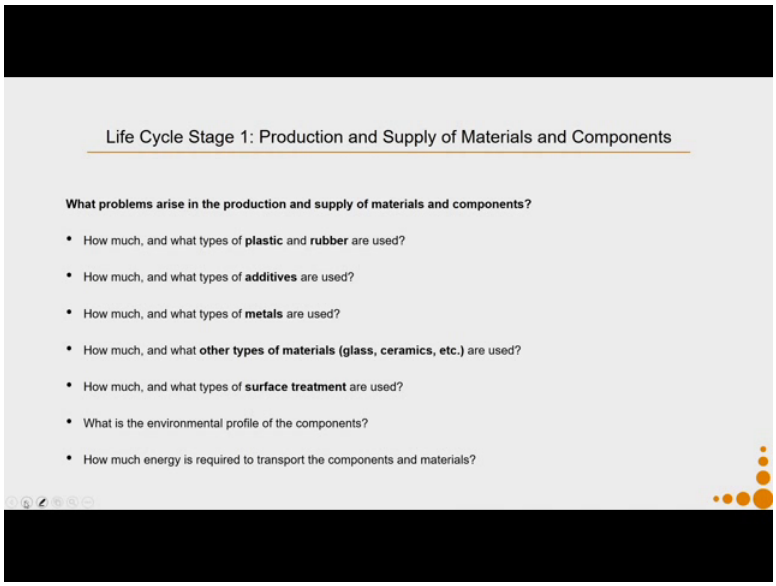

So, this in order to do this eco design strategy, we will work along the lifecycle stages. So, my first like cycle stage production and supply of materials and components. So, first we have to try to identify what problems arise in the production and supply of materials and components. However, we can study this. So, how much and what type of plastics and rubbers are used. You can also use this questionnaire to find out all the materials and processes that are being used.

Then I try to ask, so usually plastics and rubber present a different sort of recycling problem or different sort of landfilling problem than metals. Metals usually do not end up into a landfill they are always collected back even if it goes to a landfill from a landfill it will be collected back and it will be recycled hence we have them in separate questions.

How much and what types of additives are used? These additives determine whether my plastic or rubber component is any longer recyclable or not. So, although plastic like a polyethylene or polypropylene which is recyclable, but if we add certain additives which are going to emit toxic materials or I add additives and my recycler does not know what additives I have added the recycler has no way to recycle it. Then how much and what types of metals are used. Metals can usually be recycled when we go into the further stages you will see that we also have a component in which it talks about how easy it is to disassemble it because I know metals are recyclable, but say in a tetra pack it is so

difficult to get the aluminium layer used in a tetra pack out of the tetra pack that it that recycling that metal becomes very difficult.

How much and what other types of materials glass ceramic etc are used? Ceramics cannot be recycled, they cannot be incinerated, glass can be recycled but the amount of energy that goes into recycling of glass is very very high. Then how much and what types of surface treatments are used? Surface treatments like additives they also render something non-recyclable. So, like we discussed in one of our first few classes that a coffee cup made up of paper which is a disposable cup, that coffee cup is on the inside it is lined with a layer of plastic called EVF because of that lining that product is so neither the plastic is recyclable nor the paper is recyclable.

Also when I use certain kind of inks which is like a surface treatment on top of paper or on top of plastic it again or I use some kind of surface treatment like powder coating on top of metals, I again create problems in recycling. Then what is the environmental profile of the components which we will determine from our (Refer Time: 16:33) application.

How much energy is required to transport the components and materials? So, the heavier my product I need to spend more energy in transporting it. Also if the volume of my product is very high so just imagine a bucket, a bucket is not a very heavy thing, but the volume of a bucket is very high. So, if I cannot stack one bucket on top of each other if that was not a possibility then it would be a huge disaster in the transportation, I will have to transport almost empty trucks to the to the marketplace. Hence they are always made stackable similarly for chairs and so many products. So, usually its always advise you design products in a manner products which have higher volume higher empty volume you design them in a manner that they become stackable to reduce the energy required for transporting the components and materials.

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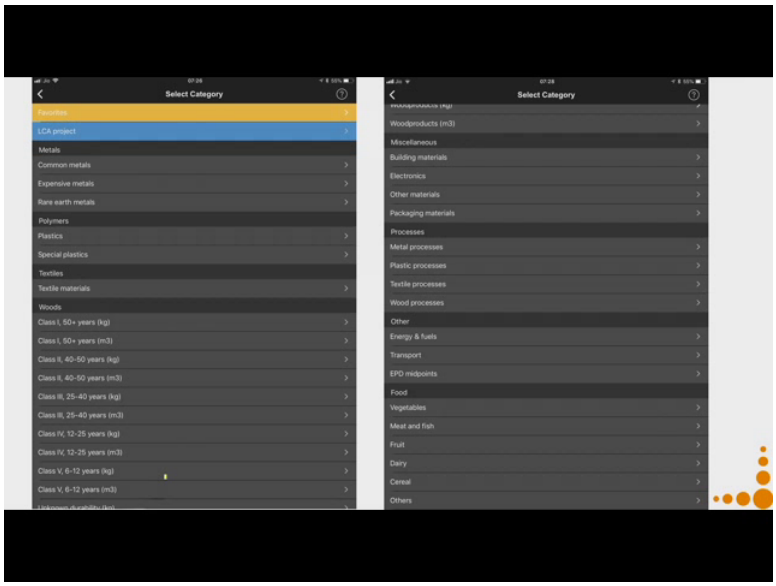

So, we will use this particular software where we can find substitutes or materials for processes in order to identify what is the environmental profile of the product. We can also use it to see and compare different plastics and rubbers with respect to their impact, with respect to their mechanical properties there are times when I can also replace certain metals with carbon fibres. So, I will come to an example of that so that is all possible when we try to use this LCA software because what it gives me is the life cycle impact. In terms of eco-costs and carbon footprint also it gives me all the mechanical electrical and all other properties so I can compare them and I can select materials and processes with lower impact and lower toxicity.

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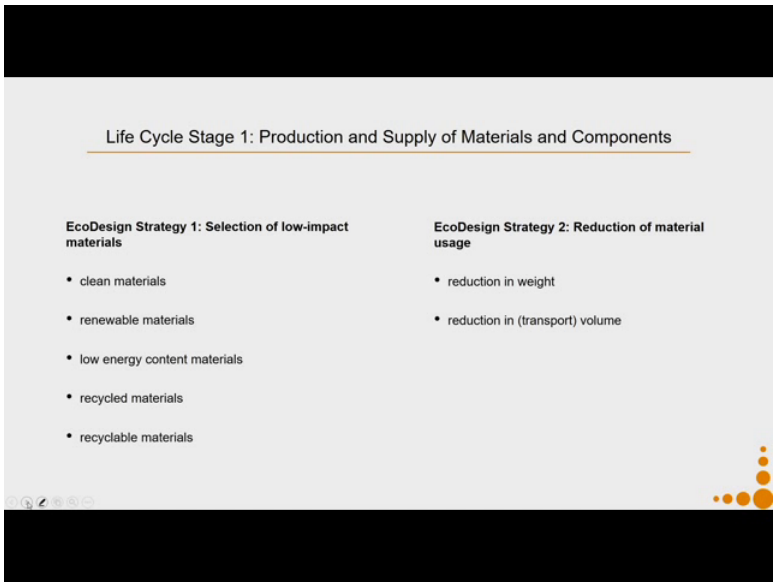

So, what are my strategies at the life cycle stage of production and supply of materials and components in order to achieve sustainability? So, my first group of strategy is called a selection of low impact materials. So, what all you can do in this context? You can select clean materials. Of course, this selection of clean materials is greatly helped by our IDE mat software. You can also select renewable materials you can substitute the non renewable with renewable materials by using the software.

You can also use materials which have low energy content again the use of this software, you can use recycled materials not all recycled materials might be good in terms of their property if mechanical property electrical property requirement also in terms of their ecological impact. So, you have to use the software to check and ensure whether that is a feasibility or not.

Then can you use materials which are recyclable. The next strategy that we can use is reduction of material usage. So, where we try to reduce the weight and red reduce in the transport volume. So, let us see some examples to understand this context better.

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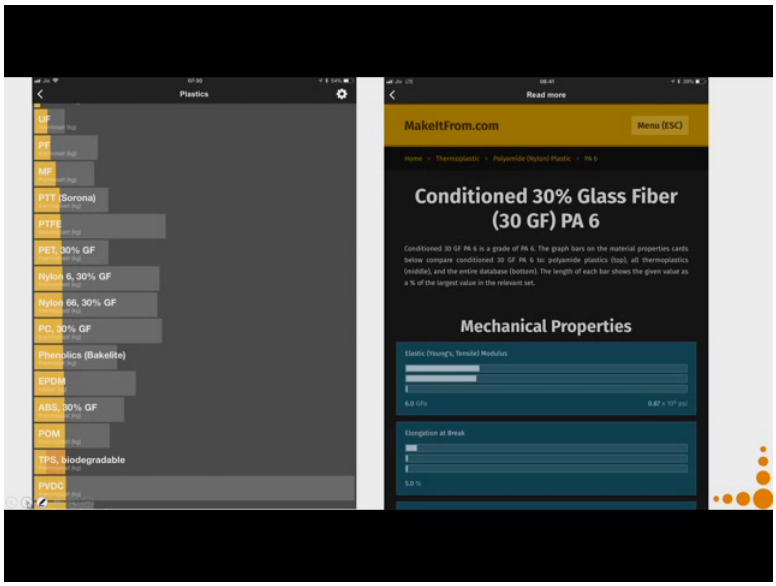

So, say for example, we had already discussed about it you can compare over here say all the plastics in terms of their ecological impact. I am right, and when I click on a particular material I can see all the properties the mechanical properties and as a result I can find an appropriate substitute.

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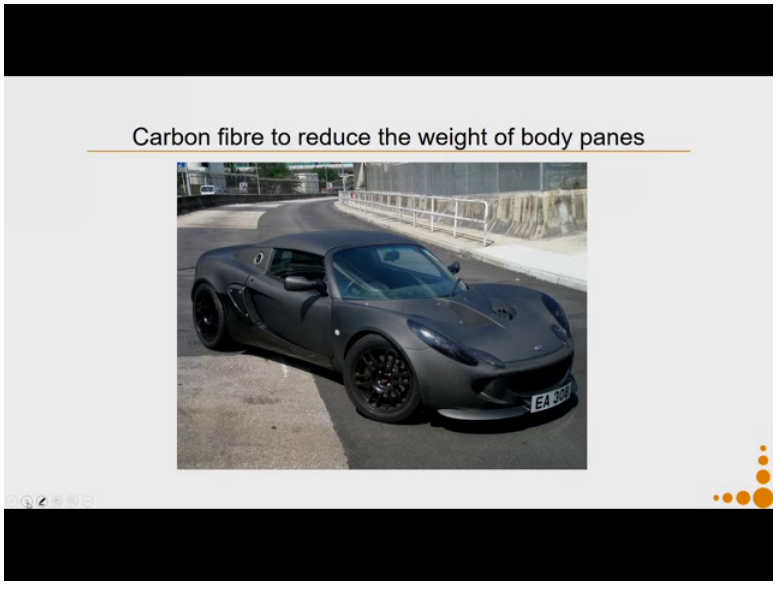

So, talking about reduction in weight. So, say for example, the body of the car it is made up of certain kind of metal alloys. Now, if I take the mechanical properties desired for making these body panels and I find a substitute, so carbon fibre is also plastics

reinforced with carbon fibres is a good material for that in terms that it offers higher strength to weight ratio. What it implies is for the strength required the weight of carbon fibre panels is way much lower than the metal panels.

Of course, this is a more expensive material hence not all our vehicles can be made up of carbon fibre bodies. So, the higher end vehicles they are made up of carbon fibre body to reduce the weight of the body panels as a result what you will achieve is a reduction in the fuel consumption while this vehicle is running. Also when you want to transfer this vehicle from the factory to the distributor because the weight is now lower there will be savings, but the impact of a car is highest at the usage phase, and at the usage phase I am able to reduce the fuel consumption because I am using this carbon fibre. So, this substitution is possible again if you compare the life cycle cost versus the mechanical and other properties required for a given purpose.

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Next example substitution of something which is so when I take a lead acid battery lead acid battery is environmentally hazardous product it has toxicity. So, see if I can replace it with lithium ion batteries. So, the toxicity problem is gone, but there is a fire hazard. So, in case I do kind of a substitution. So, I will have to see how do I build in systems to avoid fire hazard.

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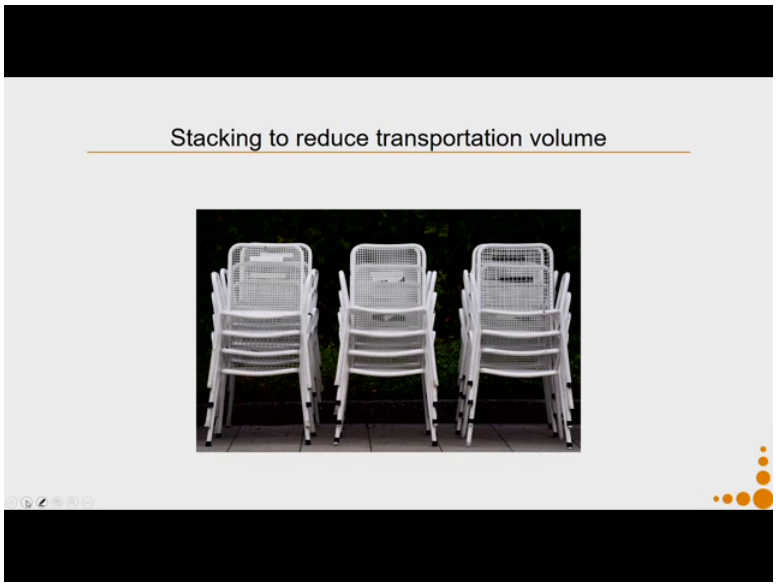

Another example as we said we need to reduce the transportation volume. So, because for a chair you will have a lot of empty space over here that is unavoidable because that is how the typology of that product is you have to design a bucket you have to design a mug you have to design a water bottle with lot of empty space. Unfortunately water bottles, so like these are not disposable water bottle that I am talking, but about, but any water bottle, water bottles are something in which there is huge transportation volume wastage because I cannot stack them in any way. But say for chairs, for buckets, for mugs many other products where it is possible to stack them people design the product in a manner that you can achieve the best degree of stability. This one, this is also true in the context when you are talking about individual components as well as the raw materials.

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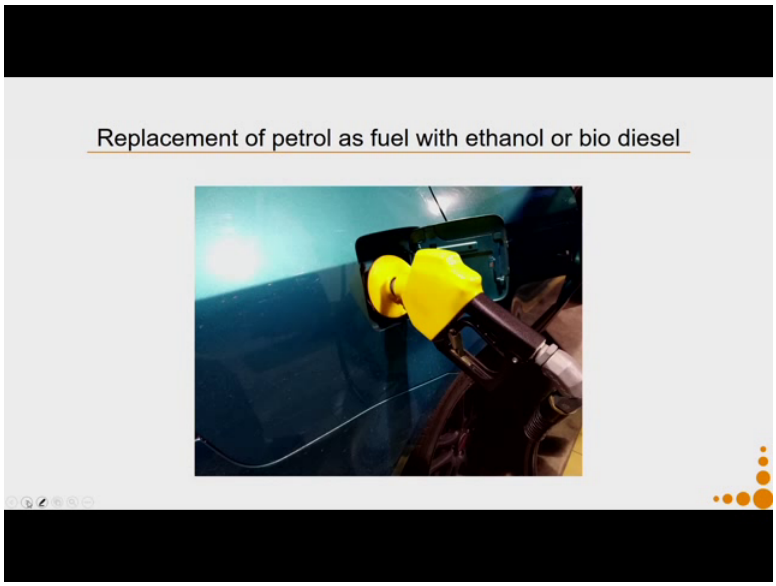

Then comes how can I replace certain components. Say for example, I want to replace petrol as a fuel with ethanol or diesel. So, at this particular junction at the production and selection of resources I can use the LCA tool identify what are the lifecycle costs for say petrol, ethanol, biodiesel and find out the best possible solution. Of course, there will be many more other considerations as well along with this which is right now not the scope of our discussion.

So, considerations like whether the place has ethanol, generation facilities ethanol, dispensing facilities and or not they are also matters of concern, but right now we are not discussing on that aspect we are discussing about design with a lifecycle assessment aspect in mind.

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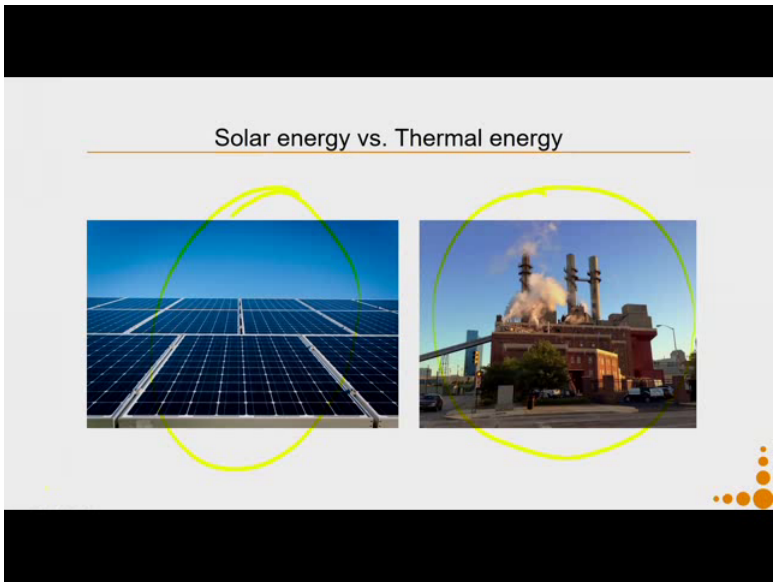

Then can we do certain kind of intervention at the level of the energy that we are using. So, like we discussed can I replace non-renewable sources like thermal energy which is generated by using by burning coal with solar energy which is a renewable source.

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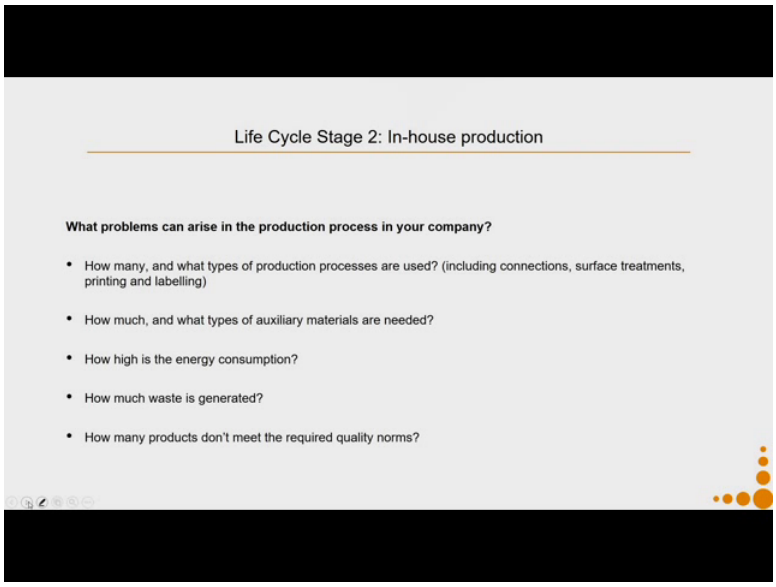

The next life cycle stage that we will pick up after this is in-house production. So, after I have done procurement of the material have done selection of the material I will do the design process I have to produce that product. So, in this phase you have to ask the following questions what problems can arise in the production process in your company.

So, how many and what types of production processes are used including connection, surface treatments, printing labelling, assembling everything? The more the number of processes, the more the overheads on the company the more might be the environmental impact.

How much and what types of auxiliary materials are needed? So, the auxiliary materials are materials which are needed for running the day-to-day operations which might not go directly into the product, but they are required. Say for example, if I require labels with adhesive behind them and I have another layer of paper to protect that adhesive layer what I am doing is at the end of the process that back paper is a waste. How high is the energy consumption? How much waste is generated? How many products do not need the required quality norms?

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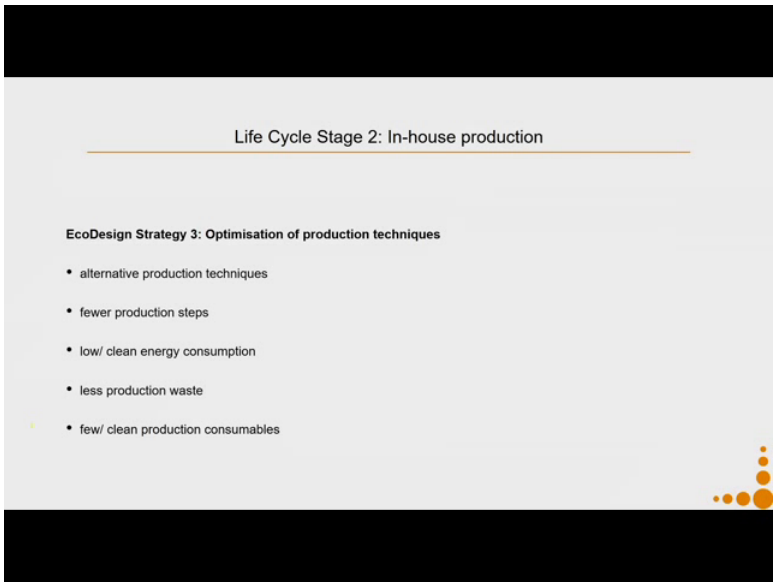

So, in this particular stage we can use our optimization of production techniques. Many of these techniques require the intervention from specialists we will in particular discuss those interventions which we as designers can I do, for the other things we need to optimize on the production processes and so on.

So, say first you have to consider that if your product can be made with the production technically, are there alternative production techniques for which you might have to do design changes which can produce your require product more environmentally friendly.

Can you reduce the production steps? Can you use low or clean energy while you are trying to do production or maybe for certain activities. So, you offset the amount of energy that you draw from the main grits. Then how can you reduce the production waste? So, as designers we can make a very good contribution at this level in reducing the production waste. So, we will discuss about it shortly.

Then next one is can you use few or cleaner production consumables during production. We will have certain kind of consumables can I use them which are more cleaner and can I reduce their number. So, talking about the production processes because a lot of these steps were talking about the production technique and the production processes.

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So, there can be different types of wastes or losses from the production process. Say for example, I can have greenhouse loss, I can have loss because of packaging material. So, my raw materials comes in certain packaging materials that is a wastage or say I have losses in the process or I have losses in my stock because of certain conditions, maybe there are perishable stocks or maybe because of weather conditions they tend to get damaged or any other such reason.

Then we might engage into activities like washing. Say for example, in the food industry if you are trying to wash certain products. So, a they will tend to lose a amount of weight because of dehydration there might be losses in the furnace and so on. There can be many different kinds of losses, even there is something called as customer returns

because your product is not up to the mark, so the customer returns the product. So, in this particular phase in all these particular areas wherever there is a loss optimization can be done at this particular stage. So, you have to identify the losses the losses which are most significant the losses which have the highest eco costs and try to solve those.

For certain losses you might say for example, for process losses you might have to engage specialists who specialize in optimizing the processes in a in the production process.

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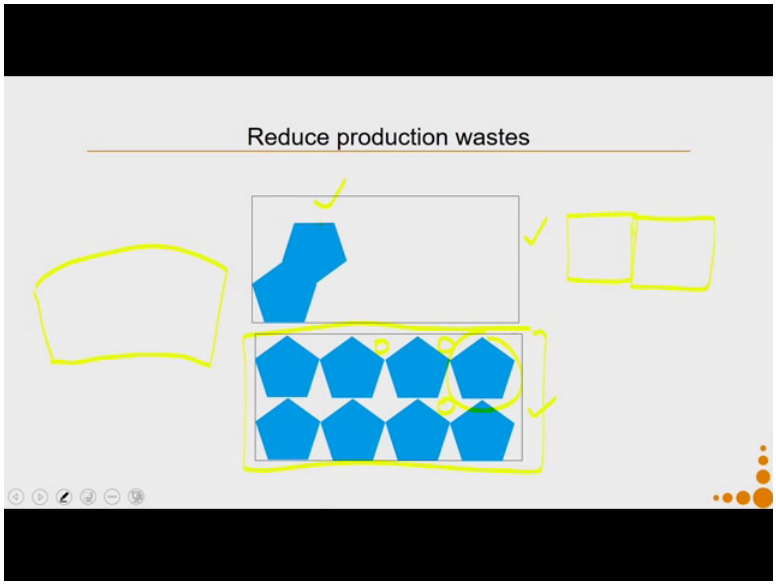

Now, say as designers what we can do. Say for example, this is an example of a sheet metal fabrication. Say for a particular design that I am making I need to cut out this pentagons. So, this is my standard sheet of mild steel and from this I want to cut these pentagons. So, all the white space that you see over here they are my wastages. So, they are my scraps.

Of course, this sheet metal because it can be recycled. So, it will be taken back and recycled and converted into another sheet, but still what I am having over here is losses. So, as designers what we can look up say one option is can I change my products design in a manner I do not need a pentagon, I need something which is a more regular shape, say I need a square because squares or rectangles can be way much more without glasses can be stacked to each other. So, if that is a possibility we can do that and we reduce the scrap.

In this particular context say I cannot avoid I need pentagons, I can try to see how all I can orient my pentagon on that sheet. So, then you can calculate whether this orientation gives me less wastage or this orientation gives me less wastage. Even the same applies to the label making industry. Say for example, you want to put a label on a bottle the development of that label will look something like this now you cannot avoid it that is a shape that you have to make. So, you have to identify the best possible way of orienting it on the sheet of paper in order to reduce the scrap waste of like not used paper as much as possible. So, this is where as designers we can contribute.

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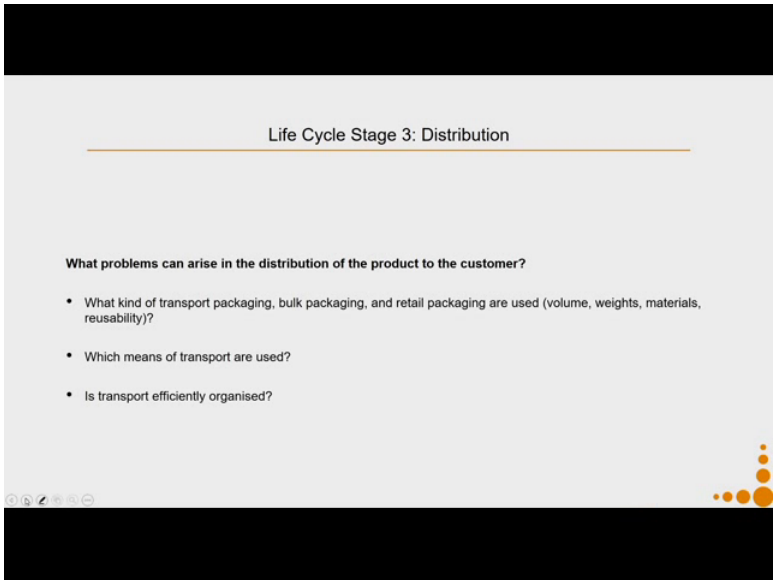

Now, let us go to the third stage. This is the distribution stage, so my product is now manufactured, now it has to reach to my customers. So, in the distribution stage you have to ask yourself what problems can arise in the distribution of the product to the customers. Like what kind of transport packaging, bulk packaging and retail packaging are used, in terms of volume weights materials and their reusability. So, let us understand what is the difference between transport packaging, bulk packaging and retail packaging.

Say for example, you have a mobile phone, a mobile phone when you buy it is inside a package so that package is the retail packaging that is the packaging which you see and when you want to buy the product. There can be other types of packaging say when the company wants to transport all these mobile phones in bulk to a particular retail store or to a particular wholesaler, they will create say in cardboard boxes or recycled paper

boxes and one box there will be say 200 retail packaging boxes so that is about bulk packaging. Say for example, if you go to buy a pack of 12 water bottles they will be available in a shrink sleeve so that is the bulk packaging for shrink sleeve.

You might also have additional packaging which is the transportation packaging. So, say for example, crates plastic crates, wooden crates they can be used which will help them in keeping the product safe during transportation. Now, the volume of all of these the weight of all of these the material and whether we can reuse them or not have a lot of impact on the environmental sustainability of a product or in we can say the eco cost or the carbon footprint of the product. So, a product it is not only its own carbon footprint, but it is in addition all these aspects that you have to consider the packaging, which means of transport are to be used. So, say for example, are you going to use that trucks are you going to use ship or something else that will also determine what kind of packaging you will need.

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Is transport efficiently organized? So, say for example, I might be able to use this large truck when I am transporting huge volumes of the these mobile phones from over a large distance. Now, this truck can easily travel on a highway, but as soon as I reach a particular destination and I have to distribute it over say in many shops of the city because the city cannot allow that large truck to get inside it does not have the space. So,

I will have to change my kind of vehicle that I am going to use. I might also use way much more smaller vehicles depending on the context.

Then say I want to transport it from Europe to India.

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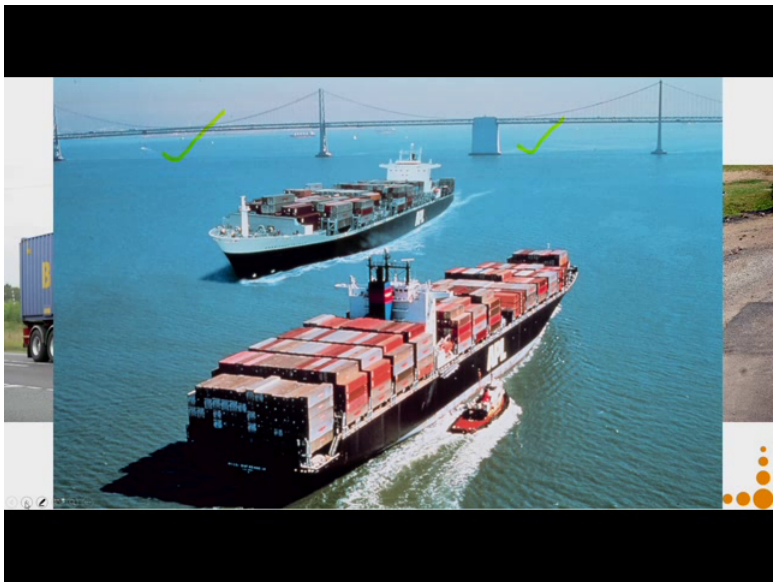

So, of course, a truck might not be the most efficient solution in that case. I might have to use a ship or I might have to use a cargo aircraft.

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So, for all of these you have already seen that the IDE mat tool offers you the eco cause of using each these means of transportation. So, you can use the calculations to optimize the transportation energy or the transportation eco cost efficiency.

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Now, this is an example of packaging. So, with the popularity of E-commerce growing in our country, this is a common scene you might have experienced this yourself also you order a product. So, this is my tiny size of the product and because the shipper is very very concerned about the product safety and is not aware maybe, how to ship it they put it in such a large box with lots of protection material. It is very good for the product because most likely the product will stay safe this way well this is a huge amount of environmental burden because this is over packaging. The package has already been designed by the company this tiny package in a manner that it is going to keep the product safe. So, this is a overkill. So, maybe because ecommerce is becoming so much popular nowadays you can also think in terms of like how this package is supposed to travel in case this product is brought through a E-commerce website. ah

Another way of optimizing the packaging design is by using appropriate structural material. So, you can open any mobile packaging, so most of the mobile packaging boxes. So, this is the retail packaging they are now quite optimized. How they have optimized it? So, they have built in structural elements in the packaging. So, there are structural elements in all that in the components of the packaging which have given a

very compact packaging reduced volume of the packaging which means you have savings in the transportation volume it also ensures that the product is safe. So, a product does not get damaged.

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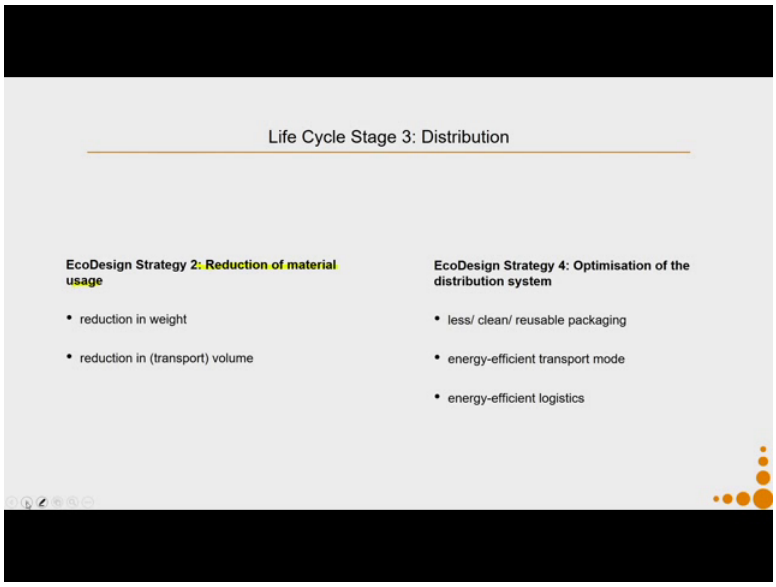

So, what all strategies we can use at this particular stage? That is the distribution stage. So, be aware when you are designing it you are just not designing one product, we do not do that. What we do is we design it over the entire lifecycle. So, we think how will it be produced, how the before that we think, how what the raw materials will be procured, then we think how it will be produced, then we think about the distribution, then we think about the usage and then finally, we think about the disposal.

So, in order to do this design strategy what we can do? So, you remember from our first phase we had this eco design strategy two which was about reduction of material usage. So, we follow the same. So, we have to reduce the weight and we have to also reduce the transport volume.

Another strategy the eco design strategy 4 over here is optimization of the distribution system in itself. So, you have to optimize it so that it can use less packaging, clean packaging or reusable packaging. Energy efficient transport mode, again you can calculate both these aspects from the IDE mat app, also energy efficient logistics. So, logistics is the management system of how something is going to reach from point a to point b. So, say for example, if you schedule your transportation once every week you

might be able to better utilize the transportation facilities. So, this how do I decide this once in a week? So, I have to consider the volumes, I have to consider the demands, and the distances and so on all these comprise the logistics.

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So, say for example, reusable packaging. So, this is an example of reusable packaging so I can transport a lot of things in this plastic crates and depending on how well it is used and how well the crates have been designed. You might be able to use reuse these crates for 6 to 12 or 13 times. So, a lot depends on the design a lot depends on the in the way it is being used.

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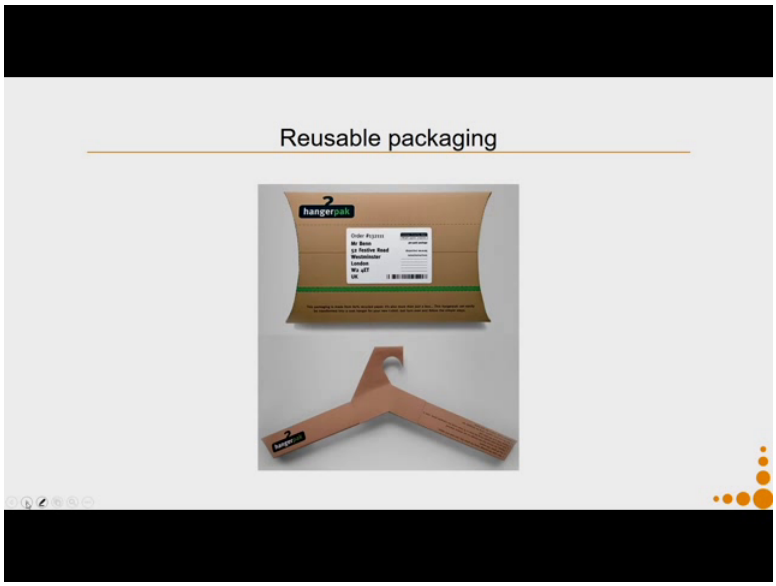

This is another example of reusable packaging. So, your product, your clothes it comes in this particular carton bag and then the when you open up the bag it has instructions how you can fold it and make the hanger and then you can keep using the hanger to hang the clothes that came with this.

So, another example of achieving reusable packaging which is a design oriented approach. Say for example, we can buy refillable packs.

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So, whenever we buy a hand wash, so we buy the dispenser and after that till our dispenser is functional. So, the part which stops functioning is the spring. So, as long as my spring is functioning good I do not buy more of these bottles what I do is I buy the refillable packs so that can also be a strategy. So, that reduces your distribution cost because this bottle it is it acquires lot of volume.

So, you can see there is lot of empty volume and when you are stacking it in the truck there is no way to reduce this. Of course, you can design it in a manner that you could have kept another bottle between these two bottles, but in case if that has not been done this is a huge amount of volume wastage. Also this packaging consumes more material this packaging also is heavier as compared to a ship shipping the same amount of soap in a plastic pouch.

But there are additional problems which you need to consider say the plastic pouch in which you transfer it, when you look at the eco costs of that on the IDE mat software you have to compare that with respect to this bottle. Usually the plastic pouches have a big problem that they are multilayer plastic pouches and they are not recyclable whereas, these bottles are at least recyclable. So, you have so the answer is not very easy and simple and intuitive you have to again calculate to identify what will be the best or most eco efficient solution to supply lots of soap in this dispenser or to supply concentrated soap in the dispenser so that the user can dilute it and use or say you ship pouches only.

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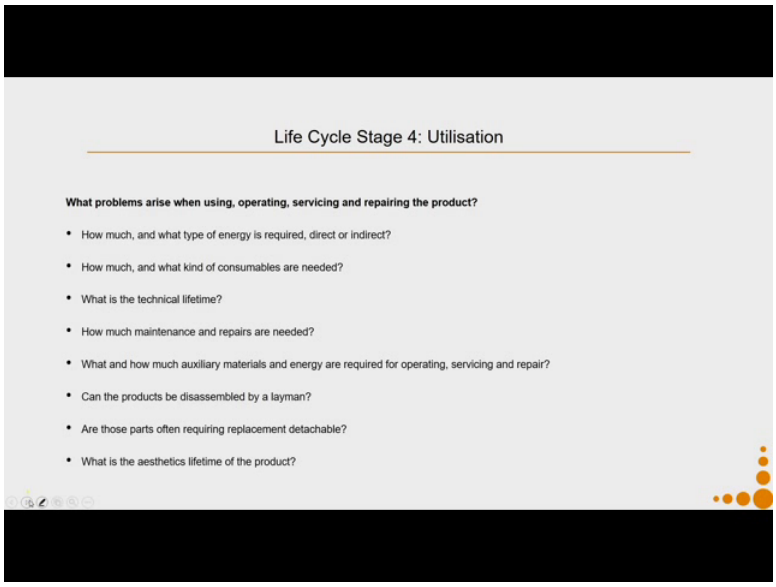

Now, coming to the fourth stage which is the utilization this is the use phase of the product. Not necessarily as a designer you have large amount of control on this use phase because say you have designed a very energy efficient air conditioner, but you cannot have this control whether your user is using it in the most optimal way or not, whether the user is switching it off or not. So, you can build in strategies in your product design. So, say your air conditioner comes with an additional sensor, if it does not sense any human being in that area it automatically switches itself off. Or say for example, the air conditioner when you switch it on it automatically switches on at say 24 degree Celsius or 25 degrees Celsius that is the default value rather than switching at 18 degree Celsius. So, these aspects can be taken care of while you are trying to design it. So, let us see in the utilization phase.

So, what problems arise when using operating, servicing and repairing the product? So, all these comprise the utilization phase, so usage and maintenance or repair. So, how much and what type of energy is required direct or indirect? So, say for example, I will require certain amount of energy to run my refrigerator, but say I need to clean the components inside the refrigerator, like there are a lot of containers inside the refrigerator which need to be clean, and I am expecting that in my context all that cleaning will happen in a dishwasher. So, although the dishwashers energy was not a direct energy, but it was an indirect energy. So, usually it is not very easy to assume all the indirect energies because again it is so much dependent on the customer, but if you can imagine all those scenarios in which a in an indirect uses of the energy then it will help you in designing for those contexts as well.

How much and what kind of consumables are needed? So, say for example, a printer needs paper that is the consumable. So, if your printer has a problem that it keeps on getting jammed very often which means it is going to waste a lot of paper. Or say for example, each time you change the toner you have to align the toner and for doing the same you have to put in 2 to 3 papers. So, you are wasting ink and you are also wasting paper. So, it has consumables and this consumables are also waste. So, what is the technical lifetime of the product? How much maintenance and repairs are needed? What and how much oxilary materials and energy are required for operating servicing and repairing the product? Can the products be disassembled by a layman? So, like each time you want to change the component which keeps on getting damaged very soon.

So, say if in a machine the cartridge is something. So, the filter is something, so in a water purifier the filter needs to be changed quite often. But now if each change you need to bring in a technician that is a additional amount of eco impact. But say you can just buy it from the shop and do the replacement yourself there is a lower impact. So, can the products be disassembled by a layman or not can also have certain ecological impact. Are those parts often requiring replacement detachable? What is the ascetics lifetime of the product? So, let us discuss some with as with some examples.

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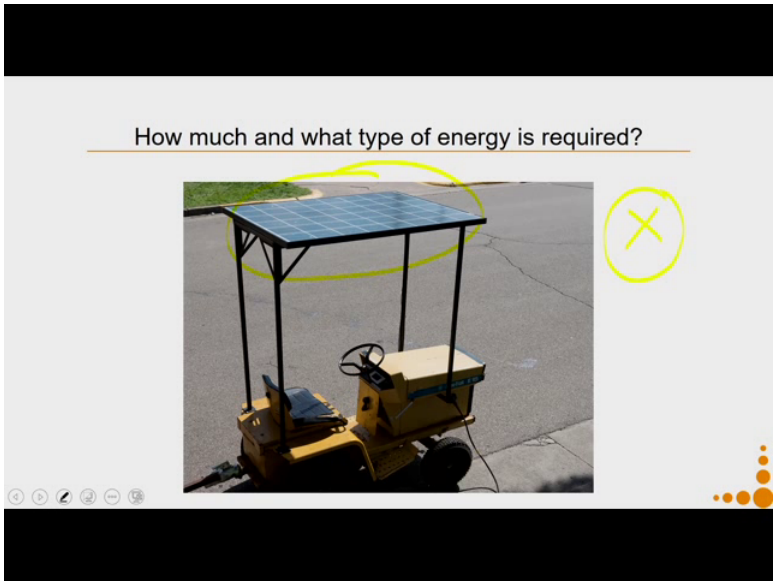

Say for example, this is a solar tractor. So, our question was how much and what type of energy is required. So, I know that I have this much of available space and I have certain solar panel technology. For a certain cost I can give solar panel which have the possibility to deliver x amount of power. So, I can design this tractor which can do activities using this x amount of power and not more, but up to that x amount of power it can work free of cost. So, consider that utilization aspect that can help you in optimizing your design in terms of the energy required to operate it.

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Then, comes very importantly the aesthetic lifetime of the product. So, about 70 percent of the product or more of our products that we use are discarded before the end of their lifetime because they are no longer in fashion. Say for example, if you compare this dining table versus this cloth, the cloth has much shorter aesthetic lifetime as compared to the dining table. So, you might think of changing your dining set only when you are changing the decor of your house which is not something you people keep on changing very often. Whereas, cloths they keep on getting discarded as and when the fashion changes. So that is what is implied by the aesthetic lifetime of a product.

So, you have to also consider that while you are trying to design your product and if there will be certain eco-costs there will be also; so if you know a product is not supposed to live for a very very long time you do not need to build it up with extremely durable materials.

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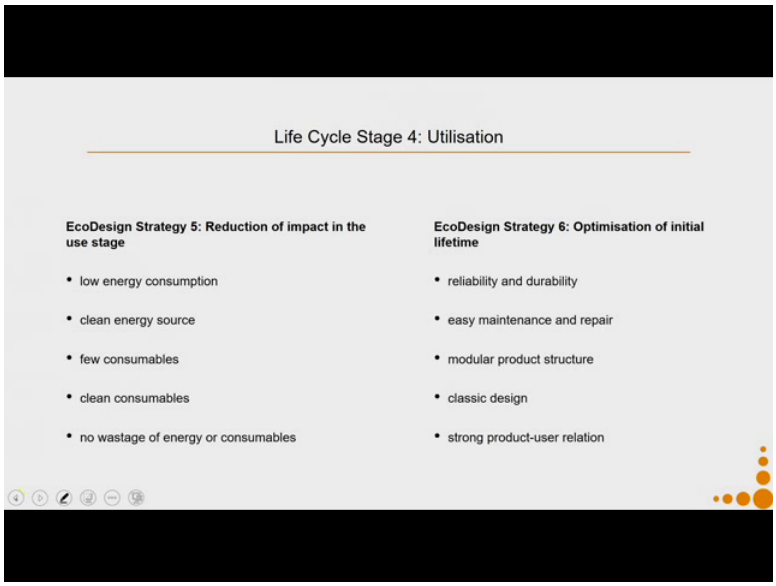

So, what are the eco design strategies that we can use in the utilization phase? So, reduction of impact in the use stage by reducing the energy consumption, by using clean energy sources, by using few consumables or by using clean consumables. So, you can choose cleaner consumables by using the IDE mat software, by no wastage of energy or consumables.

Another strategy that is optimization of initial lifetime. There is certain aspect like aesthetics, but apart from ascetics your product should not technically break down. So, you have to design the product for appropriate reliability and durability, easy maintenance and repair, because if it is very difficult to maintain or repair it again it will get discarded. Then you have to build also product with modular structure. Classic design is something that you try to do to optimize on the a aesthetic life decline. So, if you remember the emotionally driven design, designed for sustainable behaviour they can be thought of as something belonging to this category, but it is very difficult to implement.

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Then finally, building strong product user relations. How do we do that? So, as we discussed during emotional durable design. So, a customized glass which you can take away and remember the even so that you do not use disposable glasses and the chances that you will keep it is longer because there is a special message which keeps on reminding you of that event.

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Or say for example, designing products that age with dignity. So, again because of this aspect you might create emotionally durable designs.

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You can also design for sustainable behaviour, like our example where in the depending on how much of energy you are using at a given instant this particular wire glows differently. So, when you use more energy it starts glowing more drastically giving you a visual feedback about the amount of energy and trying to influence you to reduce your energy consumption.

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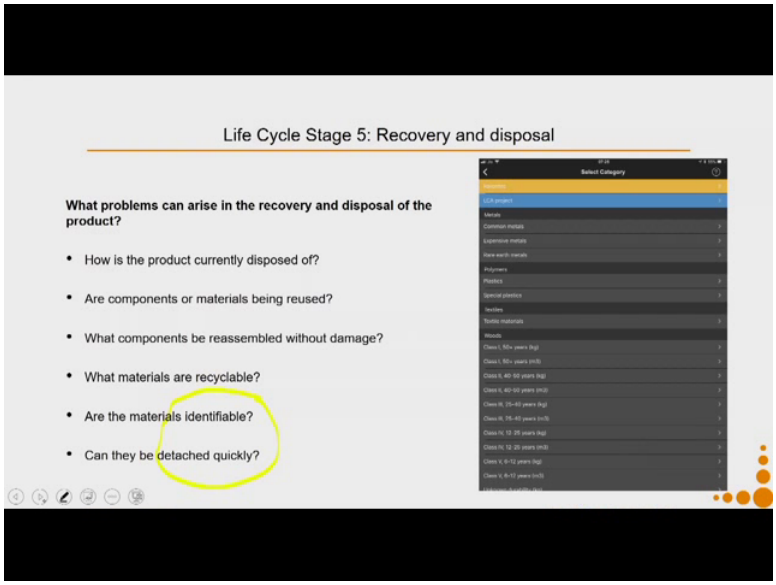

Now, let us come to the last phase. So, we have to also design keeping in mind recovery and disposal. Again the software IDE mat can help you in deciding appropriate materials

for doing this. So, what problems can arise in the recovery and disposal of the product? So, how is the product currently disposed of you need to understand? Are components or materials being reused? What components we reassembled without damage. What materials are recyclable? Are the materials identifiable? If you cannot identify which plastic you cannot recycle it. Hence recyclability is important and it is also very important identify ability and then recycling is only possible if you can detach it quickly or cost effectively.

So, you have to in if you are designing for recycling you have to ensure that it is the materials are identifiable and they are easily detachable or cost effectively detachable. You can also study existing municipal waste recycling processes see what are the processes available to them how do they currently detach materials from each other that will also give you a idea in the design phase how to do the same.

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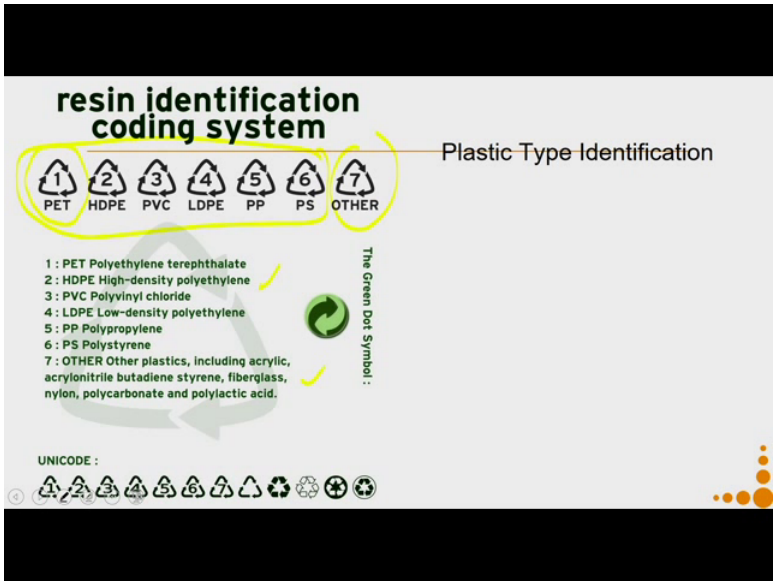

So, say for example, this is an internationally accepted plastic type identification chart. So, you might have seen in many of your plastic products this kind of a symbol. So, the symbol along with the wording they tell you what plastic it is. So, pet goes for a different recycling process high density polyethylene goes for an altogether different process. So, all these products they can go for certain recycling process. Of course, many municipalities do not have recycling facility for all these different products and 7 is a category which is meant for other plastics including acrylic, acrylonitrile, butadiene,

styrene, fibreglass, nylon, poly carbonate and polylactic acid most mostly they have to go for incineration there is not much recycling possibilities available for these particular plastics.

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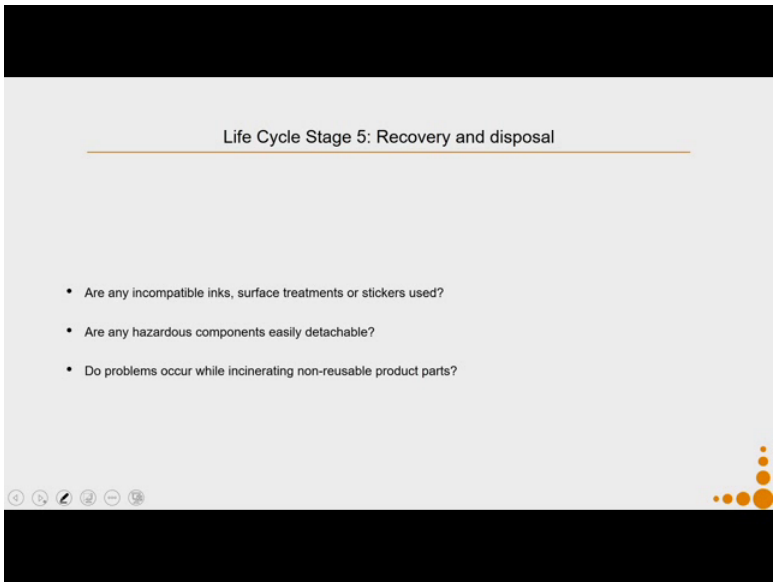

So, you have to also consider are any incompatible ink surface treatments or stickers used? Say if you put a sticker on top of a pet bottle although the pet water was recyclable because of this sticker it creates difficult it is very difficult to remove. So, if there is a certain kind of inks on a paper. So, a printed paper again cannot be recycled because of the ink on the paper or if I have a coated paper I cannot recycle that in a paper because of the surface treatment.

Also you have to consider if any hazardous components are available and are they easily detachable or not? Do problems occur while incinerating non reusable product parts?

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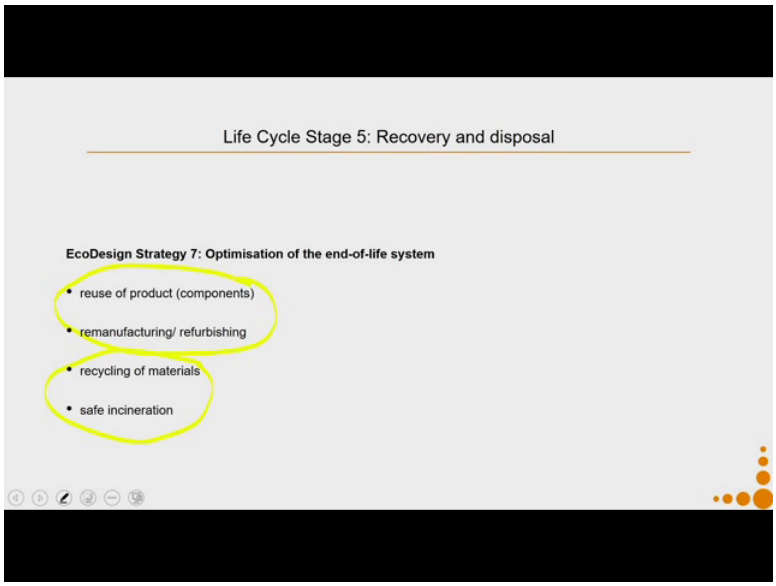

So, what are the strategies that we can use? So, I have to do optimization of the end of life system. So, how do I do it? I can design it so that I can reuse either the whole product or some components of it. So, say for example, you can my companies always have a buyback for mobile phones or many other electronic components there is a buyback for refrigerators. Why? Because a part of the product components can be reused or they can be remanufactured or refurbished, or you can do recycling of the materials or you can do safe incineration because many materials can release toxic items when they are being incinerating.

So, again the answers to many of these questions you can find whether something is necessary whether something is recyclable or not, or whether something is safe to incinerate or not. This information you will find in the IDE mat app. Whether you can design it for reuse of the product or remanufacturing or refurbishing that is part of your design strategy. How do you do that? So, if you follow these eco design strategy you will and along with the IDE mat app you will be able to design products with lower environmental impact. So, this is the first level of intervention that can be done at the product innovation level.

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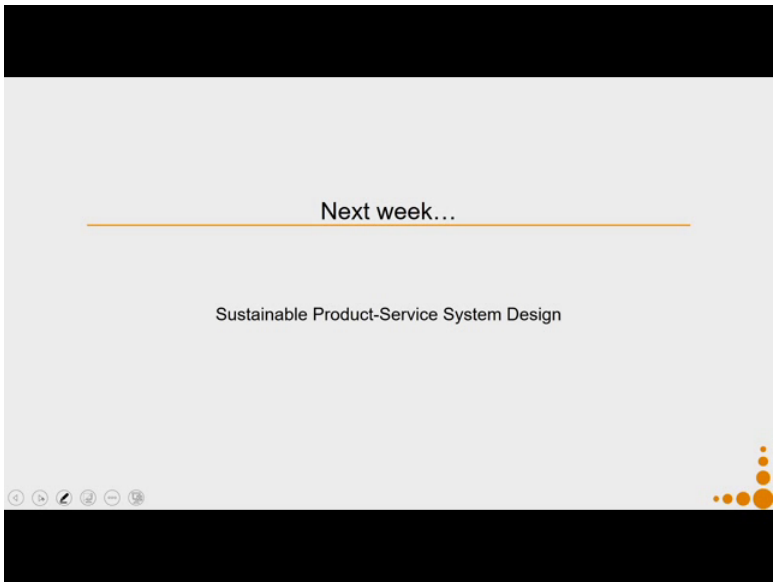

In the later parts of our course we will discuss about how do I expand this whole scope into the products of a system innovation level? At the end of the towards the end of the course we will also be talking about engineering design guidelines in order to achieve better environmentally performing products. They are way much more granulated very big guidelines, even if you are not able to follow those guidelines this is the easiest guideline to follow and you should try to follow them in whatever product you are trying to design.

Thank you so much.