Strategies for Sustainable Design
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Lecture 18
Low Environmental Impact

Hello, everyone. In this lecture we will talk about low impact design. So, how to exert low environmental impact on the environment is I think matter of concern for each one of us, how we can go about it.

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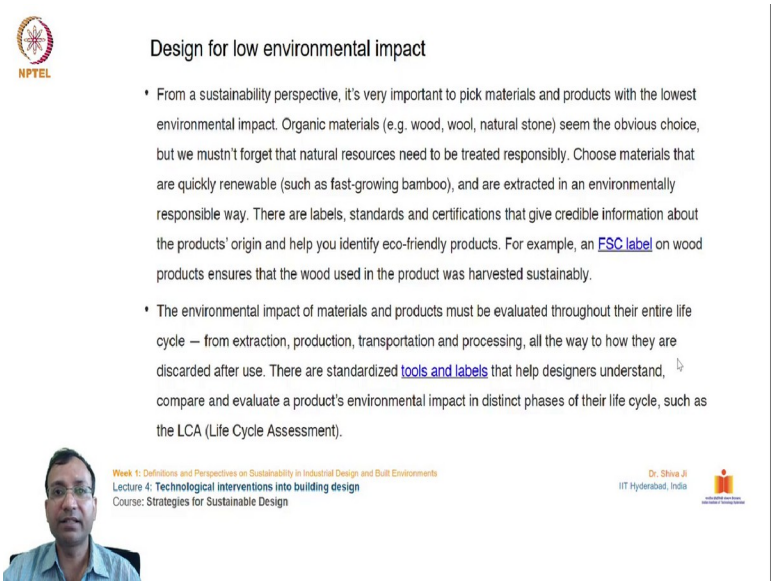

So, we will take some examples from different domains of design and we will discuss one by one. So, if you see, like a form of sustainability perspective, it is very important to pick materials and products with the lowest environmental impact. Organic materials, such as wood, wool, natural stone seem like an obvious choice for our selection.

But we must not forget that natural resources need to be treated responsibly. Choose materials that are quickly renewable, such as like fast growing bamboo that material can be re-grown at a very faster pace, and these are the materials which are extracted in the environmentally responsible. There are like a label, standards and certification that give credible information about the products origin and help you identify eco-friendly products.

For example, you may have seen these FSC labels on the wood related products, which ensure that the wood used in the product was harvested sustainably from managed forest. The environmental impact of materials and products must be evaluated throughout the entire lifecycle, from extraction, production, transportation and processing, all the way like how they are discarded after their use.

There are standard tools and labels that help designers understand and compare and evaluate a product's environmental impact in distinct phases of their lifecycle, such as the LCA. So LCA is one of the tools where we can analyze a particular product or a particular material like how it was used in this particular product.

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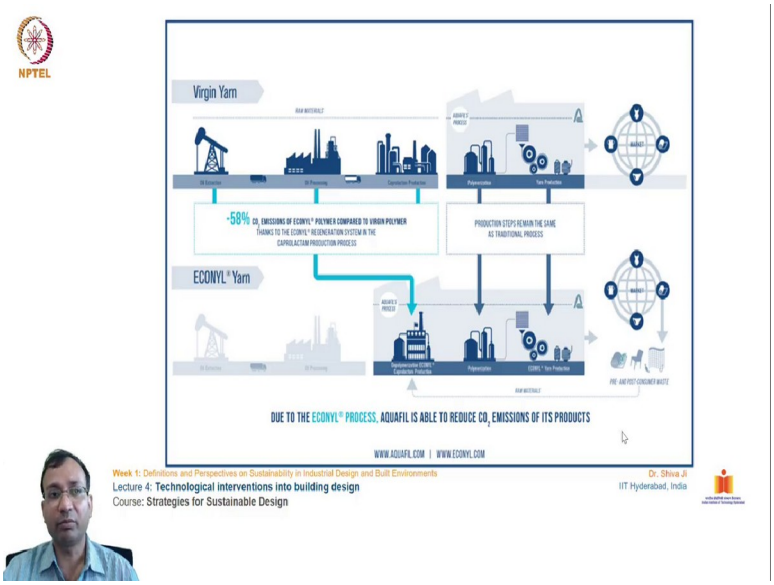

So, if you see, for example, I have taken this example of a commercial yarn, which is known as ECONYL. So, how it is improved for suitability to reduce the carbon emissions through its entire lifecycle. So you can see from the beginning, so, it extracts the raw material okay, and then, it goes for processing then it goes for the fabrication.

Then it goes for further processing, there are some chemical process and the product is made out of this process. And then it gets supplied to the market. So, this is actually a normal cycle of any product. And how about this ECONYL, so, how they have differentiated them self from any generic process in the beginning scale only.

So, in the first phases of the life cycle of their material they are a like a yarn. So, there only they adopted some strategies resulting into 58 percent saving of carbon dioxide emissions through this sourcing of this polymer compared to any other Virgin polymer. So, this uses this re-generation system in the Caprolactam production process.

So, from there they take this material for further processing. And in overall sense, they have tried to reduce the CO2 emissions. So, similarly, in the similar fashion, there are several companies and corporate sectors who are employing who are exploring, several ways for reducing carbon emission footprint.

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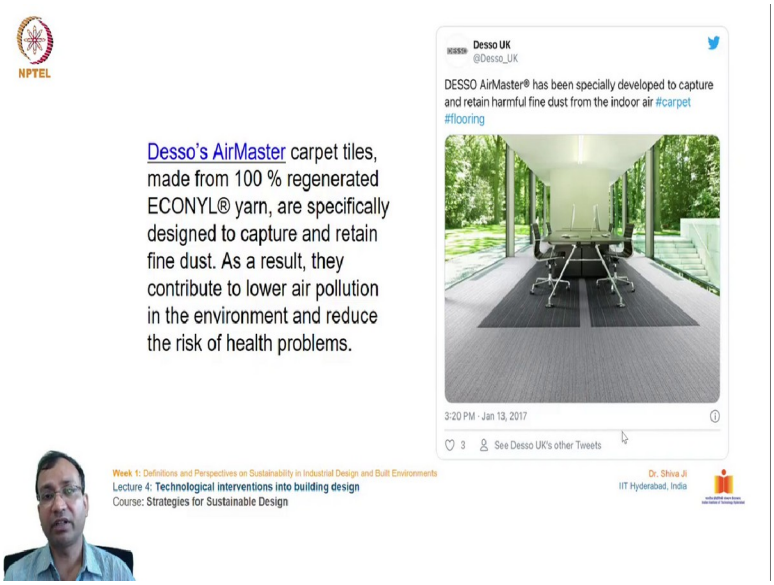

Like for example, if you see this carpet tiles over here in this picture. Okay, so, this is a Tweet from that company, which talks about like a Desso's AirMaster has been specially developed to capture and retain harmful fine dust from the indoor air carpet. So, we were talking about improving indoor air quality. So, there are IAQ indexing also.

So, how much of IAQ can be tolerated? And how much it reaches once we have to intervene to improve it? So, this carpet retains the fine dust which gets accumulated in the atmosphere over here and further which can be cleaned from the vacuum and all. So, this talks about like Desso's AirMaster carpet tiles made from like a 100 percent regenerated ECONYL Yarn, are specifically designed to capture and retain fine dust.

As the result, they contribute to lower air pollution in the environment and reduce the risk of health problems. So, this is conscious effort for at least solving one aspect of the overall sustainability issues which are happening in and around us. And this is how corporate, this is how the manufacturing sector, this is how different companies are contributing to the overall cost.

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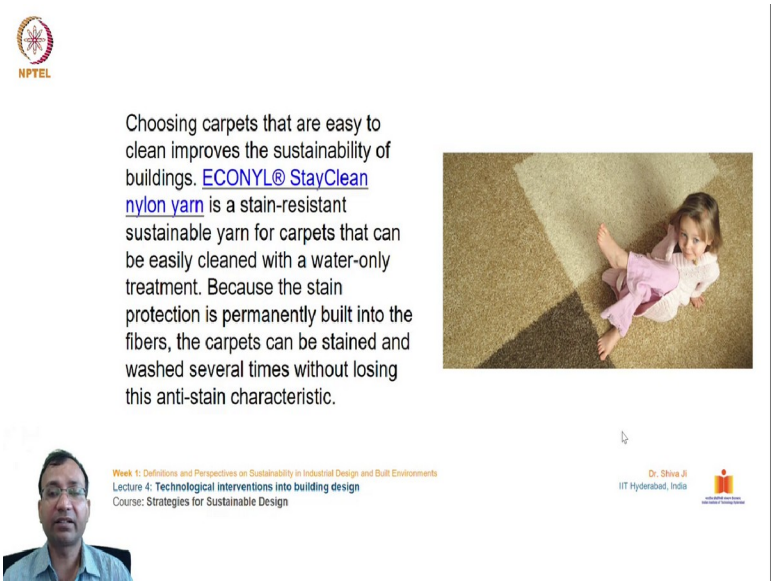

Another example from the same company, this piece of carpet over here is named as a ECONYL StayClean nylon yarn is a stain-resistant sustainable yarn for carpets that can be easily cleaned with a water-only treatment. Because the stain production is permanently built into the fibers, the carpet can be stained and washed several times without losing this anti-stain characteristics.

So, it reduces the need of the detergent. It reduces the several other like processes. So, it reduces the harmful uses of all the cleaning agents, the detergents and several other types of cleaning materials used for carpets. So, this compound is quoted on the fiber of this carpet itself, the yarns of this carpet itself, so that it can gets easily cleaned by using simple water.

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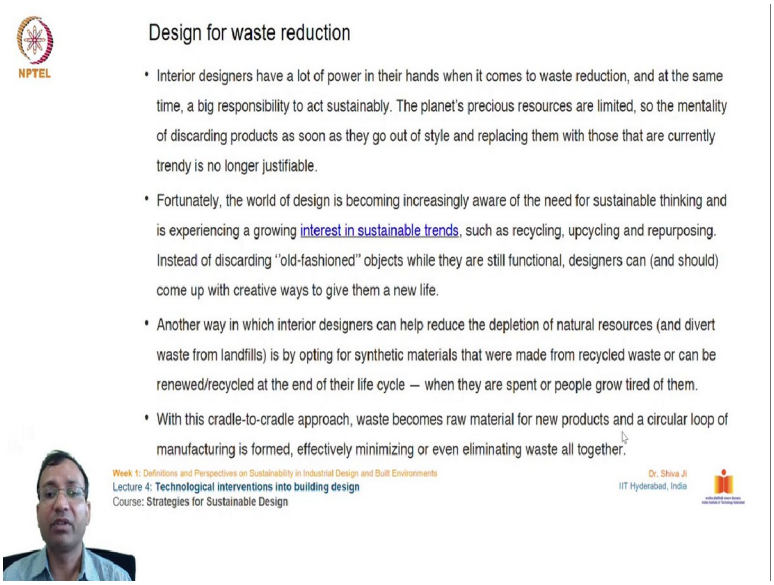

So, we saw several these type of efforts. So, how to go for waste reduction? So interior designers have a lot of power in their hands, the architects and the designers and engineers have a lot of opportunity in their hand, when it comes to waste reduction and at the same time, a big responsibility to act sustainably. The planet's precious resources are limited.

So the mentality of discarding products as soon as they go out of style and replacing them with those that are currently trendy is no longer justifiable. So we must keep on using as long as the material is going to last. Fortunately, the world of design is becoming increasingly aware of the need of sustainable thinking and is experiencing a growing interest in sustainable trends such as recycling, upcycling, and repurposing.

Instead of discarding old-fashioned objects, while they are still functional, designers can and should come up with creative ways to give them a new life. So, these are strategies which you can apply in your design processes.

The next one, another way in which interior designers can help reduce the completion of natural resources and divert waste from like landfills is by opting for synthetic materials that were made from recyclable waste or can be renewed/recycled at the end of their life cycle - when they are spent or people grow tired of them.

The last one with this cradle-to-cradle approach, waste becomes raw material for the new products and a circular loop of manufacturing is formed, effectively minimizing or even eliminating waste altogether. So, this is what we learned from here, from the strategy perspective, one should not discard material just for the sake of it, one should keep on using it for longer period of time for the complete longevity of that product, which was like envisioned with this product or even if it is once discarded, one should learn how to reuse them or repurpose them into different other applications.

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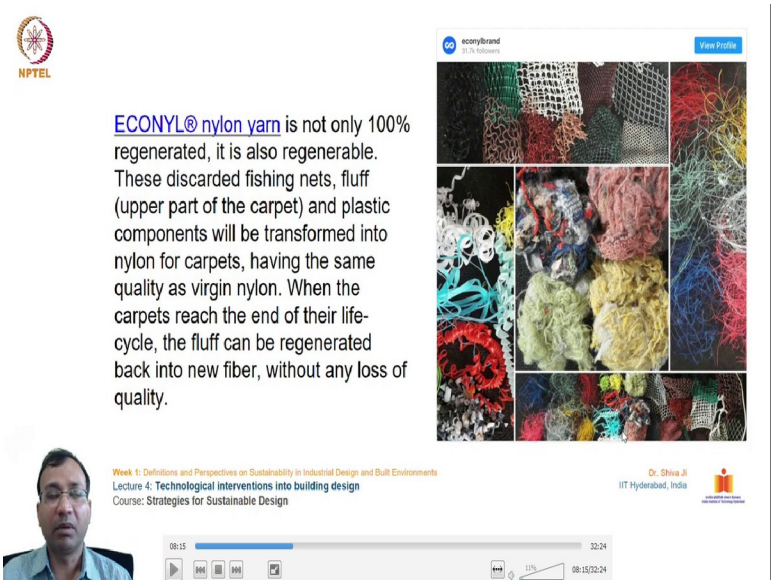

So further getting going back to that company, so here in this image if you see, ECONYL nylon yarn is not only like 100 percent regenerated, it is it is also re-generable. These discarded fishing nets you can see in this picture, okay, fluff in upper part of the carpet like a fluffy those bubbly those kind of a wooly that the portion of the carpets and the plastic components will be transformed into nylon for carpets, having the same quality as the Virgin nylon.

When the carpets reach the end of their lifecycle the fluff can be regenerated back into new fibers without any loss of quality. So, how beautiful is this, because most of these materials what we are seeing in this picture, they end up in the landfills, they end up into water bodies. And we have seen in the previous lecture how several aquatic animals are falling prey to such pieces of polymers and plastics.

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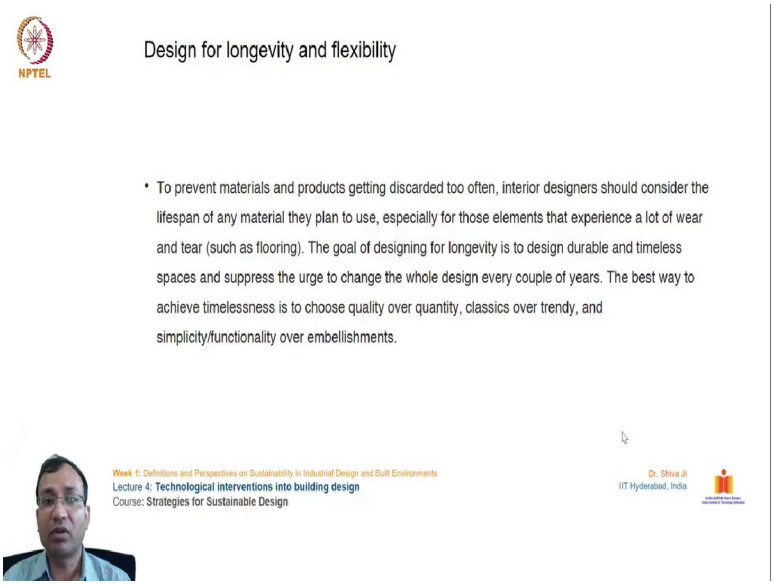

So design for longevity and designed for flexibility becomes one of the very important strategies to adopt for our design exercises, to prevent materials and products getting discarded too often. Interior designers or designers should consider the lifespan of any material they plan to use, specifically for those elements that experience a lot of wear and tear, such as like a flooring materials.

The goal of designing for longevity is to design durable and timeless spaces and suppress the urge to change the whole design every couple of years. The best way to achieve timelessness is to choose quality over quantity, classics over trendy and simplicity functionality over embellishments.

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Just see this picture. What comes to your mind? What is it? Well, it looks like a staircase. And it is a staircase.

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Let us see this picture. It is conscious effort to allow the vegetation to grow right beneath this staircase and that is why this has taken this shape and this forms. So you can see in this picture, right over here, this is how they have spread this material allowing the vegetation to grow comfortably right beneath it.

It allows water, it allows air, it allows it gives the space particularly to grow that grass which is right now growing beneath this material. So, it is conscious effort by the designer, you can see the detail over here like SPBR Arquitetos, so this is the formed from like a Brazil, they have used this idea in one of their projects, where they have integrated with the landscape design to have like a low impact and to allow the plants to grow right below them.

So with the aim of having as little impact on the environment and the ecosystem of the area as possible. So, this was approach they have adopted in this particular approach, which is really worth praising.

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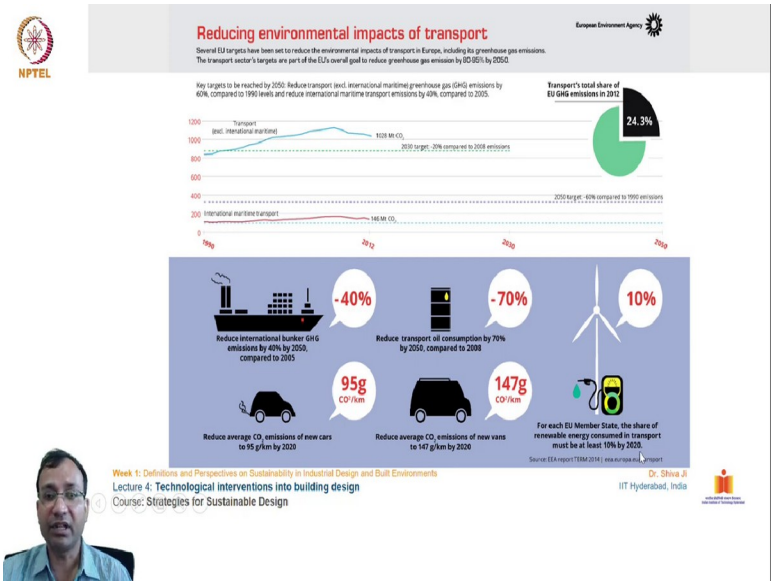

So how to like, if you see and if you analyze the scenario of reducing environmental impacts of transport. So, let us see, how much of, in the number, in the terms of the number it is causing this, so this data is sourced from like European Environmental Agency.

The several EU targets have been set to reduce the environmental impacts of transport in Europe, including its greenhouse gas emissions, the transport sector's target are part of the EU's overall goal to reduce greenhouse gas emissions by 80 percent to 95 percent by the year 2050.

So key targets to be reached by 2050, reduce transport exclusive international maritime greenhouse gases emission by 60 percent compared to 1990 level and reduce international maritime transport emission by 40 percent compared to 2005.

So, on the share part, if you see, the transport total share of EU's GHG emission in 2012 was 24.3 percent, almost one quarter of the total. So, that is like a too big, if we see for like a just one continent. On the, on this table, if you see like how it has evolved, how it has grown in the like recent times, so in the year 1990, in the year 2012 and how they are targeting the same level to maintain by year 2030 and 2050.

So, you can see over here like how the transport has grown significantly in this, this blue line over here. But they have this target to bring it back and that is how they have taken several steps to bring it back to this the stage which was there in the initial like years.

So if you see, like by reducing international bunker like greenhouse gas emissions by 40 percent by 2050 compared to 2050 levels, so the reduction of like a minus 40 percent. Okay, reducing like a transport oil consumption by 70 percent by 2050 compared to the year 2008, reduce, reduction of like almost like 70 percent and reduce average CO2 emission of new cars to like a 95 grams per like a square kilometer by 2020.

So, this is 95 grams of CO2 per square kilometer, per kilometer. And in this one, reduce average CO2 emission of new vans to 147 grams per kilometer by year 2020. So, here if you see this is like a reduction what they have target they have set is 147 grams CO2 emission per kilometer.

So, in overall, if you see, for each EU Member State, the share of renewable energy consumed in transport must be at least 10 percent by 2020. So, this is the target what they have set up for the EU countries.

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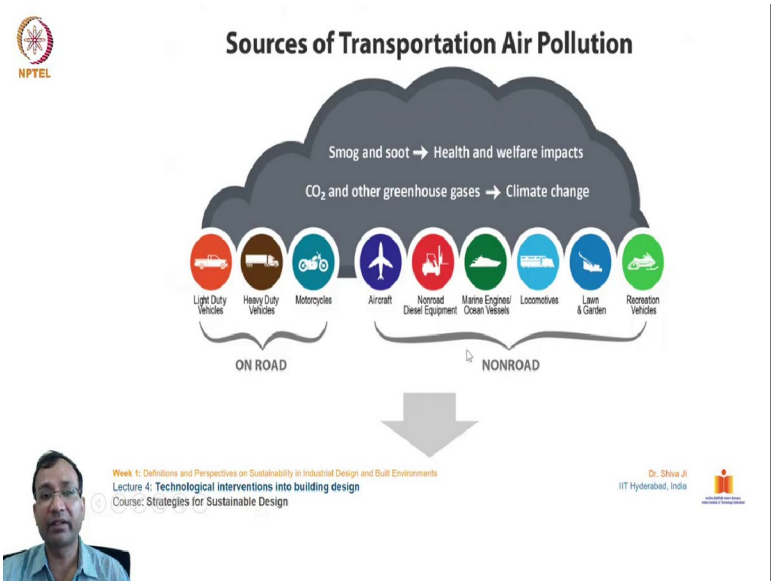

And these are the of course in the transportation sector when we are talking about these are the major contributors for the air pollution. So from smog to shoot to health and welfare, so smog and shoot has health and welfare impacts, CO2 and other greenhouse gases have climate change impacts on the overall sense.

So, these are the actually ones which we see generally on everyday life, we are also part of it on the regular basis from on the road, light duty vehicles, heavy duty vehicles, motorbikes, et cetera. And then we have a non-road other modes of transportation forms aircrafts and other off-road heavy equipment, marine vessels locomotives, trains, lawn and garden equipments also contribute to this, other recreational vehicles, et cetera.

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So, if you see what are the solutions possible for transportation sector to prevent air pollution? So, from emission reduction, emission reduction they can go for cleaner air and better a healthy atmosphere. So, what are those possible areas possibilities where strategic interventions can be made, is by using catalytic converters, well they have been like forced in our like Indian scenario also.

So, several years ago Government of India forced to adopt catalytic conversion converters in conjunction with unleaded gasoline and low sulfur levels, significantly reduced hydrocarbon and nitrogen oxide emissions.

The second one like a fuel is setting up like a fuel standards. So, these helped reduce exposure to pollutants like lead and benzene. Renewable fuels reduce CO2 emissions, for example a solar fold type, solar fold PV cells, et cetera. The third one if you see engine technologies, like computer controls, variable valve timing, multi-valve engines, turbo charging and gasoline direct injection improve fuel economy and reduce CO2 emissions.

The fourth one, transmission technologies a seven plus speed like a gears dual clutch transmission and continuously variable transmission CVTs improve like a fuel economy and reduced CO2 emissions. Diesel filters because diesel is one of the very harmful

hydrocarbons. So, this will reduce particulate matter from on-road and off-road diesel engines.

The next one alternative vehicle technology a plug-in electric vehicles and fuel cells, so these will result into like a zero tailpipe emissions. So there will there would not be any emission from like the car itself and better transportation planning and better transportation systems for passengers and freight reduce emissions and fuel is fuel uses.

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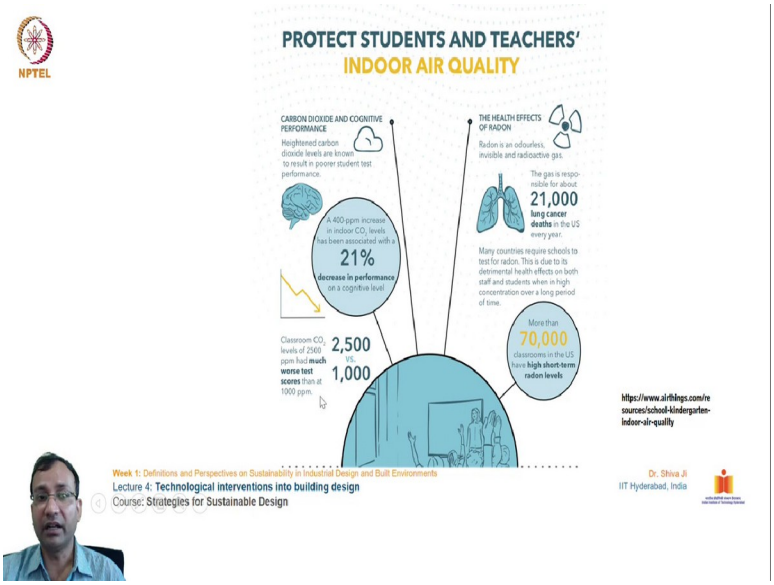

So let us see how to protect in an another scenario for example, school where students and teachers are there, how to improve the indoor air quality? So what to do and how to identify it? So obviously, wherever the humans and any like a living being will be there, there will be emission of CO2 and once CO2 has emitted at the large scale for school and once it is closed, so there will be a high concentration of CO2.

So heightened carbon dioxide levels are known to result in poorer student test performance. So this is a proven fact that the CO2 and concentration of CO2 results into the fatigue and the low level of consciousness in human brain. 400-ppm increase in indoor CO2 levels has been associated with the 21 percent decrease in performance on a cognitive level. So this is the actually one of the findings.

And if you see like a classroom CO2 levels of 2500-ppm had much worse test score than at 1000-ppm. So the moment it starts increasing from 1000-ppm to 500-ppm, there will be a significant difference observed. And other health effects of radon for example these kind of materials, so radon is an odourless invisible and radioactive gas. So the gas is actually responsible for about 21,000 lung cancer deaths in the U. S. alone every year.

Many countries require schools to test for radon. This is due to its detrimental health effects on both staff and students when in high concentration over a long period of time. So, this is one of the elements which, which we must take care of any such high concentration place where there are a number of people are participating. More than 70,000 classrooms in the U. S. have high short-term radon levels.

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So indoor air quality, affects asthma sufferers also, the people with some special health condition. So maintaining the right humidity and temperature levels to prevent mold formation is beneficial for all, especially asthma sufferers. Toxins and chemicals like a TVOCs come from an area of everyday items including paints and varnishes, wax and cosmetics, so and cleaning and other hobby products, cooking.

So, you may be wondering where are these, these, these compounds and these toxins and these chemicals are coming from, in any given at indoor air, indoor air placed? So, these

are common material and substances which we generally use in our everyday life and these are the sources of search toxins, which are emanating from them all the time or while on the uses.

So, total TVOCs volatile organic compounds can cause serious health effects in both the short and long-term. Health effects vary from minor eye, nose and throat irritations all the way to liver and kidney damage or cancer depending upon the level of the exposure. So see the extent of it with the smaller doses to the high doses and the persistent exposure over a long period of time can cause severe health issues.

What is the solution? Well continuously monitoring the indoor air quality to ensure that students and teachers have the best of like a cognitive performance and healthy air inside the spaces. And ventilation, ventilation is one of the strategic methods which is very effective and almost free of cost with which we can make, with which even we can bring changes in like a such practices.

So the ample ventilation in schools and spaces in the kindergarteners can help to reduce the concentration of radon CO2, TVOCs and another asthma triggers. Maintaining healthy indoor air quality can reduce sick leave costs and increase productivity and test scores. And in the overall long-term scenario also it will save us, it will save the occupants from severe diseases.

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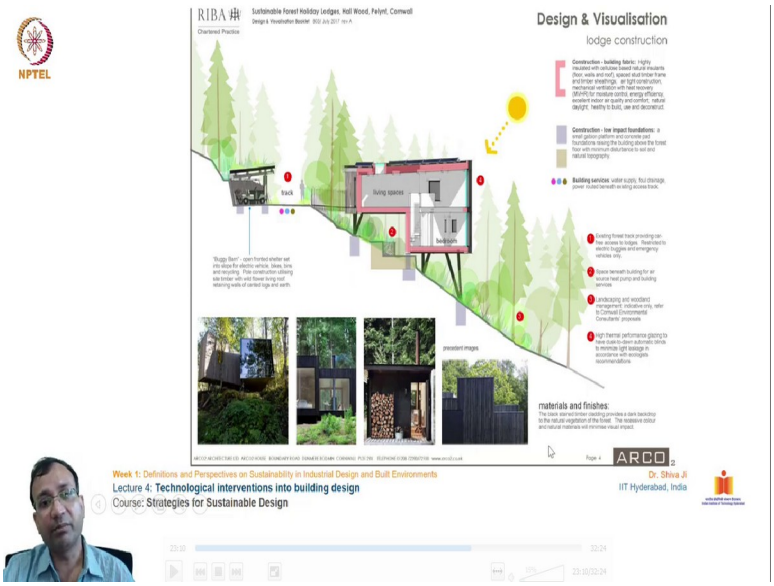

So, how this visualisations can be done in any given space, this is one case example I have taken, this is from Cornwell, okay. So here forest holiday lodge was designed, without causing much damage to the landscape. If you see over here from the foundation itself, okay, so how it talks let us go through the detail of this project over here.

So, you can see the Buggy Barn created right next to this road over here. This open fronted shelter sets into slope for electric vehicles, bikes, bins and recycling. Pole construction utilizing the side timber with wild flower living roof, retaining walls of like a canted locks and earth.

So, using the materials which are easily available on the site and that to in the minimal quantity and keeping it like a semi open, so that it is not completely closed and reducing the consumption of the material. And on the point 2, if you see, the space beneath the building is open for air circulation and open for growing of the grass and bushes and things, as well as utilizing it for a smaller area for creating heat pump and a cooling capacity and things like that.

In the third point, if you see over here, landscaping and woodland management indicates the environmental compliance with the local laws of this place. And the fourth one, if you

see, like a high thermal performance glazing to have dusk-to-dawn automatic blinds to minimize light leakage in the accordance with ecologists recommendations.

So, the uses of that technological advancement of the materials is also used to minimize the losses of the energy from indoor to the outdoor. So, with this if you see, the construction fabric is shown in this pink color over here. So, this is the construction fabric.

Highly insulated with cellulose based natural insulators, like a floor walls and in the roofing, space stud timber frame and timber sheathing, air tight construction, mechanical ventilation with heat recovery, MVHR and for moisture control, energy efficiency, excellent indoor air quality and comfort, natural daylight healthy to build, use and deconstruct.

This purple color lights you can see over here. So, this indicates low impact foundation. So, a small gabion platform and concrete pad foundation raising from the building above the forest floor with minimum disturbance to the soil and the natural topography. So that there is no much damage caused to the land form, the topography over here.

So, this is kind of effort taken into designing such a building. You can see the pictures over here, how easily this building is sitting over here in this natural setting without causing much damage.

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Another, for example, product as simple as a chair. How this company, Knoll has taken responsible of fabricating like a chair in the today's context, okay. And they have also complying with the rating system such as LEED and other like ISO standards also. So, what are these?

They are assembling this product and for the LEED, like a gold compliance and ISO 14001 Certified Lubin manufacturing facility using a clean technology. Such as no ozone-destroying CFCs, they are using in the fabrication of this chair. Hot melt adhesive processes is 99 percent VOC-free, volatile organic compounds free. Metal powder coating processes is 99 percent VOC-free.

Chrome processes meet Knoll design for the environment SMaRT sale for the public health and environment and BIFMA LEVEL 3 requirements. Returnable packaging is used for chair component parts. So, the packaging material for this product can be returned and can be reused.

So, this is one the very advanced and very sensitive consideration and strategy because much of waste today is caused by the packaging material itself. 100 percent of the electricity used at the site is offset by the wind energy. So they are utilizing wind energy for this manufacturing facility.

So you can see as the component wise over here like recycled and recyclable content, in the main frame of this chair. Finishes, if you see, like a powder coated paint and chrome processes meet the Knoll design for the environmental guidelines. Here if you see like the structural components, it is constructed using like a minimal materials and polyvinyl chloride PVC-free like materials.

In the environmental fabrics available with 20 plus environmental fabrics from KnollTextiles, which are GREENGUARD certified and can be cleaned with low environmental impact fluids, including GS-37 certified products. And in the seat foam here you can see, 7 percent bio based content on an average is also used in this the seat foam over here.

So, this is actually a conscious effort. So first of all, if you see this design, it has the minimal number of components and minimal quantity of material is used in the fabrication of this chair. So, in an overall sense, there is a conscious effort from these companies. So, this is an good example, a good case study for you to understand like how these strategies, how the different set strategies can be adopted for coming up with this sustainable solutions.

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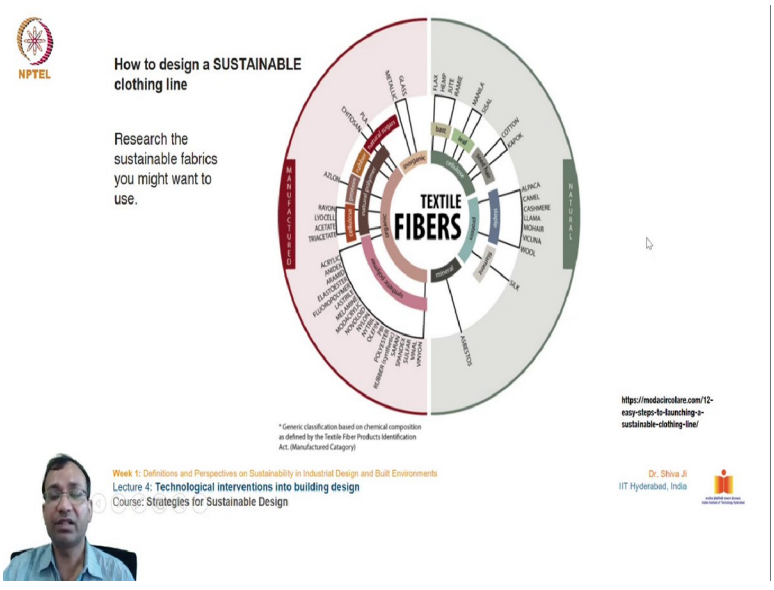

How to source like a responsible fabric? How to source like a responsible textile fabric for our uses? So, I have taken this example, if you see, the types of textiles fabrics available, so, they range from like organic to inorganic to cellulose based to like a protein based to even like a mineral base.

So, out of these there are several, like a synthetic polymers, there are natural polymers, there are some other highly like a cellulose based directly like a yarns or fabrics taken from like a bast, leaf, seed, et cetera. So, you can see, how responsibly you can take. So, the left half is manufactured yarns, the right half is actually belongs to naturally sourced yarns. So, we can always have this option of choosing like an responsible fiber for our requirements in such cases.

So, you can see over here like a cellulose based, the one example which we saw in the international case examples, so, that entire like a 5 meter structure was actually fabricated out of like a natural like polymers, like cellulose and pectin, et cetera.

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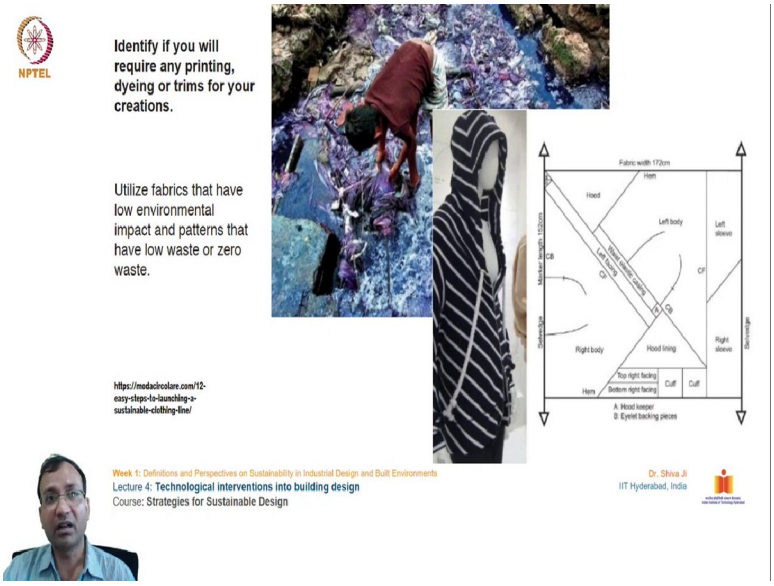

And we must be able to identify if you are willing to have lesser impacts in terms of toxic effluents and toxic chemicals, as you can see in this picture on the left side, it is a boy actually trying to take out a piece of maybe a garment from a heavily toxic, like a heavily

polluted maybe industrial like effluent like a outside area where there is a high concentration of hazardous toxins.

So a direct exposure with the skin and other like body parts in such like a conditions can have serious consequences on the human body. So how we can responsibly select our like a fabrics and yarns from like this circle and how we can maximize the uses of it. You can see on this, sketch on the right side over here.

How a piece of like a cloth can be utilized completely for taking the maximum benefit out of it? So, utilizing fabric that have low environmental impact and patterns that have low waste or zero waste.

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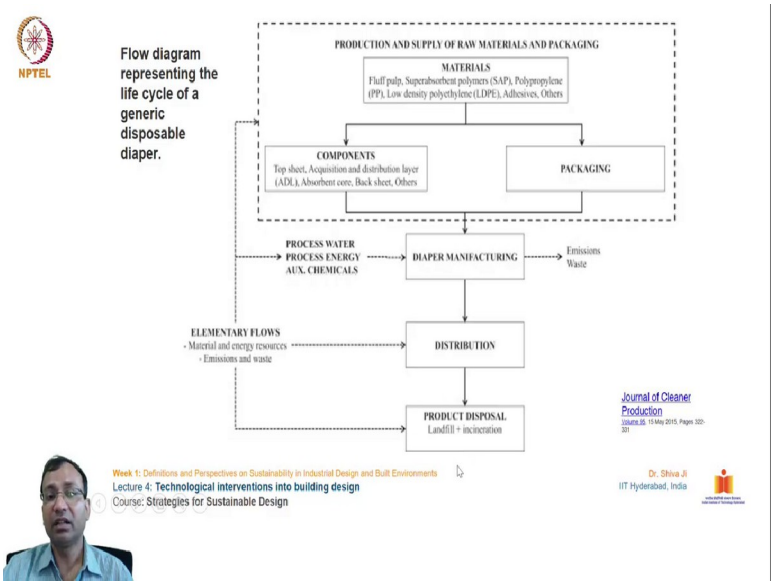

So this flow diagram represents the life cycle of a generic disposable diaper. So it is a baby diaper we are talking about over here, we may have seen it, I think every household uses this product and it is a very functional and highly usable product in the recent times. But what are the impacts of this simple material which is used by innocent babies. So, let us have a look of this.

So, the production and supply of raw materials and packaging. So, the materials such as like a fluff pulp, Superabsorbent polymer like ASAP, polypropylene like PP, low-density

polyethylene, LDPE, adhesives and others are forming the bulk of this material used for making of diapers.

And on the component part, like the top sheet is there, acquisition and distribution layer ADL, absorbent core which absorbs the liquid part, the back sheet for the cover and other components and then there is packing. So, then happens this manufacturing and then there are like emissions and waste it goes further distribution.

And then the product is used, is goes for incineration or lands up in the landfills. So this is the end of the life for this product. So, is there any way this can be improved? Well, I will leave it for your own understanding and exploration.

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So here if you see, average products available on European market in recent years have been modelled and evaluated from cradle to grave. Results point out the importance of materials in the definition of the environmental profile of this product. These are followed by the end of life for some impact categories, while the contribution of manufacturing, packaging and transport to the overall LCA results seem of like a minor relevance.

Significant environmental improvements at European level have been achieved in the recent years through the design of lighter products and the introduction of super

absorbent polymers. Careful selection and use of materials at the design stage could allow lifecycle impacts or products to be further decreased, while ensuring that human health and environmental risks are controlled and that functionality and performance requirements fulfilled.

Indeed, potential malfunctioning of products would result in increasing consumption. Resource efficiency is also important at the manufacturing level of optimize the demand for materials and limit waste production. Special forms of treatment at the end of life stage of the product could instead require significant structural changes of the waste management system.

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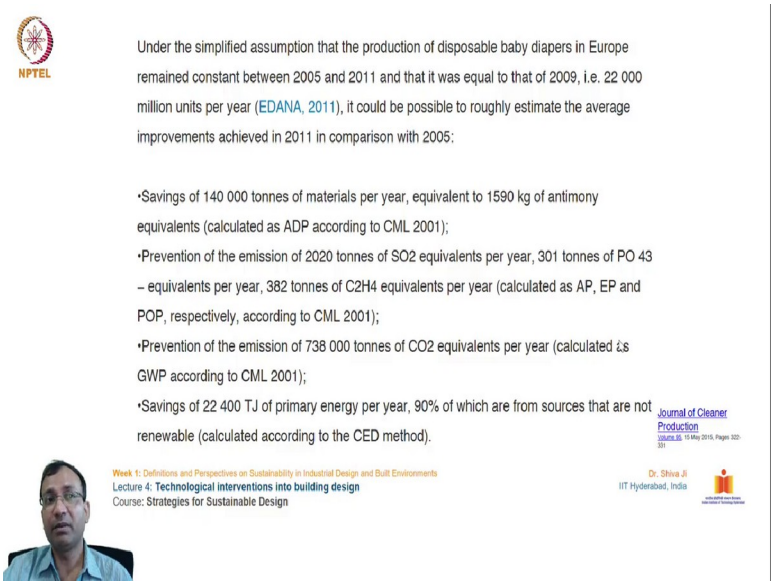

Under the simplified assumption that the production of disposable baby diapers in Europe remained constant between 2005 and 2011 and that it was equal to that of 2009 that is 22,000 million units per year. It could be possible to roughly estimate the average improvements achieved in year 2011 in comparison with 2005.

Savings of 140,000 tonnes of materials per year, equivalent to 1590 kg of antimony equivalents calculated as ADP according to CML 2001. Prevention of the emission of 2020 tonnes of like a SO2 equivalents per year, 301 tonnes of PO 43 equivalents per year, 382 tonnes of C2H4 equivalents per year.

And prevention of the emission of 738,000 tonnes of CO2 equivalents per year calculated as GWP according to CML 2001. Savings of 22400 TJ of primary energy per year, 90 percent of which are from sources that re not renewable calculated according to the CED method. So, these are benefits you can see which has been kind of achieved in a shorter span of time between like a 6 years of period. With this, I would like to bring to the end of this lecture. Thank you all.