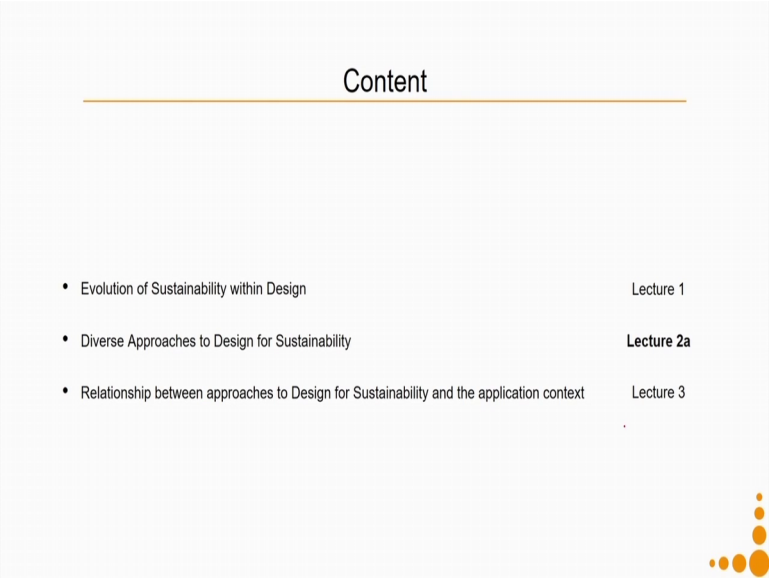
System Design for Sustainability
Prof. Sharmistha Banerjee
Department of Design
Indian Institute of Technology, Guwahati

Week 2
Lecture - 2a
Diverse Approaches to Design for Sustainability

Welcome, to the second lecture of this week. Today we are going to discuss about Diverse Approaches to Design for Sustainability.

(Refer Slide Time: 00:39)



This particular lecture will be divided in two parts. So, we will cover a part of it today and rest of it tomorrow along with the lecture 3 topic. So, let us begin from where we ended yesterday.

(Refer Slide Time: 00:56)

So, in our last lecture we were talking about selection of resources with low environmental impact, design of products with low environmental impact. These are possible design approaches as you can see in both these approaches, it is about the environmental sustainability that we are talking about.

We may get economic sustainability, but it is not for granted because it has been observed many a times products which are more environment friendly they are relatively more expensive than their counterpart which are less environmental friendly on the economic front. So, it might be that the economically also sustainable and it may not be also the case.

Next coming to the third approach, which is productservice system design for eco-efficiency. In this particular approach economics as well as environmental sustainability is possible. We can also build a ways of bringing in social sustainability. Whereas, the last approach which is designed for social equity and cohesion, it starts from social sustainability and builds in economic and environmental sustainability as well.

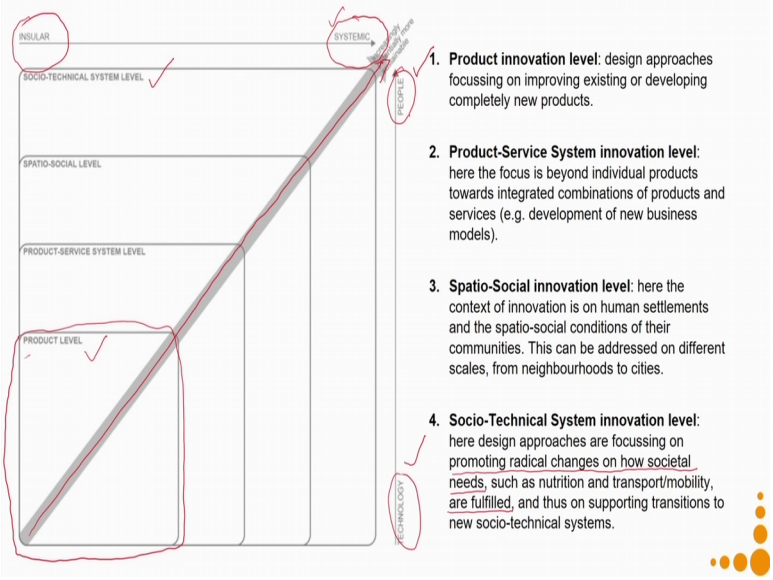
All these approaches, all the first and the second approaches because of the approach it talks about bringing in environmental benefits, but the third and the fourth approach we have to be careful that not all products of a system design are ecologically efficient or economically efficient or socially efficient. So, we have to build in the sustainability into them. So, not all product service system design are sustainable on the 3 dimensions. Also

not all design for social equity and cohesion might be sustainable on the economic and the environmental perspective.

Say for example, if I give out equal pay to each and every person that is social equity, but that is not economically feasible. Also sustaining it at a long run people do not have the motivation for putting in efforts and so on. So, let us go into further details.

Since we are from the design discipline, we will be talking about evolution of response from design discipline to the sustainability issues.

(Refer Slide Time: 03:20)



So, we can put the design responses in this kind of a framework that you can see on the screen. So, what this framework talks about is product level, product-service system level, spatio-social level and socio-technical system level. These are the four levels at which design intervention for sustainability is possible.

What do these levels mean? When I talk about the product level, it talks about product innovation; these are a set of design approaches focusing on improving existing or developing completely new products, wherein, environmental sustainability is built into them.

The second one product-service system level, it talks about the focus here is beyond individual products towards integrated combination of products and services. Like for example, at the product innovation level we can talk about the 5 star air conditioners. So,

product level innovation has been done, so that we achieve higher energy efficiency.

Similarly, product service system innovation; so, like we saw in our previous lecture about Kluber lubricant service, so, a lubricant along with the service in which the vehicle goes and checks the lubricant quality and replaces it when the lubricant is no longer useful. So, that is the approach which comes under the category of product service system innovation level, where I bring in a product plus service in order to achieve sustainability.

The third one is spatio-social innovation level. Here the context of innovation is on human settlements and the spatio-social conditions of their communities. So, this can be addressed on different scales, we can do it on a neighbourhood scale, on a city scale, on a district scale. So, for example, the example that I gave you in the previous lecture on Waranapura, that is a providing urban amenities in rural areas in the Warana district. So, that is an example of spatio-social innovation, where the innovation was done at the human settlement level and the spatio-social conditions of the region were taken into consideration and how it could be influence. So, various farm related activities, farm related innovations, farm related industries and so on was brought in.

Then comes the fourth level which is the socio-technical system innovation level. Here the design approaches are focusing on promoting radical changes on how societal needs such as nutrition and transport of mobility are fulfilled and thus unsupporting transitions to new socio-technical systems. We have still not discussed much on examples on this particular level, we will do it now. This is the highest level at which we are working right now. What it implies is I bring in changes in the way societies perceives it is needs. Needs related to say for example, nutrition or transportation of movement from one to another place and how we can bring in technological innovations. So, that I can bring in a change in the consumption pattern and thus bring in sustainability.

We lightly touched upon the Khadi movement in our previous lecture. So, Khadi movement which was a movement in during our independence struggle was a very good example of a socio-technical system innovation level. We will discuss this in the next lecture when we discuss more in this on this level.

So, if we come back to the diagram on the left side what you can see on the top is something called as insular; it goes to systemic, technology and people. What to these

terminologies mean? What I mean by insular is if a company decides to do a product level innovation what they are trying to do is mostly work with their own company. When they work with their own company with their own set of resources is the area intervention that area of intervention we call it as more insular.

Whereas, in the systemic one which is on the other side of the axis, when we try to involve more and more other stakeholders than what is me as a company itself? So, if you can see the product level, it is more insular than systemic. So, it is. So, you can see a particular range. Now, we will discuss about many different approaches at the product level itself.

So, when we are discussing about these different approaches of the product level itself you will see that some of the solutions are more insular, less systemic and other solutions move towards more and more systemic. So, more and more stakeholders involved more you become systemic.

So, the socio-technical system level that is the fourth level that is very systemic in nature, whereas, the product level that is the first level is more insular and less systemic. Now, what is the technology and the people mean on the other axis? So, technology axis implies that more focus is on the changing the technological aspects of it, more we focus is on technological innovations which is the production side of the sustainability and when I involve people we are talking about the consumption side of the sustainability.

So, at a product level that is the level 1, we are more technology oriented. We try to in bring in technological innovations. At as we move ahead at the socio-technical system level we try to target more like consumption. Even in the definition you can see that by promoting radical changes on how societal needs are fulfilled. So, we are talking about consumption. So, that is what this axis tells us that there are different levels and they target from technology up to people at different to different degrees.

Now, you can see this particular diagonal arrow, what it tells you is increasingly potentially more sustainable. So, as we move more and more towards the systemic and the people level we become more and more sustainable. Why so? As we had already discussed this is because when we are talking about people we are talking more about the consumption and so, until and unless we do not reduce consumption even if our production becomes very efficient very environmentally efficient, economically efficient.

Now we will not be able to achieve my sustainability because the consumption is very higher it is what is making things unsustainable.

Similarly, to how sustainability at the consumption side we need to think in a more systemic manner which is which means we need to include more and more stakeholders. These stakeholders will be the consumers, say the local government which is responsible for collecting all the wastes, recycling all the wastes or making rules and regulations which assures sticking towards the fundamentals of sustainability.

(Refer Slide Time: 11:33)

So, coming to product innovation level; so, they basically consist of design approaches focusing on improving existing products or developing completely new products. Say for example, we know that vehicles running on fossil fuel like diesel, petrol they cause lot of smoke in the cities. So, product level innovation was done, so that I can design vehicles which can run on CNG. So, not much changes in the overall product of transportation has happen is just the engine which has been changed from a particular fuel to another fuel, that can be called as a product innovation level, where I improve the existing product I did not change people's behaviour on how do they use the product, I just change the technology being used in the product.

So, now you understand why at the product level I am talking about changing technology. So, I did not change people's behaviour I was completely working on technology level, but in order to achieve this vehicle running on CNG it is not only the

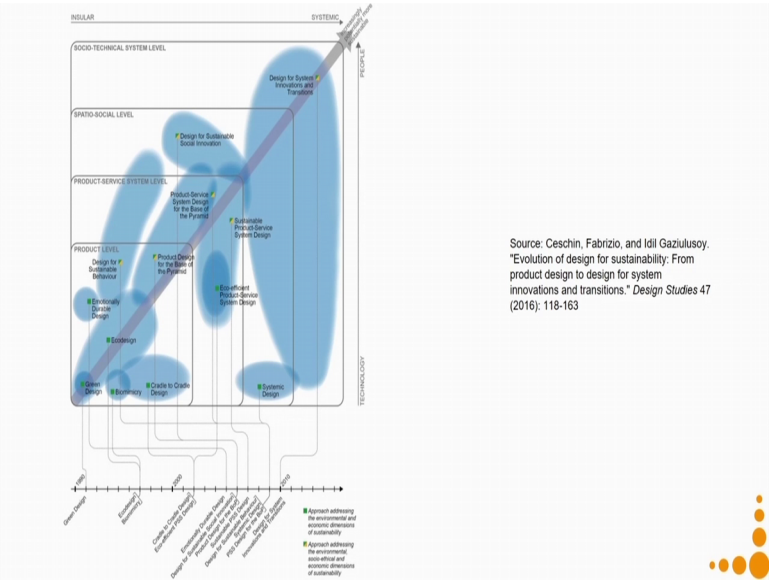
company which makes the vehicles will come into play, but they have to also involve other stakeholders say the oil companies have to start producing CNG, they have to set up fuel stations which supply CNG to the vehicles. The government has to come up with norms for the vehicles for registration of vehicles for giving permission for them to run on the streets.

So, it was not a completely insular in development, but a development which is insular in between insular and systemic, because I have to involve certain number of stakeholders. The, next example is the 5 star air conditioner that is also an example of product innovation level. What I am doing over here is I am improving the design of the components, so that energy consumption becomes more and more efficient.

Again, in this case also I am doing nothing about changing behaviour of people on how do they use air conditioners what I am doing is I am doing a technological innovation. So, again I am somewhere over here, but in order to achieve that I am also involving certain stakeholders like my supply part, somebody would be supplying with the parts for making that air conditioner and so on. So, I do not have it as a system which is completely insular, but it is again little systemic to involving some stakeholders.

So, there are various approaches in the product innovation level itself. So, green design, eco design, emotionally durable design, design for sustainable behaviour, cradle-to-cradle design, biomimicry design and design for base of the pyramid.

(Refer Slide Time: 14:46)

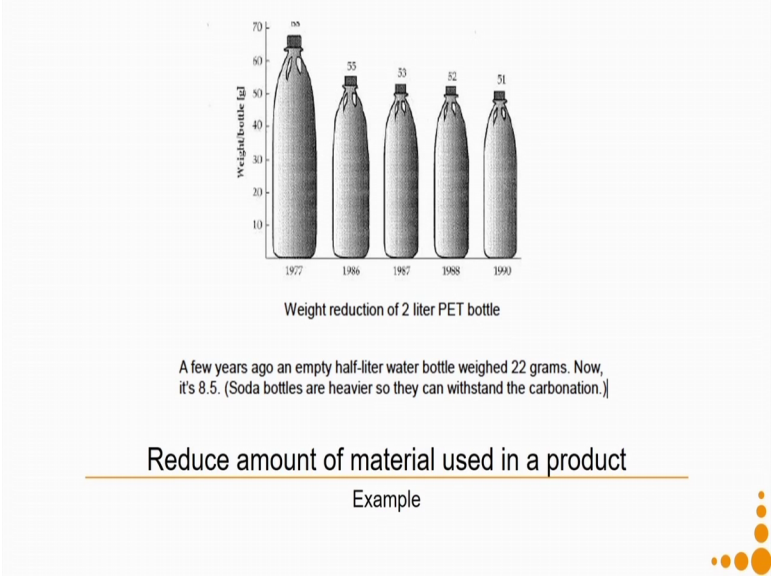


So, this is a chart which tries to put the previous chart which was the four levels and along with the sub levels the sub approaches within that particular level. So, let us discuss and it also puts them on a time line. So, let us discuss more on each of those approaches that I told you green design and so on and then we will come back to this chart again.

(Refer Slide Time: 15:12)

So, green design. In green design the focus lies on lowering environmental impact through redesigning individual qualities of individual products. So, it relies on three basic principles reduce, reuse and recycle. So, let me give you some examples.

(Refer Slide Time: 15:31)

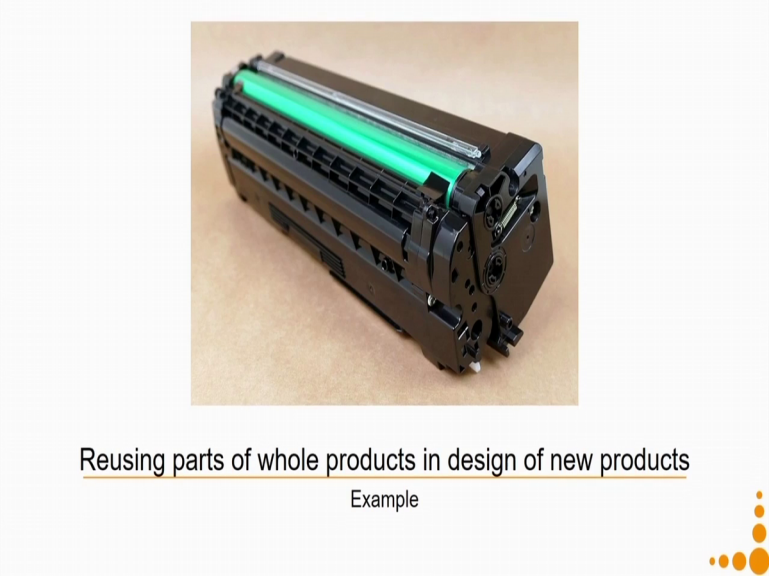


So, reduce the amount of material used in a product. So, say for example, a few years ago an empty half litre water bottle weight 22 grams. Now, it weighs only 8.5 grams. So, which means I have brought in some modifications in how do I design the product as well as how do I manufacture the in the manufacturing processes because I have to manufacture this bottle with thinner walls than my previous water bottles. So, I have to also do changes in my manufacturing processes.

So, by doing these two technological innovation structural innovation in the shape of my bottle. So, that the bottle I put in certain features in the bottle, so that the bottle is stronger even with lesser amount of material added to it and I do innovation in my manufacturing processes, so that I can produce thinner walls for my bottles.

So, in this case this comes under the category of green design. So, reduce the amount of material used in a product. A very technological technology level innovation, it does not affect in any way the behaviour of people.

(Refer Slide Time: 16:44)



The second fundamental, reuse; so, reusing parts of whole products in design of new products, say for example, I can give back the cartridge printer cartridge to the manufacture and the manufacturer can refill my cartridge. So, in this case I am reusing a big part of the whole part which was the cartridge which is now empty and filling it up with ink and I am getting my new product.

Another technological innovation, because when you are designing this product you have to make it very strong very study, so that in the cartridge has a very long life, it does not break down and you have to also design in a manner that the manufacturer can keep on refilling ink into it. Again some stakeholders will be involved because a mechanism to collect back these cartridges from the users has to be set up or say some mechanism has to be setup in which there is distribution of the refill ink bottles which the consumer can buy and himself or herself fill up this cartridges.

Again, this one does not involve much behaviour change on the user's part, but it is more of technological innovation. The third one for green design is replacing virgin material with recycled materials.

(Refer Slide Time: 18:16)

So, you can see this crates they are made up of recycled high density polyethylene which is the kind of plastic. So, recycled plastic finds another usage. So, virgin material is material which has not been used for making something so, it is like from petroleum you take it through certain processors, turn it into high density polyethylene and then you make some products that is made up of virgin material because you are using the material for the first time. Recycled material is say I made certain buckets out of that HDPE, now I will recycle them, I will use those buckets, crush them back and convert it into products then we I am using recycled material.

So, it does help in lowering down the requirement of more and more petroleum and extraction of plastic from it to certain extent if you follow this principle. Again something in which it is technological innovation it does not involve much people related behaviour. Yes, it might require that people might have to discard their old buckets in a certain manner or there has to be some waste collectors like in our country we have these entire set of people called kabadiwala's who come and collect the products that are no longer useful in your house and pays you back some money for collecting those product.

(Refer Slide Time: 20:43)

The fourth aspect of green design is replacing hazardous or toxic materials with non hazardous ones. See for example, paints because they are synthetic or synthetic paints consist of chemicals which are hazardous and toxic. So, all these pencils, these are colour pencils this is. So, on a colour pencil you need to know what colour the pencil is to be able to very easily select which pencil you want to use when it is kept in a box. So, what this particular company did was rather than colouring the whole pencil with hazardous and toxic materials they decided to chop off you can see they stop they decided to chop off the top at an angle making the colour inside it visible. So, as soon as you open your packet you can see the colour and you know which pencil to select.

So, this is another again this is innovation. So, technological innovation does not mean high end technology. What it means is; it can also be low end technology. So, again a technological innovation nothing much to influence people's behaviour.

(Refer Slide Time: 21:13)

In green design we also talk about use of renewable energy. So, say for example, using solar energy to light streetlights. If you see this particular example there is lot of cost involved in setting up solar panels. Now, if I say use solar energy to light your home or to produce electricity in your home that is an idea which belongs to the green design category, but where does it fail? It fails on the aspect that I might not have the economic capability at that very instant to invest so much of money in building that solar infrastructure in my house.

So, the green design it only concerns are large part of it only concerns about technology less and less concern is given to the human aspect of it.

(Refer Slide Time: 22:07)

Another part of green design is improvement in efficiency of products and processes like our 5-star air conditioner which we have discussed a lot. And, you again know that this does not effect on the consumption because of the 5 star things actually the consumption of air conditioner and the consumption of electricity actually increase because more and more people bought this product.

(Refer Slide Time: 22:34)

So, in green design the focus can be from design for recycling. So, you design your product in a manner that each and every component or most component of it can be

recycled. Then new design from recycling which means you make your product in a way that a part of its components or all of its components can be made from recycled materials. The next level is designed for recyclability which means I design my product in a manner that each and every component of it or a large number of components of it can be recycled.

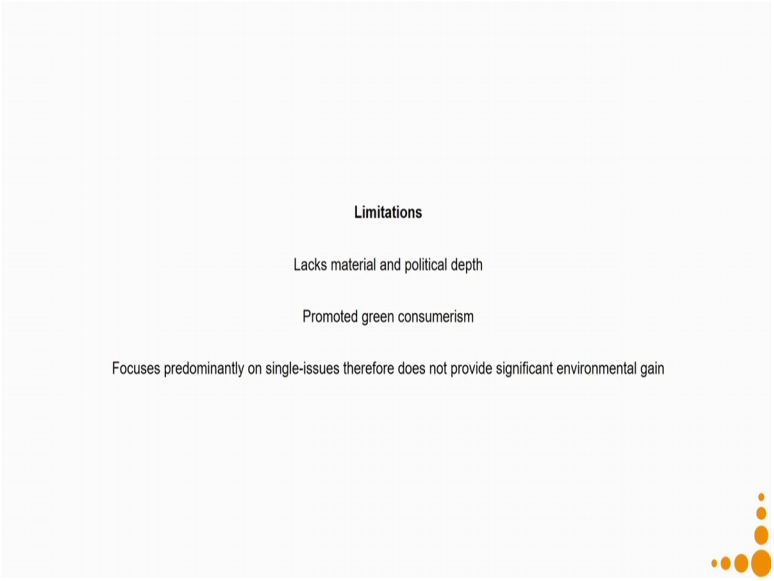
The third stage is where I am designing it for ease of dismantling. I cannot do recycling if I cannot dismantle the products into its components. So, if I have paper so, all the paper cups which I used for drinking coffee they have a very thin layer of plastic inside it. Now, there is no way in which I can dismantle the paper and the plastic. Hence my product becomes non recyclable. So, the focus also to shifted to how do I make it easy for dismantling and only then recyclability is possible.

Another approach is designed for repairability. What repairability will bring you is I can use the product for a way much more longer time or I can replace certain components which breaks down and I can keep on using the product. So, green design concerns all these aspects. But, there are certain limitations to this particular approach. First problem is it lacks material and political depth. What it implies is I need lots of rules and regulations in order for green design to function.

Say for example, it was only when the European union made it a mandate that electronic products with star rating has to come into the market and slowly one has to face all products which are in the 1 2 3 star rating category and keep only the 4 and 5 star rating this came in. Now, one has to ensure that norms are followed same is the norm for vehicular pollutions. There are rules related to what should be the pollution limit and we have to get certification. Now, if the political level or the rule level it fails then green design fails to a big extent. There is also a problem that many manufacturers label their product as green design and people assume that this is green design which is again not the case.

So, say for example, you buy plastic raincoat, many manufacturers will put in their product definition as eco-friendly or green raincoat which is not the case because this is the normal plastic product and once it tears apart it just goes into a dustbin and it cannot be actually recycled and nobody fix it for recycling as well.

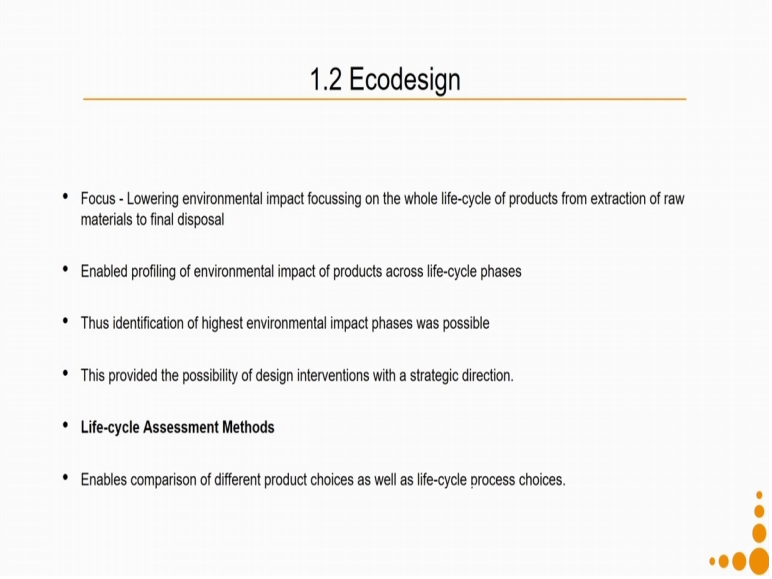
(Refer Slide Time: 25:51)



So, the problem with green design is because of the labelling because people are not much aware about it, it promotes green consumerism which. So, people assume that this product is good. So, let me buy lot of it is no problem to consume a lot of that product, but that is a misleading information.

Another limitation is it focuses predominantly on single-issues therefore, does not provide significant environmental gains. So, say for example, the air conditioner focused on energy efficiency, a single-issue. So, the consumption side went high. So, it did not bring in the long run a significant environmental gain. So, is the case with other examples that I showed you. The solar energy it has not been taken up by people because the initial cost of putting it up at home is very high and the number of years which is required to recover that cost is pretty high. So, people do not want to make that affront expenditure.

(Refer Slide Time: 27:22)



Now, coming to the second approach which is at the product innovation level, it is called as eco design. Many people confuse between green design and eco design, but these are two different aspects. In the green design we were talking mostly about only the product, but in eco design we talk about the whole life cycle of the products. So, that is a much bigger picture than the green design.

So, we focus on lowering environmental impact on the whole life cycle of products from extraction of raw materials to final disposer. So, the consumption side also comes into picture. So, if I design keeping in mind life cycle analysis I get a bigger picture than the green design.

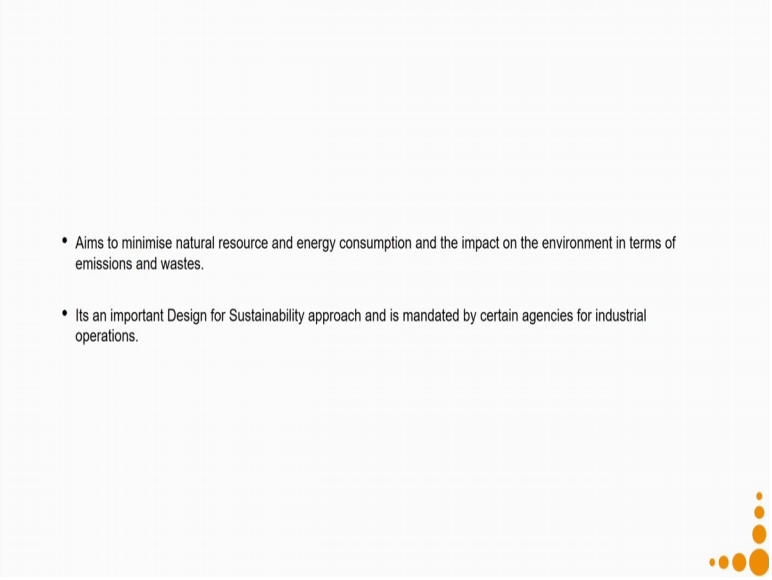
So, it enables profiling of environmental impact of products across life cycle phases. So, I will know, whether the most amount of environmental damage is happening at the production phase, at the raw material extraction phase or at the use phase or at the distribution phase. Then at that particular phase I can do design interventions to improve the efficiencies. So, this way of making an intervention it gives you the possibility of design interventions with it is strategic direction. So, you keep on a strategy that which are the phases wherein I brought in certain changes and what is going to be the final impact.

So, in order to do this there are certain methods they are called life cycle assessment methods that is the topic of our discussion on how to do life cycle assessment for module

two. This method also enables us to compare between different product choices as well as the life cycle process choices. So, in the green design you see I cannot compare between two products, but in eco design because I have done life cycle assessment method I can compare two products, I can compare two products life cycle.

So, say for example, I can compare between having coffee in a paper cup disposable paper cup versus having coffee in a earthen baked earthen pot or having coffee in a plastic disposable cup.

(Refer Slide Time: 29:29)



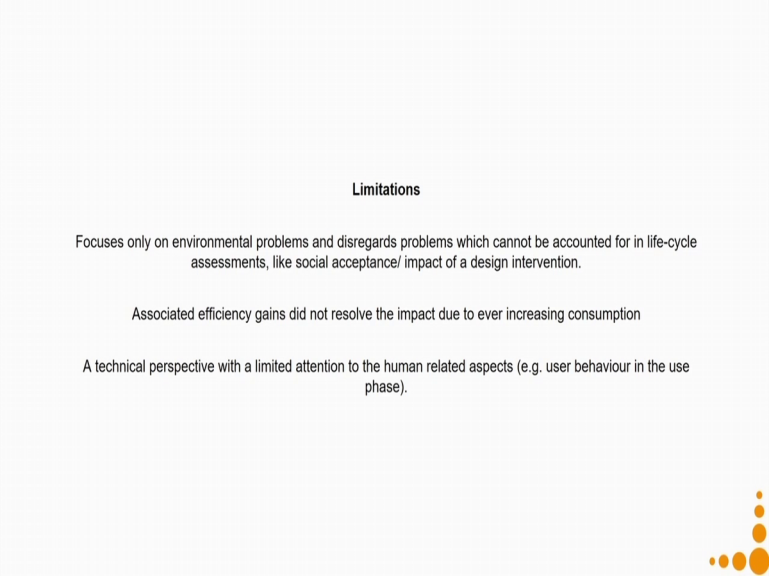
It aims to minimise natural resource and energy consumption. So, both of them are included in this, natural resources as well as the energy consumption and the third is the impact on the environment in terms of emissions and wastes. So, the life cycle assessment process helps you to track all the three and optimise on all the three.

It is an important design for sustainability approach and is mandated by certain agencies for industrial operations. In many countries it is mandated right now that all industries will have to do a life cycle assessment of their products.

(Refer Slide Time: 30:13)

Say for example, this is one particular example it is called as Fria, it is a refrigerator which is built in the house itself. It is a permanent fixture, it is like cupboards and where do they build this. So, in eco design because my aim is to reduce energy, reduce material and reduce the impact on waste and emissions. So, in this case this refrigerator is proposed to be installed on the northern wall of the house and it is designed in a manner that whenever some component breaks down, the component can be replaced and not that you have to buy a new refrigerator. The because it is located on the northern wall which is supposedly the cooler wall or the cooler side of a house it takes into account the cooler air from outside the house and it helps in refrigeration. It has been observed that over it is test period it could bring in energy efficiency by about 50 to 80 percent.

(Refer Slide Time: 31:32)



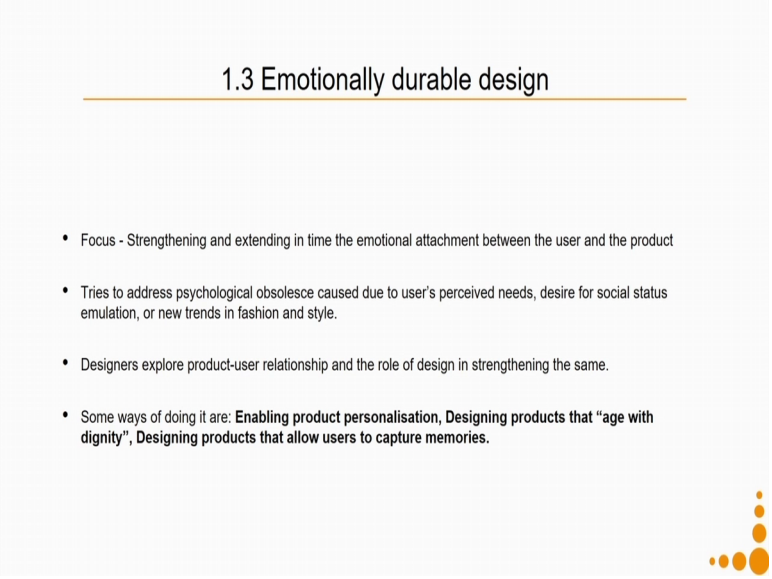
So, the major limitations, say for example, in eco design again we are talking only about the amount of natural resources energy and the emissions and wastes we are again talking only in terms of technology on the production side, we are still not talking on the people's behaviour side to a great extent. The life cycle assessment method, they are an environmental assessment method. They do not have any dimension for social and economic sustainability.

So, the major limitations are it focuses only on environmental problems and disregards problems which cannot be accounted for in life cycle assessments like social acceptance, impact of a design intervention. So, say for example, the refrigerator. Will it be socially acceptable? Maybe I would like to change my refrigerator every couple of years because the technology changes and now I want to have a better refrigerator, it is also a kind of a social status to have the latest technology and so on.

Also associated efficiency gains did not resolve the impact due to ever increasing consumption. So, I make the production processes more efficient, I also make the use phase energy consumption more efficient, but that necessarily does not decrease consumption, it in fact, increases consumption. Then, a technical perspective with the limited attention to the human related aspects. Example, user behaviour in use phase, say you make the most efficient air conditioners, but if me as a user I do not care about switching off the air conditioner when I do not need it, I am consuming a lot more energy

than what I am supposed to. So, it is a technical perspective with the limited attention to human related aspects.

(Refer Slide Time: 33:43)



Now, coming to the third approach; this is called as the emotionally durable design approach what it implies is it is focus is on strengthening and extending in time the emotional attachment between the user and the product. Say for example, you love a product you are attached to a product because of say for example, maybe the product has been gifted to you by someone you love or say you have own that product and say long time and you have memories associated with it, you get emotionally attached to it and you do not want to discard away that product.

So, this approach tries to talk about the same thing that will strengthen the emotional attachment with products through design, so that I can extend the time of usage of that product. So, it tries to address psychological obsolesce. So, mostly so, it has been observed that around 70 to 80 percent of the products are discarded not because they are no longer technologically good enough. They are discarded because they are psychologically obsolete now. What it means? So, the users perceived needs are no longer from that product. So, you think I know longer need that product or maybe the desire for social status emulation. So, I want the latest mobile phone because it is about social status, all my friends, all my colleagues they do have a better one or it might be because of changes in fashion or style.

So, most of the products like garments, accessories like handbags, shoes and so on they are mostly discarded because they are no longer in fashion and style. So, designers in this particular approach try to explode the relationship between product and the user and the role of design in strengthening that relationship. So, the stronger the relationship, the stronger the emotional bond and the likelihood that the product will not be discarded very soon is very high.

(Refer Slide Time: 36:05)

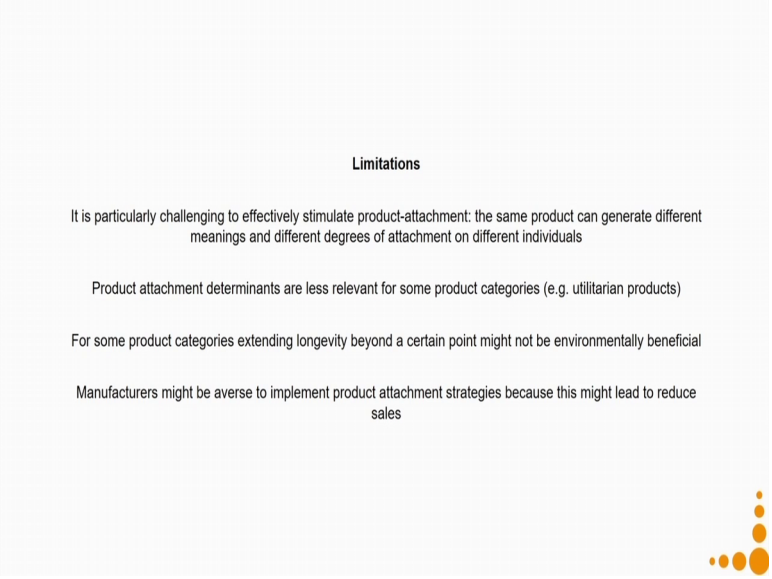
So, some ways of doing it can be enable product personalisation. Say for example, this one is lamp. So, you can see the top surface of the lamp is completely black in order to get the light you have to scratch it like these two people are trying to scratch it. So, because you buy the product like entire black box, you bring it home and you scratch the design that you want on top of it you can scratch say you can scratch something today you can scratch something after 1 year. So, what you are doing is you are personalising the product that enables some kind of emotional bonding between the product and the user.

(Refer Slide Time: 36:49)

Another example, another approach for doing the same is designing products that age with dignity. So, say for example, wooden furniture as they keep on aging, the varnish on them keeps changing colour and they aged furniture has very high value high psychological value because they have aged with dignity. They did not become like crumbling or the colour fades out in a manner that. So, like old clothes the colour would have faded out in a manner that we would not like to use them again, but with old furniture that is not the case. So, we can design of products in a manner that they age with dignity, which can cause emotional attachment with the product.

Now, there certain limitations to this particular approach as well.

(Refer Slide Time: 37:40)



So, it is particularly challenging to effectively stimulate product attachment the same product can generate different meanings and different degrees of attachment on different individuals even with the same kind of design we all respond to the same design differently depending on many aspects like I might belong to society to a set of cultural practices where throwing away product is seen bad then in that case the effect of product attachment might be stronger.

But, I might also belong to a society where discarding away products which are no longer required or changing products very frequently is very normal I might find lesser degree of product attachment. Product attachment determinants and less relevant for some product categories say for mostly for utilitarian products say for example, washing machine they are very utilitarian products, they lie somewhere in the corner of your house and product attachment for such kind of products is hardly relevant.

Then for some product categories extending longevity beyond a certain point might not be environmentally beneficial say for example, if I keep on using my air conditioner for a very long time and say for I am using an air conditioner which is around 20 years old, but now the technology towards more efficient air conditioners has come and if I still keep on using my old one I am actually being more environmentally bad because the consumption phase, I am consuming too much electricity. Hence, we have to see how do I achieve a balance between longevity and efficiency, technological efficiency?

And, the fourth point is manufacturers might be averse to implement product attachment strategies because this might lead to reduction in the sales. Let us go to the fourth approach. Although we are speaking about certain limitations, it does not mean that we cannot use these concepts, but we should be aware of the limitations and we can design certain aspects to overcome those limitations. There might be also a possibility that eco design or design for behaviour change is the only option. When we go towards the other levels, the product service levels or the spatial levels you will also see that some of these concepts are taken into those levels and combine with other design approaches, so that these limitations can be overcome.

(Refer Slide Time: 40:26)

Now, coming to the fourth approach, design for sustainable behaviour. It focuses on making people to a desired sustainable behaviour and abandon and unwanted unsustainable behaviour. So, basically what it means is it mix people aware or maybe it influences people in a manner that they will switch of the bulb when it is not required or they will waste less water when they are trying to brush their teeth. So, switch off the tap when the while they are brushing the teeth and so on.

So, for example, products which consume energy during the use phase or say water during the use phase or other consumables during the use phase, a substantial environmental impact is caused due to this use phase and it can be brought down by sustainable usage behaviour. So, there are many approaches possible in this case.

Approach 1 is behaviour coming from behavioural economics. What it says? Inform people. So, if you tell people how, what is the bad impact of your activities?

Say for example, if you tell them that if you switch off the bulb when you are not using it then you will end up at the end of the year saving 20 percent of electricity or if you replace all your lighting fixtures and change them into being led you will be able to save say for example, 50 percent of on your energy bills that is about informing. Why? Because when people are informed they might take adopt more sustainable behaviour. Mostly in this case information is in terms of the monetary aspect.

Then, comes empowering; one has to also empower the user in a manner that the person can behave sustainably. Say for example, if I have a regulator on my air conditioner it is only possible then that I can reduce the air conditioning, but in case I do not have that I cannot reduce their air conditioning volume.

Another very important aspect is providing feedback. Say me as a user I started behaving sustainably, I should get a feedback on how well I am performing as compared to my previous behaviour or if I tend to go towards unsustainability it should provide me feedback that how I am going back.

Rewarding the user for being more sustainable another psychological benefit. People always like to get rewarded and then using affordances and constraints. Say for example, it might not be possible in an office environment like keep on switching on and off the air conditioners depending on the usage of that office space. So, in that case I might have sensor based switching on and off, where the sensors determine whether people are sitting over there or not or say for example, when I am sleeping and my body has already cooled down I do not need the air conditioner running at full blast. It can run at lower energy levels.

So, the sensor can be determine that and change the settings of the air conditioner likely. So, I have to bring in affordances and constraints depending on the situation in, so that people are able to adopt this sustainable behaviour. Say for example, I love to segregate my waste; I have organic waste, I have dry waste. But, say I do not have an enabling system given by the municipality in which I can send these two waste segregated to different locations, then I will there is no point in the sustainable behaviour that I am following.

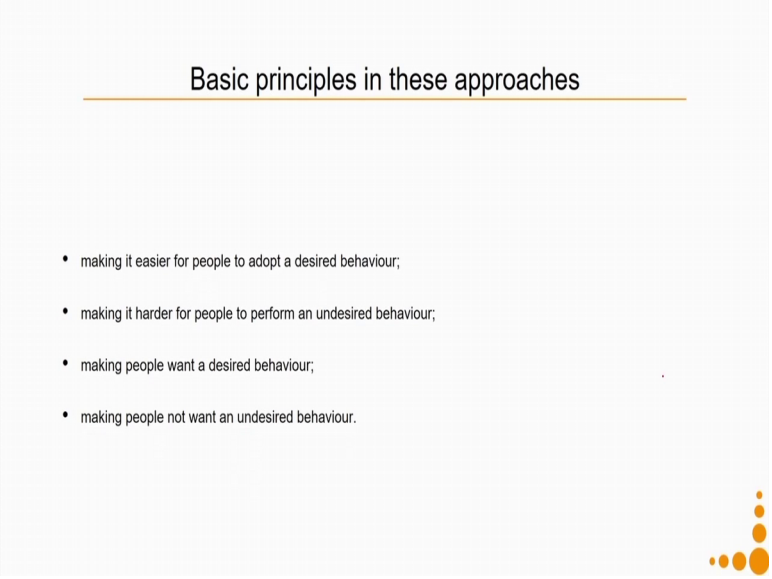
So, I am not empowered in that particular case to follow sustainable behaviour. The systems, the municipal systems waste disposal in that case becomes my constraint. Also, say I might not be living on the ground floor. I might not have a place for setting up a composting unit in my house. So, even if I am doing segregation of organic waste, I have the constraint that I cannot do that.

The next approach is design with intent; it draws from a variety of field and proposes eight lenses. These lenses are Architectural, Error Proofing, Interaction, Perceptual, Cognitive, Security, Ludic and Machiavellian lenses by which to understand and influence aspects of personal behaviour and contexts.

What this implies is; so, our behave certain our consumptions might happen in an architectural environments, certain kind of an architectural environment or say even in case of a park if I take that as an environment I might need certain dustbins at certain points of time to be able to discard my waste in a particular manner. Error proofing I have to have wastes in which I can ensure that people do not commit errors in doing it. Say for example, you have three bins. One of the bin says organic waste, the other bin says paper and the third bin says other wastes. I should be able to recognise which waste is mine usually it is easy to recognise organic waste.

Now, I have paper and other ways now my confusion might be I might have a paper on which I have written something that is completely paper, but I might have a paper cup which is a combination of paper and plastic. So, me as a user I might be confused whether I should put it in the paper dustbin or I should put in others dustbin.

(Refer Slide Time: 46:30)



So, the basic principles in these approaches are make it easier for people to adopt a desired behaviour. Do not expect that people will take extra effort to go sustainable. If using plastic disposable bottle for drinking water while travelling is more convenient and is a more is a option for getting safe water more conveniently people will adopt it. Now, we have to think of wastes how do we make it easier for people to adopt a more sustainable behaviour.

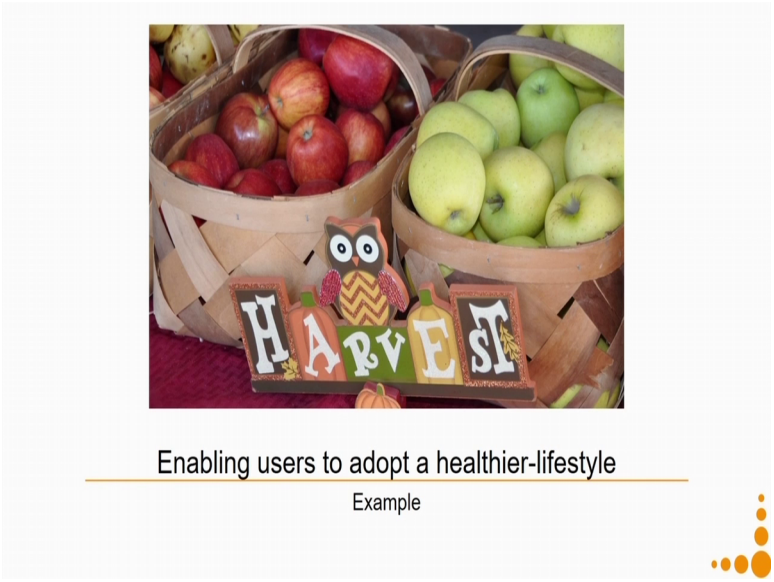
Next comes making it harder for people to perform an undesired behaviour. Many a times finds harder way of achieving it. There might be say for example, I create a I create a unit which takes in plastic bottles plastic water bottles. Now, there might be some people who might be interested in tampering with the machine and they try to put in something else. So, the machine should be designed in a manner that people cannot tempt cannot put anything and everything inside it.

Making people want a desired behaviour which is very important only when they really want to be sustainable they will do it, making people not want an undesired behaviour.

(Refer Slide Time: 47:44)

This is one example for the same; this is called as a power-aware cord design by the Swedish Interactive Institute. What it does is it depending on your power consumption you see the intensity of the blue lines that you see in this power cord will change. So, it is a very visual response that you can have and you can understand ok, now my electricity consumption is going high and then you bring it back by say for example, switching off some of the devices.

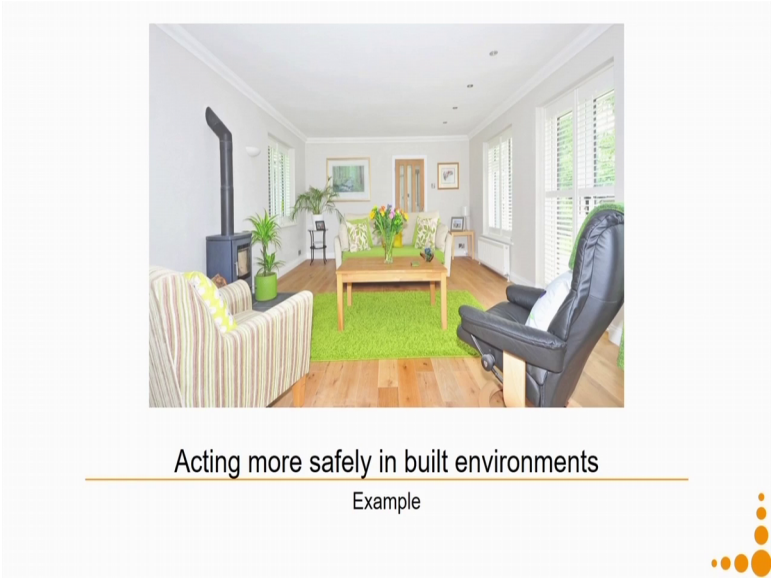
(Refer Slide Time: 48:20)



See for example, enabling users to adopt healthier lifestyle because you are doing good

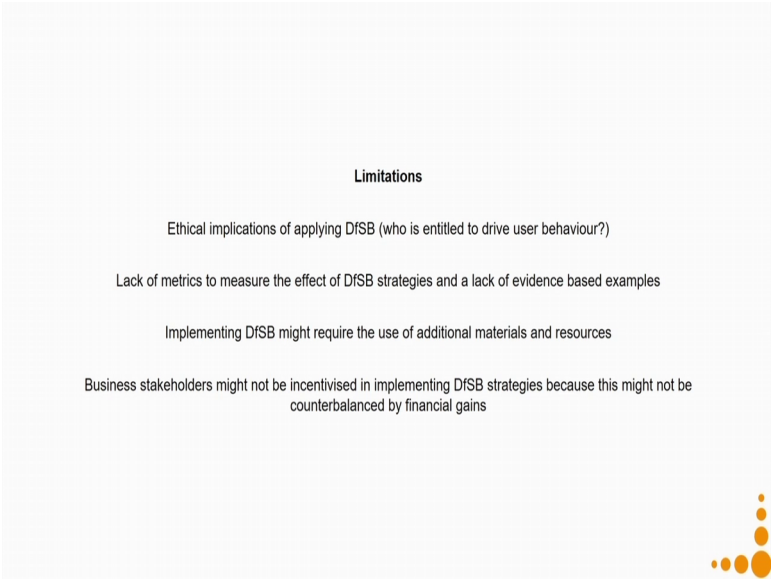
to your body, you are doing good to the environment. So, like having organic food. No pesticides, no insecticides can be a approach of it.

(Refer Slide Time: 48:35)



Or acting more safely in their built environments; say I can use paints which are non toxic. I can have plants in my house which help to clean the air in the house. But, there are certain limitations for this process also.

(Refer Slide Time: 48:46)

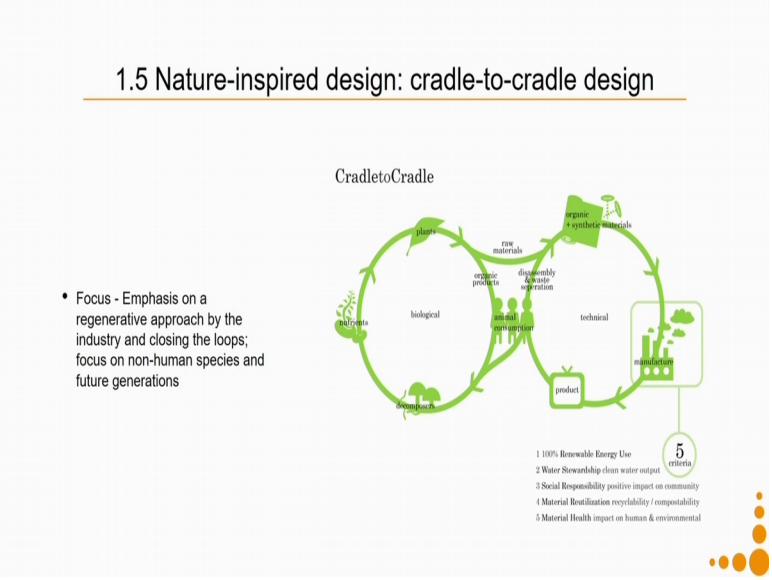


The biggest argument which comes over here is because we are talking about influencing user behaviour. So, an ethical question comes, who is entitled to do it? Is it the designer

who knows what is the best for the users? So, people have a question on the manipulative part of this, manipulation of user behaviour part of this on ethical perspectives.

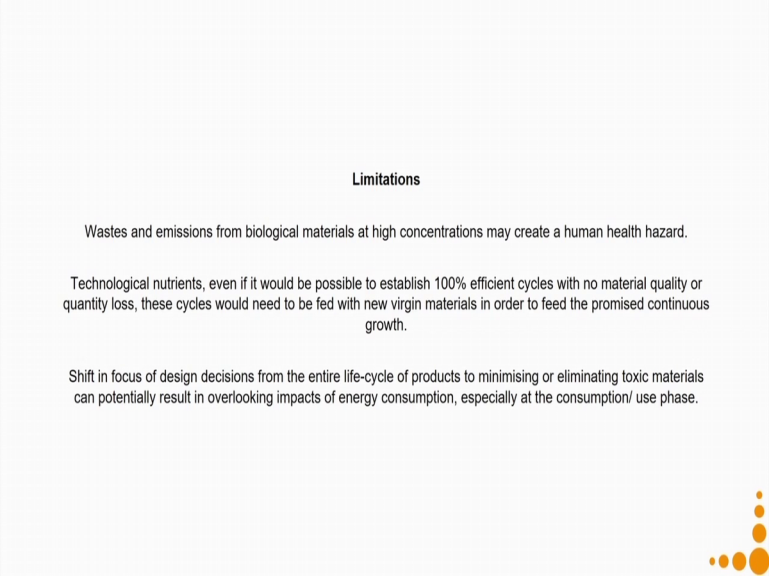
Also, there is no metrics to measure the effectiveness of this technique and the strategies and also there is not much evidence available in right now to prove that by doing this a positive and how much positive impact on the sustainability has been or can be achieved. Implementing this might require the use of additional materials and resources like a lot of advertisement campaigns and so on. Business stakeholders might not be incentivised in implementing these strategies because this might not be counterbalanced by the financial gains where they are having as a result of it.

(Refer Slide Time: 49:50)



The fifth and sixth one is about the nature inspired design. We already spoke in our last lecture about cradle to cradle design where we emphasis is on a regenerative approach by the industry and closing the loops we focus on the putting everything in the biological or the technical cycle. So, I will not give an example of it right now because we discussed about it in depth in our previous lecture, but I will talk about some limitations.

(Refer Slide Time: 50:09)

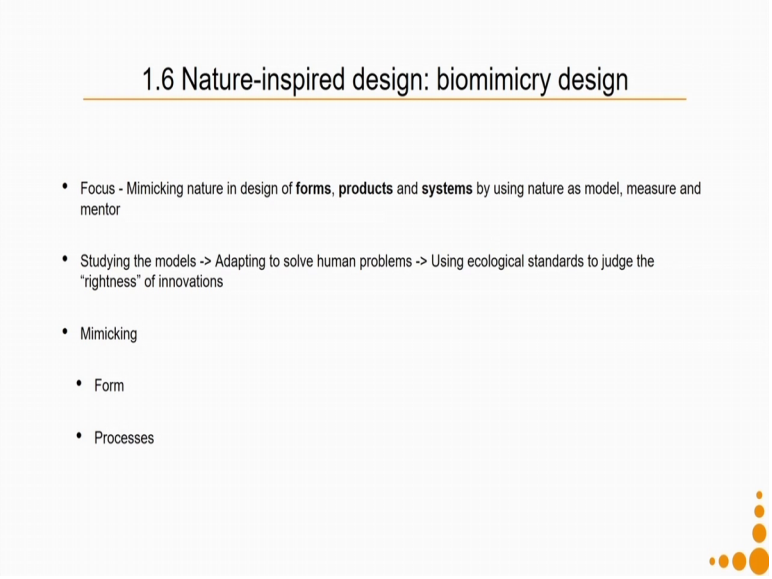


So, it is in this the basic assumption is if you put everything in biological cycle all the wastes and emissions then it can be sustainable, but that is not true. Because, at higher concentrations they might create a hazardous effect on human health so, not that we can keep on putting everything in the biological cycle and disrupt the biological cycle. Also technical nutrients even if it would be possible to establish 100 percent efficient cycles. None of the recycling process will give you hundred percent efficient recycling there will be always losses.

So, even if it is possible to do 100 percent efficient cycles with no material quality or quantity loss, these cycles would need to be fed with new virgin materials in order to feed the content promised continuous growth. Because, if we need to grow which means we need more of what we have right now so, along with the recycling thing we still keep on needing new material.

Again, shift in focus on design decisions from entire life cycle of products to minimising or eliminating toxic materials can potentially result in overlooking impacts of energy consumption especially at the consumption or use phase. So, in the whole cradle to cradle discussion from the previous lecture you see we had no discussion on the energy consumption at the use phase. So, it does not take into consideration that.

(Refer Slide Time: 51:50)

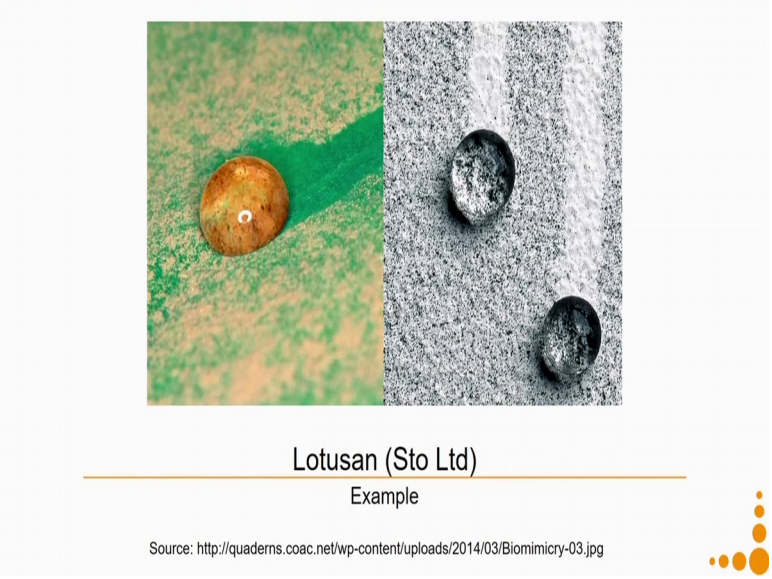


Coming to the next nature inspired design which is bio mimicry design which is mimicking nature in design of forms, products and systems by using nature as a model, measure; measure means I want to measure the success and or failure or the degree to which I succeeded or degree to which I fail, so, measure and a mentor. So, I am learning from nature.

Now, what we do in this case we study the models from nature adopt them to solve human problems and use them for ecological standards to judge the rightness of the innovations mimicking. So, how do I do this mimicking? Mimicking can be done at three levels at the form level which is the shape of the product that is the more superficial level at which we can copy and gives the least amount of environmental benefit if any, then in processor which can be like how the whole may be how the manufacture happens or how the product is used.

Again, in the process level although it is higher than the farm level, but even in the process level we might not be able to ensure much of environmental benefits. But, we if we take it like an ecosystem level if we take inspiration from the ecosystem then we might be better able to achieve environmental sustainability.

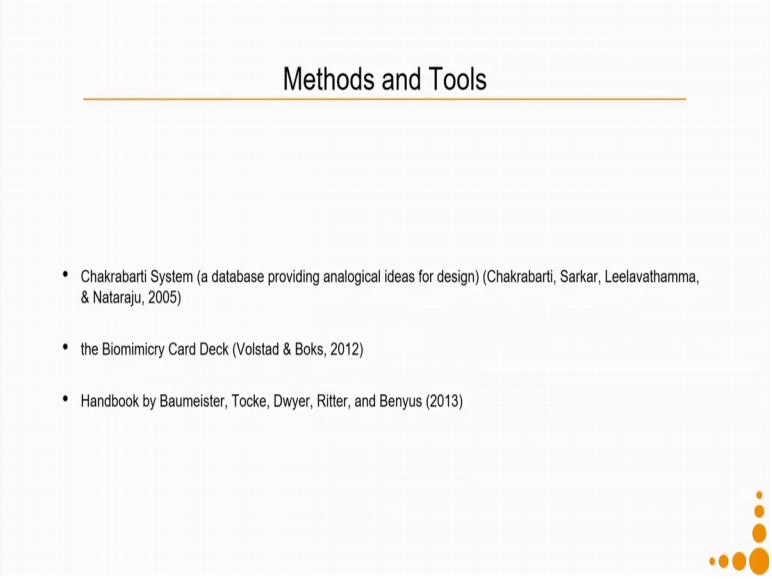
(Refer Slide Time: 53:10)



Say for example, the blue economy principles that we discussed in our previous lecture they all follow fall under this particular category. This one is a example of a paint it is inspired from the lotus leaves. So, if you know or maybe you can search on the internet on how a water droplet does not stay on a lotus leaf, it just falls down. So, along with that no dust accumulates on the lotus leaves because of this particular phenomenon. So, this phenomenon happens because of certain physical structure of the leaf.

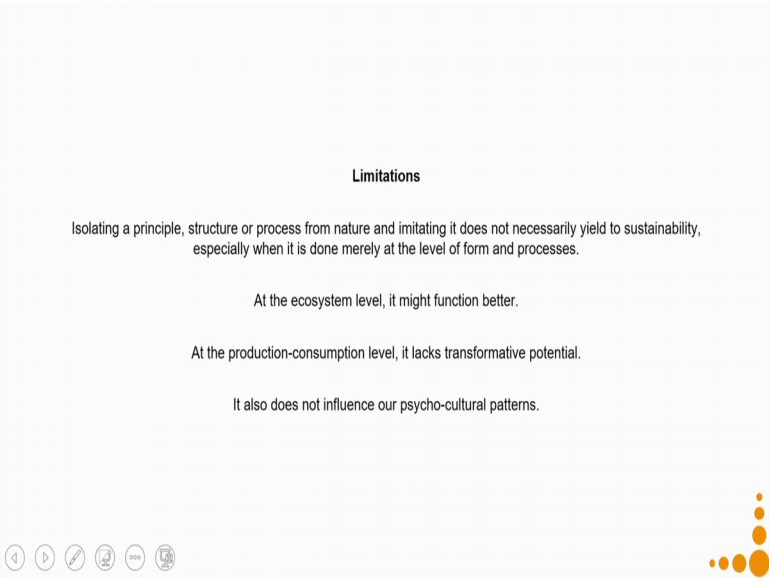
So, same was emulated into this particular paint this paint can be used on the exterior walls. So, it does not. So, whenever rain will happen it has self cleansing property. So, it will not allow accumulation of dust, it will have a self cleaning property. So, it will not allow accumulation of dust, it will have a self cleaning property and also the paint is less hazardous than other paints in the same category.

(Refer Slide Time: 54:14)



There are various methods and tools for achieving this. These are some of the methods this one of them is Chakrabarti System, it is a database providing analogical ideas for design, the biomimicry Card Deck and there is a Handbook. So, you can go through these if you are interested more in exploring this domain.

(Refer Slide Time: 54:33)

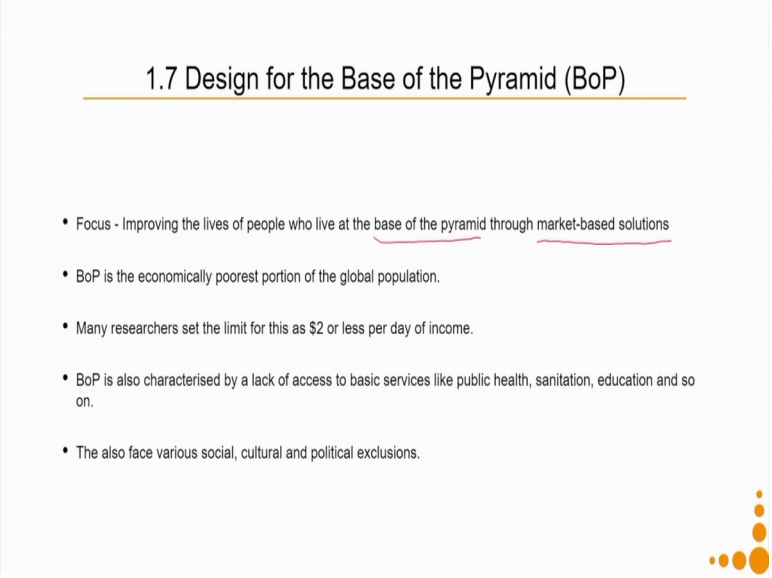


There are certain limitations in this case. Firstly, I am isolating a principal structure or process from the nature and imitating it, that does not necessarily mean sustainability, especially when it is at the form in the process level. At the ecosystem level it might

imply greater sustainability, but mostly not at the form in the process level. At ecosystem level it might function better. At the production consumption level, it relax transformative potential. It does not do anything on the consumption side. No consumption behaviour is influenced as a result of it.

It also does not influence any psycho-cultural patterns. Psycho-cultural patterns is the way we think and we they determine how we think and how we behave with our materials or the products that we own, it does not influence that also. It is again a technological innovation.

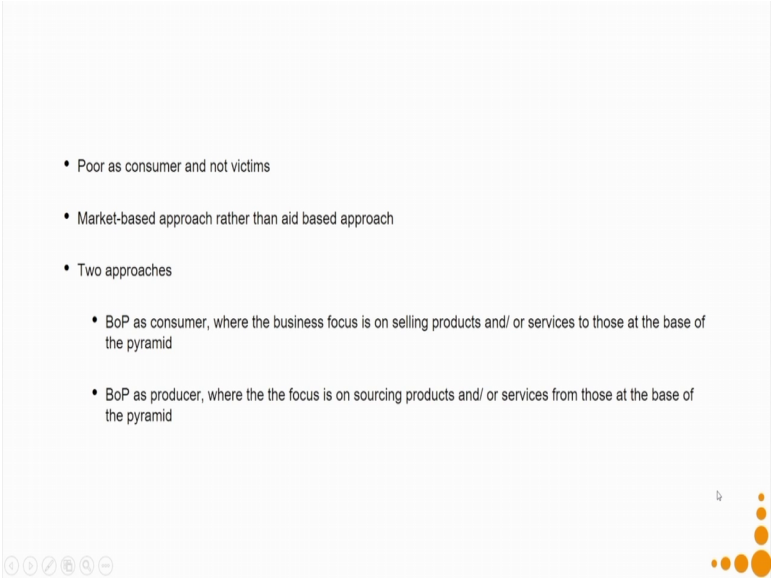
(Refer Slide Time: 55:40)



So, the seventh approach within the product level product innovation level approach is called as design for base of the pyramid. So, the focus in this particular context is improving the lives of people who live at the base of the pyramid through market based solutions. So, first let us try to understand who are base of the pyramid and then we will try to understand what is meant by market based solutions. So, base of the pyramid or BoP as it is called is the economically purest portion of the global population many researchers said the limit of this as dollar 2 or less per day of income.

Another way to understand BoP is so, usually BoP is characterised by lack of access to basic services like public health, sanitation, education and so on. They might also face various kind of social cultural or political exclusions.

(Refer Slide Time: 56:36)



So, what do we mean by market based solution is? So, whenever you whenever we think that this person is poor and let us give that person some kind of aid which might be in terms of free food, some money, free education and so on that is more like a model which is based on aid when we think that the poor are the victim. So, the market based solution means that look at poor as consumers and not as victims and give them aid.

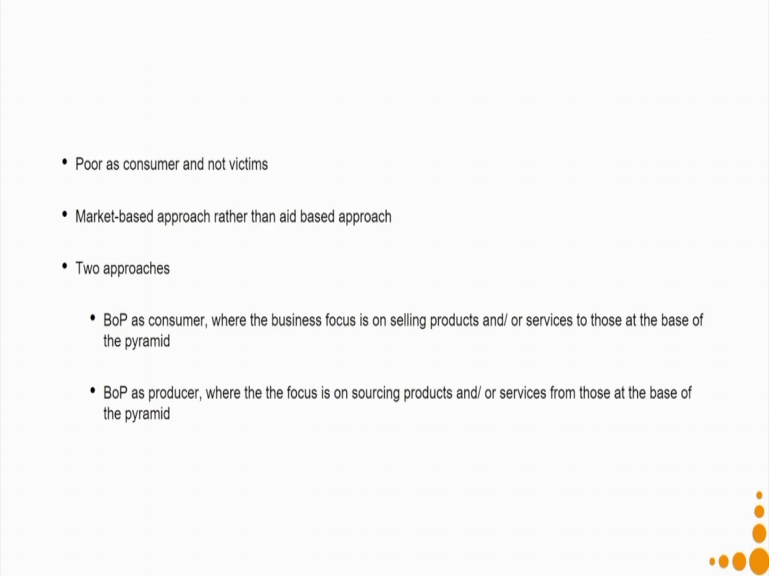
So, market based approach rather than the aid based approach. There are two approaches within this particular context. In approach one which was how it started as BoP is considered as a consumer where the business focus is on selling products and our services to those at the base of the pyramid.

(Refer Slide Time: 57:29)

So, I will show you an example. So, how all these sachets of shampoo or say sachets of biscuits or sachets of washing powder came into a picture, because it was realised at that at the base of the pyramid since there daily income is very low they do not have enough money. So, that they can buy an entire bottle of shampoo which might cost something between 100 to 200 rupees or even more, but these people do have the money to spend 1 rupee per day or 2 rupee per day as per their requirement and by small sachets of shampoo. So, these sachets can are for one time use.

As a result of this particular realisation which is an since BoP was now targeted as the consumer. All kinds of products which were earlier more expensive because they came in huge bulk started coming in sachets and the BoP could now afford it. What they do not realise in this particular context is a bottle of shampoo which we might buy at rupees 200, the same volume the people belonging to the base of the pyramid are buying at a much higher cost.

(Refer Slide Time: 58:47)



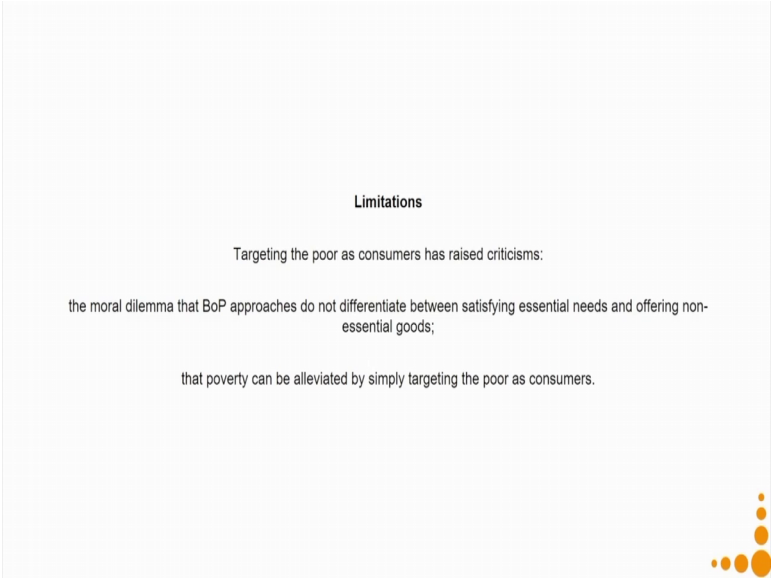
The another approach was BoP as producer, where the focus is on sourcing products and or services from those at the base of the pyramid. Why this concept came, because if you treat them as consumers you are not actually doing anything in order to improve their current financial status, social status or economic status. Yes, they are able to use products which the rest of the market who are above the BoP market are affording, but they you are not actually doing anything good.

But, concept of BoP as a producer where the focus is, so that I can the BoP can produce products or services and I can source them and select in the proper market that can elevate their position economic position as well as social position.

(Refer Slide Time: 59:41)

So, say for example, Fabindia, their strategy is source your garment, source your other handy crafted items from the craftsmen who usually belong to the base of the pyramid category and bring it to the mainstream market. So, they are basically aggregators of different kinds of products we source from BoP.

(Refer Slide Time: 60:08)



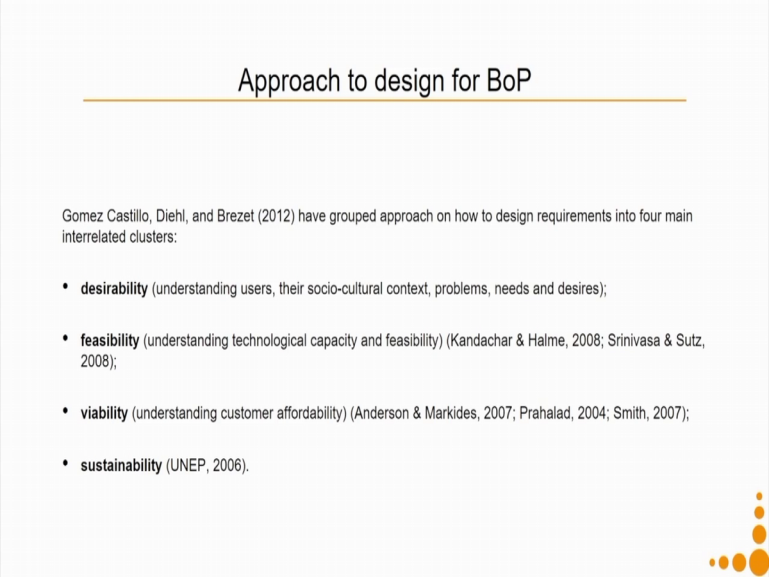
So, now coming to what are the limitations of this? So, targeting the poor as consumers has raised criticisms as I told you because it does not increase their capacity to come out of their current socio-economic political poverty. There is also moral dilemma that BoP

approaches do not differentiate between satisfying essential needs and offering non essential goods.

What does that mean? If I am trying to sell them washing powder or trying to sell them shampoo by bringing them down into smaller products, smaller size products, smaller cost products, I am offering them, are they the essential needs. Maybe they are more essential need over there is safe drinking water, safe sanitation facilities. So, the targeting the poor as consumer has raised this criticism that we are trying to bypass the providing them essential needs satisfaction because the cause that they could have incurred to achieve them is now being spent and getting non essential goods.

Another point of criticism is that poverty cannot be elevated by simply targeting the poor as consumers. Actually we are asking them to pay more for a bottle of shampoo by dividing them it in smaller parts. Now, how do we design for this particular approaches? So, the approaches are grouped into finding out how to determine what is the requirement? So, like we argued are we giving them their essential needs or are we giving them their non essential goods.

(Refer Slide Time: 61:55)



So, in order to get out of the dilemma we have to consider what is their main requirement. So, the first aspect is desirability, understanding the users, their socio-cultural context, the problems that they face and the needs and desires. So, in a particular slum area where we were doing research once, every household express their desire to

have a television set at their home, but when we asked them what about sanitation facilities like proper toilets or bathing spaces. They were regarded as secondary importance as compared to having a television or a refrigerator. Why? Because having the television or the refrigerator came into the desired side and when as researchers what we saw that they had really poor sanitation facilities. So, we thought the sanitation is the bigger need. So, we need to understand the desirability, understanding the users, their needs and desires.

Then comes feasibility; feasibility in terms of technological capacity as well as feasibility. So, say for example, if you provide toilets to poor community which is flood bound, you have to try to understand which is a technological solution, which is suitable for that environment, also a technological situation which is suitable for the kind of usage they will use?

For example, in a particular context in a slum certain bio toilets were installed. Now, these bio-toilets, the faeces is eaten away by certain kind of bacteria. The bacteria can survive without new faeces coming in for up to 3 days. Now, every family goes on a vacation, even the poor people go on a vacation. Now, they can't go on a vacation from more than 3 days. So, in order for this toilet to function it was for its technological capacity and feasibility to function as it is. One might have to have a context in which couple of family share the same toilet. But what happens when a festival comes? All of these families might go to their hometown at the same time. So, that is why very important understanding the feasibility, the technological feasibility and capacity.

Now, considering viability; which is about how do you make your solution affordable to the customer? So, the sachet was an example in which they divided it up into smaller packets, so that it becomes affordable. Next comes sustainability. So, in design for BoP, sustainability is not insured by default. We have to consider sustainability and build in into design and only then sustainability comes in. So, say for example, those sachets of products which are available they are thrown after one use and they are a big source of clogging our drains every year. So, it is a big environmental challenge.

(Refer Slide Time: 65:11)

Now, coming to the point of viability; so, here in this picture we are trying to transgress from the product level into the product service level with design for base of the pyramid.

So, in this picture you can see this is an example of a water dispenser. So, the dispenser itself purifies the water and people who want to drink water or who want to collect water in container they pay per use. They do not own this particular product, for every use they are paying it. It ensures that the people belonging to the base of the pyramid who really have a problem getting access to safe drinking water get safe drinking water, because you are not spending too much of material and energy in installing each of these water purifiers and everybody's house which also requires that you have a constant supply of water coming into your homes which is not a case in base of the pyramid.

So, you are being more sustainable. This particular machine is maintained by the company who created this machine. So, they will ensure that they really build long lasting products. So, the product is owned by the company and what they are offering is the service. Service of safe delivery of water, people pay per use which means again the cost per use is very small.

So, here you see we transgressed with the same design for sustainability for base of pyramid from product level to the product and service level and thereby be achieved on points of desirability, feasibility, viability and sustainability.

(Refer Slide Time: 66:59)

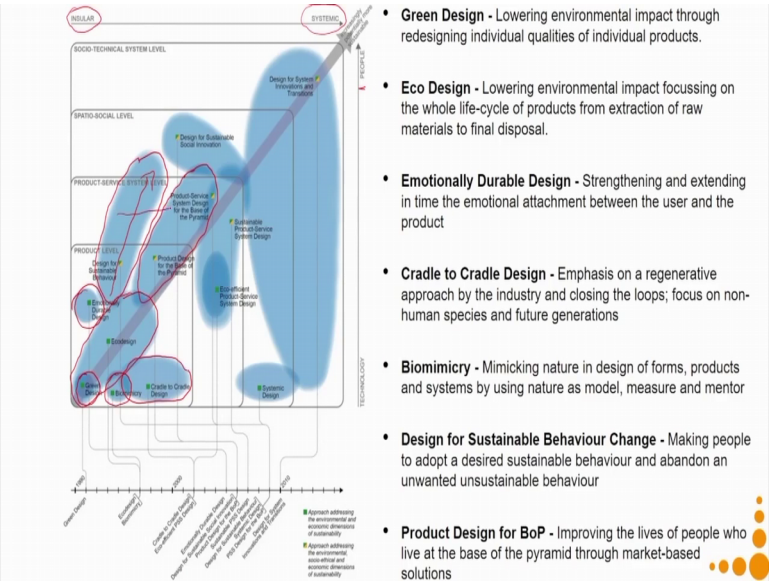
So, move towards product service system design, which is the next level after the product level. So, what are we supposed to do? First we do innovation in business model because how you will deliver this safe drinking water the entire mechanism, how people pay for it that is part of the innovation in business model, not much change in existing water purification technology has been done in this case. Existing technology has been scaled up to give you water at a particular rate, which is suitable for public usage scenarios.

Then as a result of this business model it offers wider opportunities for addressing the complex set of requirements that characterise BoP projects which we already discussed the feasibility, the viability and the sustainability and the desirability. This leads to developing solutions capable to meet the three sustainability dimensions, which is environmental, economic and social.

So, the assumption in this case is that the PSS innovation. It may act as business opportunities to facilitate the process of socio economic development in emerging and low income contexts by jumping over or by-passing the stage of individual consumption or ownership. So, you can see that the water purifier is no longer supposed to owned by individual households, but it is something which is owned by the community. So, by-passing the stage of individual consumption or ownership of mass produce goods towards a satisfaction base and low resource intensive advanced service economy. We

will learn more about what this means in the next lecture when we did discuss in detail about product service system design.

(Refer Slide Time: 68:58)



So, the summary of today's lecture is. So, we try to lot all the product levels and all the techniques. So, all the our approaches the product level the product service system levels spatio-social level, socio technical level and bring in our sub approaches within the product level.

So, let us talk first about green design–lowering environmental impact through redesigning individual qualities of the products. So, if you see over here green design is mostly about technological innovation. It also does not involve much of many to stakeholders, very few stakeholders are involved. So, it is also lying closer to the insular level. It is also at the lowest level of potential for more sustainable in design. Why, because the impact which is got in through improvements that usually gets lost in a very short time because of the consumption pattern.

Next coming to eco design which is lowering environmental impact focusing on the whole life cycle of the product rather than just one product and it focuses from extraction of raw materials to final disposal. So, you can see in this particular image, it lies in this particular zone. So, it is again a technology driven approach, it does not focus much on the consumption side that is it is low on the people side. It is again more insular than systemic, but it is more systemic than green design because I am since I am considering

the entire life cycle and as a result different stakeholders will be involved. So, say raw material extraction is done by completely different set of stakeholders, similarly, final disposal done by completely different stakeholders. So, in order to achieve eco design I need to involve more stakeholders. So, I move more towards the systemic site, but still lesser number of stakeholders. It has greater sustainability potential than green design.

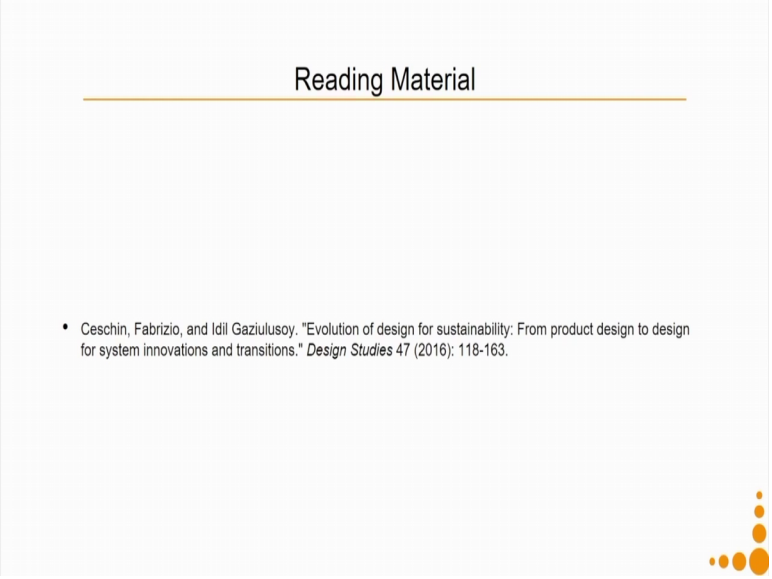
The next one, emotionally durable design; so, you can see emotionally durable design lie somewhere over here because I am trying to think about how do I build the attachment between a person and the technology which is the product, so, I move little bit higher. Since not many stakeholders are involved in it is the company which takes call on going towards emotionally durable design that is why it is more insular.

Next one cradle to cradle design, so, if you see it over here cradle to cradle design. In this case again I am not tackling the consumption side, I am only working on technology as a result it is location in the graph also more number of stakeholders are involved as compared to the green design or eco design.

Next one biomimicry, it lie somewhere over here, again something which is more about technological innovation and less about attacking the consumption side of it. Design for sustainable behaviour change; in this case what you can see that this transgresses between various levels. So, it is at product level, it is at product service system level, it is at spatio-social level. Why because in order to achieve product service system which we will discuss in the next lecture. We need to do certain amount of behavioural change because we need to change the consumption behaviour of people. Same goes to the spatio-social level. So, you can see as I go higher and higher, so, as I go higher and higher involvement of people goes higher and higher in this particular context.

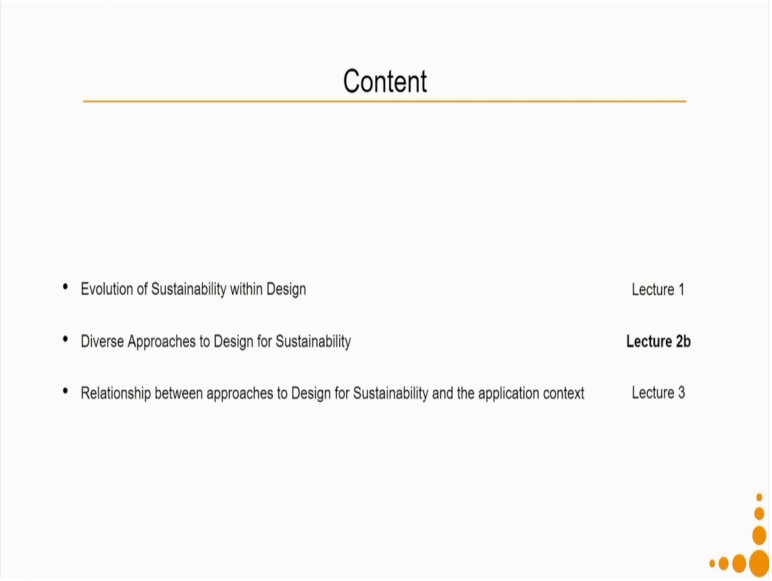
Next comes product design for base of the pyramid. Again, you can see this transgresses on the same three layers. So, I can go in all the three levels with increase in involvement of more and more people. As more and more people in are involved or as we try to do more and more impact on the consumption side, the whole system proceeds more towards systemic method. Why because we have to bring in more stakeholders.

(Refer Slide Time: 73:15)



So, the reading material for this lecture will remain the same as was from the previous lecture of this week.

(Refer Slide Time: 73:24)



In the next lecture, we will be talking about Diverse Approaches to Design for Sustainability which is a continuation of this.

Thank you.