Life Cycle Assessment
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Lecture – 03
LCA and Sustainability

Welcome back. We will look at the third module for the first week.

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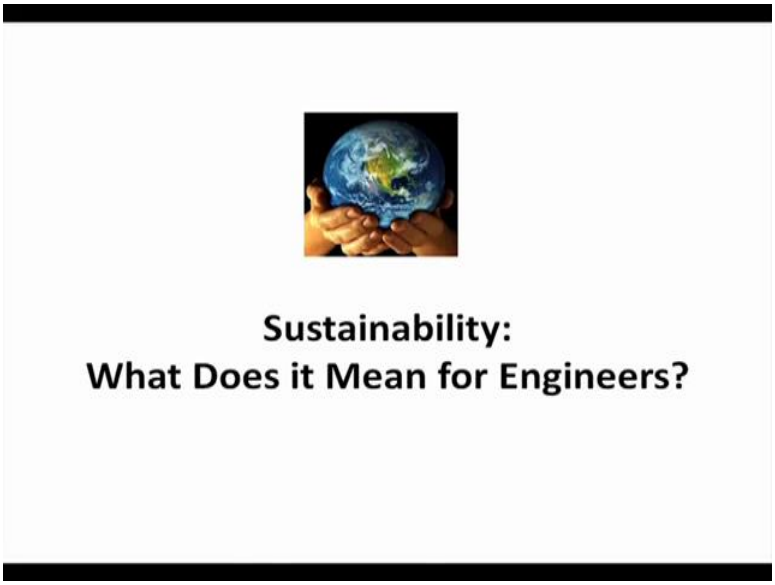

If you remember in the first two modules we had a brief overview of what is this whole concept about, what this course will tell, I will give you a brief overview of the material demand, the energy demand, the water usage and all that. Now we will look at some of the more; this is again we as if you have looked at the course information this week the whole first week is focus mostly on introduction and giving you some background material so that we can go into a detail lifecycle analysis exercise later on.

So, as you know for whole this the big picture concept is actually what is defined as sustainability. Many times we use this words these days sustainability is a highly used and many times I tell that it is highly abused term today you hear sustainability being used in all different ours different aspects. And some places people probably do not even know what sustainability is all about and, but they still use that word.

So, here in this particular segment, in the third module for the first week we will look at it what is it need for engineers. And we will come back to that again in later weeks, but kind of big what is it as an engineer what does it mean, what is the meaning of sustainability, what we are talking about.

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So, very basic is what is sustainability? What actually is sustainability? So, the sustainability means if you are meeting society's present needs without compromising the ability of future generations. So, me and you using our own needs say if you want to make an Smartphone, but you there are different types of Smartphone's out there. So, we can still make our own Smartphone, but as you know the Smartphone uses lots and lots of metals, lots of lots of rare earth metals which is from the periodic table, and they the quantity of those are limited.

So, how our say grandchildren, our great grandchildren can still have something similar to Smartphone probably they have better technology now at out there. So, they should be able to meet their needs. So, we should use the use the material because whatever is the material a represents in the mother earth has a finite quantity, they cannot be created; only God- if you believe in God only God created he can create or destroy the material as we say.

But whatever is there on periodic table we can change its form, we can make it form to a usable from to non usable form. So, we should not make it in a non usable form that will

be not sustainable. So, we should keep it in the usable form so that it in the future generation should be able to use it as well. This was like a big overview of sustainability. And I started concept is started in date is you can see; the definition comes from the Brundtland Commission 1987 which was a United Nations relation say pointed commission.

And they wanted to come up with this the concept of sustainability, because as our population was is increasing our water demand is going up, our energy demand is going up, our resource demand is going up, and everybody wants to be more have a better life style so that does also means that there is lot of demand on the resource. So, how to make use of this resource without compromising the ability of future generation to do that as well?

And as you know we humans are integral part of the natural world and the nature must be preserved. So, that is another concept in terms of we have to preserve the nature so that our future generation again can enjoy.

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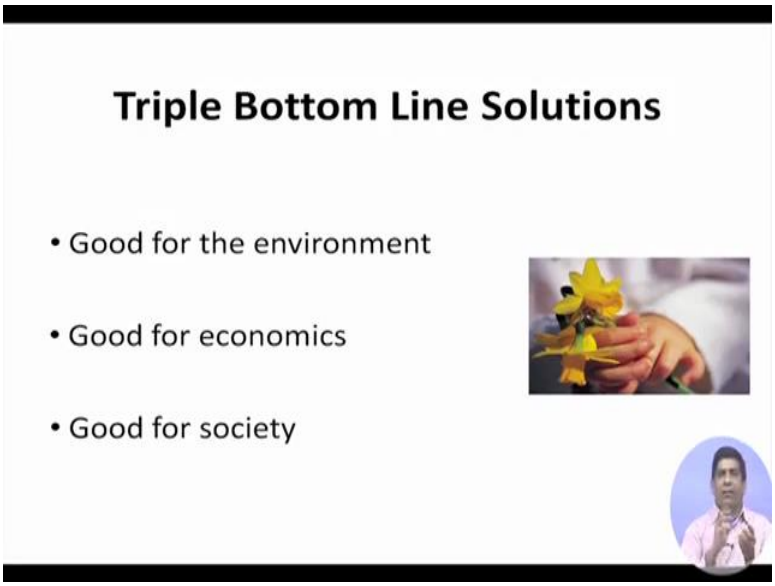

So, what does in terms of in terms of the solution? So, sustainability requires you to have met the present need without compromising the future generation. So, how we can approach it? So, what the approach has been suggested is also called as triple bottom line solutions. When we say triple bottom line solutions; we have to design something which is good for the environment, we should not pollute the environment too much, it should

be good for economics, the economics has to work, it has to be cost effective, effects to costly there is something you designed which is very very good for the environment. But at the same time it is so much costly that all the fraction of the population can afforded.

So, then there is no point making those products, because the product will be there but unless lots and lots of people can use it, because they can afford it then there would be no real impact in the environment. People will still be using the product which is not that environmental friendly. So, it should be good for economics and at the same time it should be good for the company as well. The company should be able to make profit out of that. So, because the profit is essential, so they need to make profit so that they can invest back into the economic.

And it should be good for the society. So, it should be good for the society and that is it should not have too much of lecture, as child labour issues or human rights issues involved. So, those things are also there. So, that is why it is called Triple Bottom Line. So, there are three arms like three pillars: one is environment, other is economics, and third is social that is society. So, these three pillars when it has when you hear about sustainability people will say sustainability has three pillars or sustainability has three legs. So, those legs are environment, economics and society. In this course we focus most on the environment aspect bit will touch a little bit on economic and society as well.

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So, same thing expressed in different way. You can have environmental protection and resource conservation that is your part of the environmental aspect. Then you have economic prosperity and continuity, which is your economic aspect; and then social wellbeing and equity, so that is your social aspect. So, these three together is what is our sustainability aspect.

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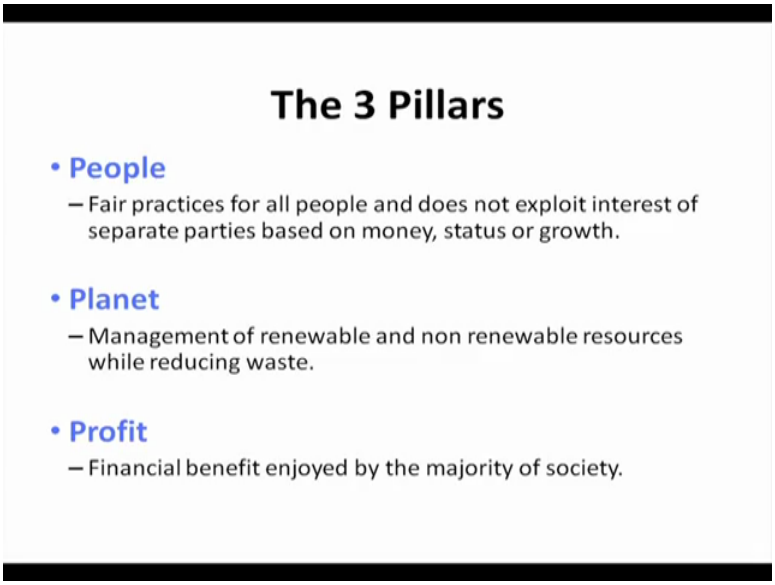

So, again three pillars: people: people will be what social that is the social aspect, that is a fair practice for all people, does not exploit interest of separate parties, based on money status or growth, it should not happen that all the high wastage sent way sent to poor countries or all the electronic ways been dumped in Asia or Africa from the European as well as American countries that is not fair. So, that is why we need to take care of those issues.

Then planet its environmental aspect: we have to manage the renewable and non renewable resources while reducing waste. So, make it more effective. As you can see that happening already, if you remember say 10 years ago or 15 years ago when you had a desktop- a desktop is to so heavy that you need to at least have two people; one people carrying the monitor and one people carrying the CPU. And same thing with laptops: initial laptops are so heavy now the laptops are getting lighter and lighter you can carry from probably three laptops together in your hand if you have too. Same thing with the

desktop: you can one person can handle the entire desktop now because things are becoming lighter we are becoming more resource efficient.

And we are also going to towards non renewable energy, like we are going for; sorry renewable energy we are using less and less of non renewable energy. And at the same time we were trying to reduce the waste that is been produced. And profit has to be made, financial benefit has to be made and then the benefit has to share with the society; it is not that few people becoming richer and richer the rest of the country rest of the society getting poor and poor that is not sustain as well.

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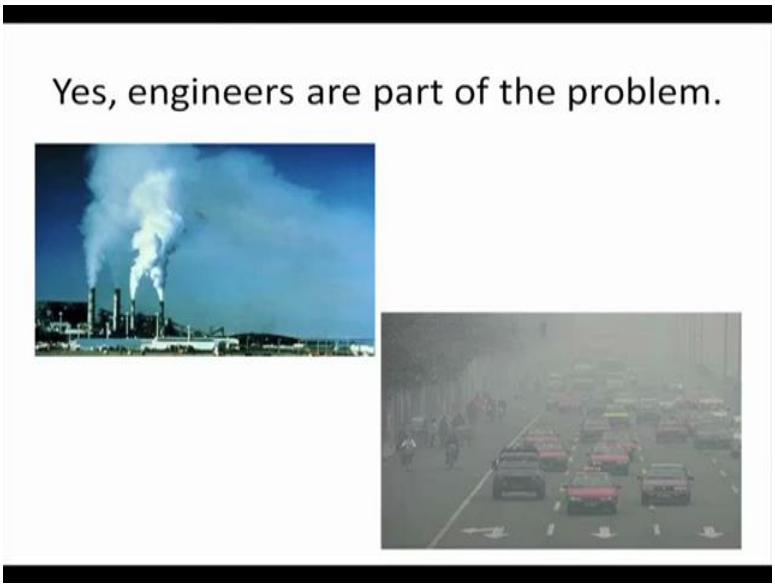

So, the many times we engineers get the blame being the part of the problem, because we have created a specially after second world war there has been so much with industry revaluation, so many new products coming up, so many new organic chemicals being centralized, and many of those chemicals many of those products have environmental implications. So they are what we call as anthropogenic they are not stop they are not biogenic; biogenic is what is already present in the environment. So, anything biogenic Mother Nature has a mechanism to deal with that kind of material, because it is biogenic. There is already a system in place where you make of lots and lots these anthropogenic products or chemicals and other things and you dump it into the environment then our mother earth does not know how to handle it, and it becomes a problem.

So, one in call console fuel and then you produce lot of smoke which leads to air pollution issues, burning stuff and you are pollution vehicles. Now, the winter is coming, as well see in the many parts of the world during the winter months in especially Delhi Beijing they get lots of news where you see that the air pollution becomes a major problem.

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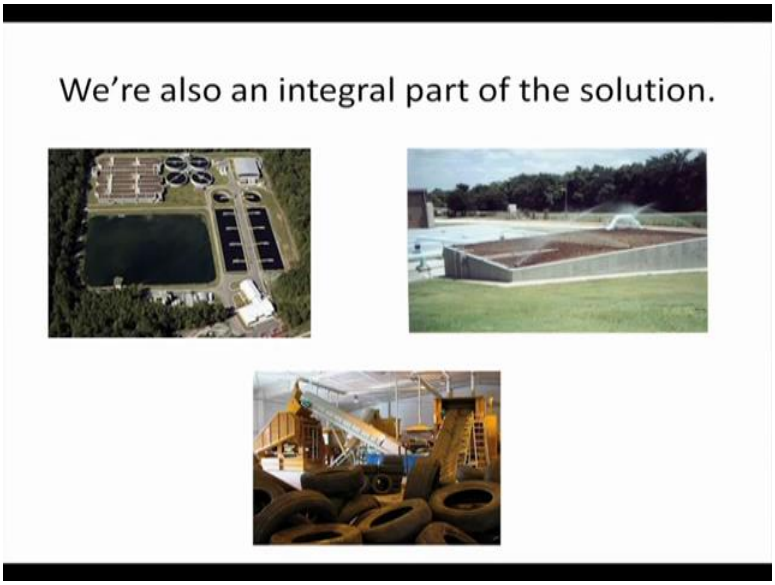

But at the same time we are also part of the solution. We are the people who design the water treatment plant, we design the waste water treatment plant, we are trying to recycle the product, we have trying to design the recycling facility, we are also trying to design electric car, more efficient cars. So, engineers are also part of the solutions. So, we need to be in making things and much environmental friendly way now as we have being doing earlier.

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But, at the same time we cannot just like, although we do not have to feel bad that we creating all these environmental issues; we are creating solutions to those environmental issues as well. As the society will develop these environmental issues too it get created. The bottom line is that we need to do it in a responsible way. We should do it in a responsible way so that the things get done is ways it does not harm the environment. Whenever the economic prosperity is there, whenever new factor is gets building there will be some environmental implication, but we need to manage the environmental implications.

So, some other example as you can see here electrical car, hybrid cars, solar panel lots of solar panel recycle as fall which is also being used in India. Plastic to road, lot of plastic to road is being done in India as well.

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So, lots of things are being made; I mean solar panel, win power. So, we are trying to remove this fossil fuel based energy to renewable energy. And some countries especially Western European countries have much higher, India also trying to develop lot of work in this area. So, as an engineer we are also part of the problem; we are also part of the solution. So, we need to design things in a in a better way.

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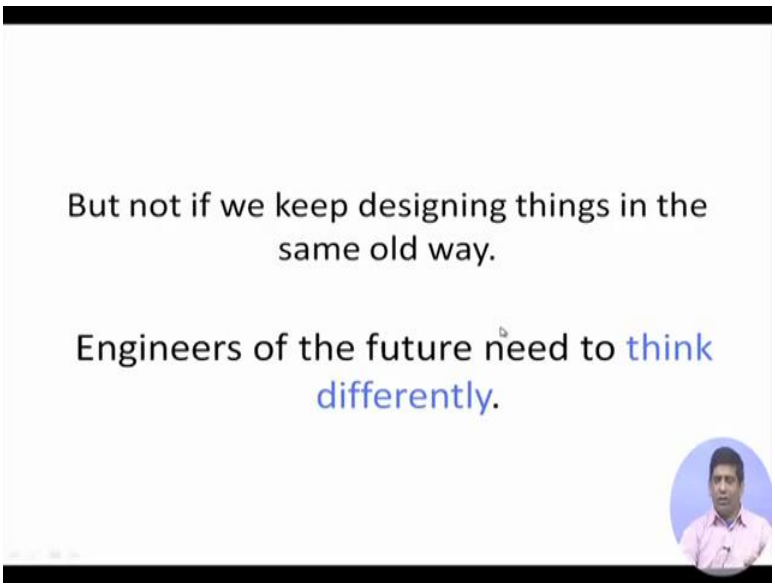

So, when you we cannot keep design things in same old way. Whatever the pictures you saw where some of the newer initiative over last 10 years 20 years may be last two

decades or two and half decades, so things are moving towards more sustainable stump, but again many of our design of products, processes are still turn in a old way. We need to start moving. So, being engineer of the future as probably you are you needed to think differently. Now you need to think differently when you try to design some stuff. Now, what you need do think differently?

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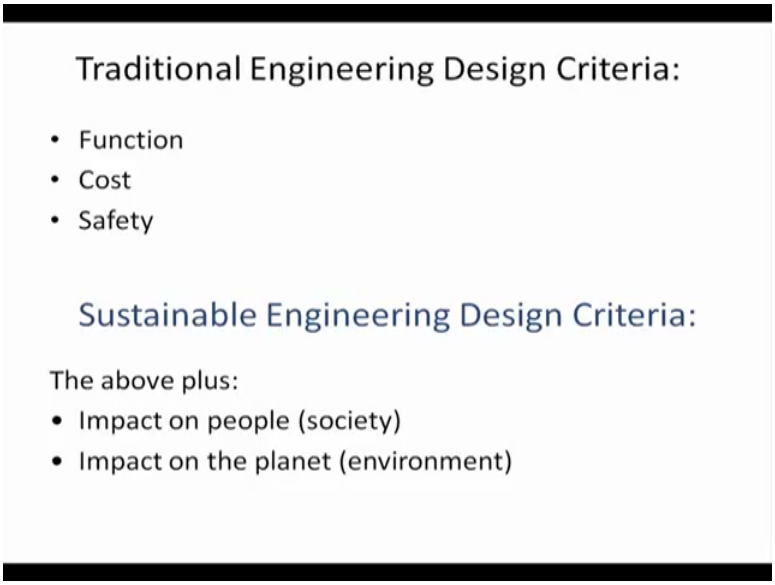

The traditional engineering design criteria are function, cost and safety. As you know function is very important. If you design, if you design a product it has to perform that function. If it is come up with the design product which does not perform that function it is of no use. Say if you want to make, say even if the water bottle if you want to design a water bottle and the water bottle cannot hold the water properly if it is not robust and that it gets broken down very quickly nobody is going to use that.

So, similarly any product you make should be able to perform its function, its intended function- it should be strong enough, it should do function. Should not be too costly; if it becomes too costly, it cannot goes out of the affordability charge and then it has to be safe. So, these things are what have been the driving forces behind any design criteria. You look at any of your design criteria whether you are a civil engineer, chemical engineer, mechanical engineer, electrical engineer, these are the three basic criteria that you do- function, cost and safety.

Now we need to add some more criteria to become it more what we know is sustainable engineering. So, sustainable engineering design criteria we need to have this three from the top which is has to be there plus we need to look at what is the impact on the environment, how much pollution it will create, how much while making it as well as while it is being used, what will happen to the product when it is not being used any more, when it is thrown into a waste collection system, can it be composed it, can it be easily recycle. So, we need to start having those concepts in there as well, and impact on people.

So, like what is the impact on people are we are using the like a human rights relation or child labour issues those things and other whether in general it is good for the society. So, these criteria have to be built-in in addition to the first three criteria's we talked about top. Now these two criteria need to blended with these criteria to come up with a better design.

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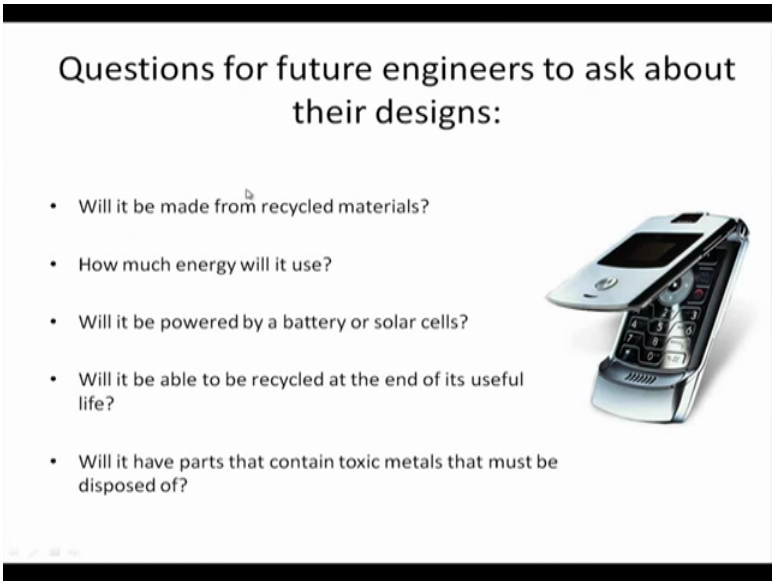

Now questions: what you try to do that what are the questions you need to ask about any design you do. Number one could be; will it be made for recycled material? Again remember that it has to perform its function, so you cannot lower the quality of the product by making it environmental friendly, you have to keep the quality of the product in tag, but at the same time you have to look at how to have less environment harm. Can it be made from recycle material? How much energy will it use? Can we make it more

energy efficient, which you see already in things of moving earlier, you would have like things are becoming more energy efficient you see all those energy star. If you buy new refrigerators, new TVs and other stuffs they come up with energy star this is more its say it consumes this much less energy and as compares to the previous product in that category.

Can it be powered by a battery or solar cell? Can we use that? Will it be able to recycle at the end of its useful life? Can we recycle that? And does it have any toxic material present? If it toxic material is present can we get those toxic materials by using some other material which is less toxic or possibly be nontoxic at all. And like what will happen if it is a toxic material how to better manage it when it goes to the disposal strain, what could be the way to manage the material.

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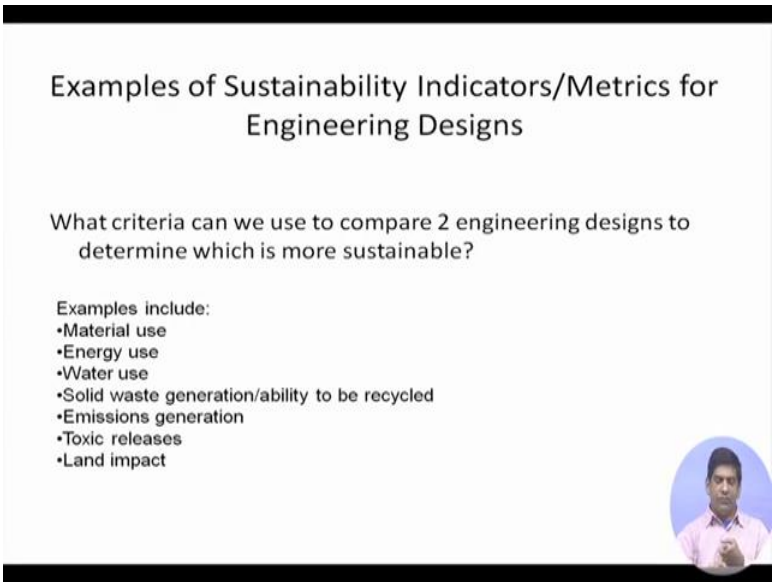

So, there are sustainability indicators and metrics for engineering designs. And there are what criteria can we use to compare two engineering designs to determine which is more sustainable. So, there are different some examples are here, like a material use, energy use, water use, solid waste generation, ability to be recycled, emission generation, toxic release, land impact, so this list can go on and on.

So, what we do as part of the life cycle analysis is we try to quantify all these different parameters that you see over here. So, these parameters we are trying to quantify as part

of LCA exercise which you will see when you go to the week 2; I will show you several examples of ways done and you will see that in more detail.

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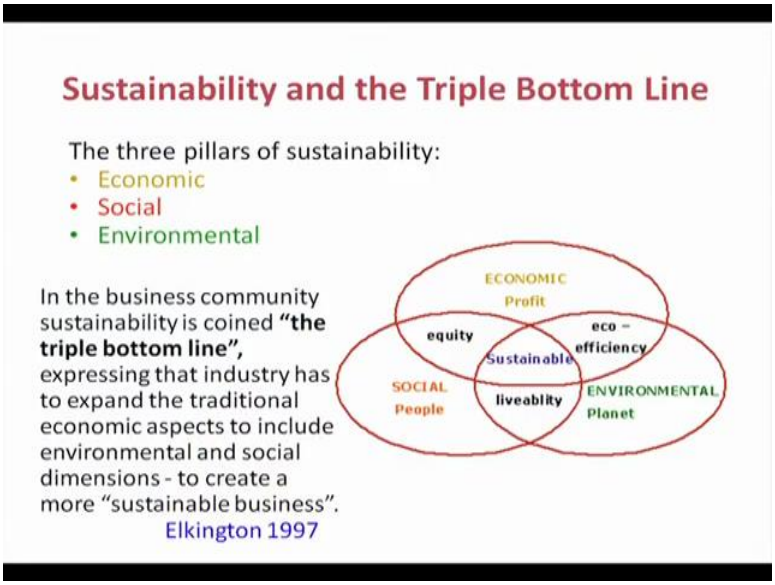

So, kind of summarise for the last 4-5 minutes that have been talking about. The three pillars of sustainability: economic, social, environmental. In economic is all looking for profit; we are looking at the profit on that side, social we are trying we are worried about the people, environmental we are worried about the planet. So, where this three; this is a wend diagram as you probably know. Where we have these three wend diagrams are meeting together is what is known as sustainable.

So, that is solution with comes under this particular area is our sustainable solution. Anything over here this equity it has overlaps profit and people, anything over here is eco efficiency; economical it is good, environmentally also it is good. And anything at the below social environmental is liveability. So, it is good for environmental, it is good for social, so it is good. But anything which will really work taking all three into account is our sustainable.

So, in the business community sustainability point the three bottom lines: express in the industry has to expand the traditional economic aspect to in between corporate, environmental, and social dimensions to create a more and sustainable business. So, that is what it is.

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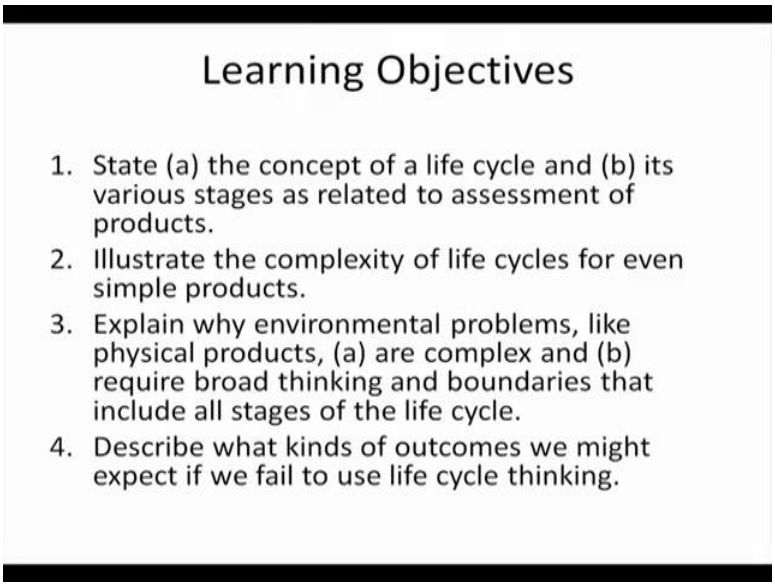

So, based on that so far; so in terms of again since we are kind of in the middle of the week I wanted to reemphasize on what is the learning objective of this particular course and also for this particular week: is we need to look at what is the concept of life cycle, that is what am trying to explain. And what are the different various stages related to assessment of the product. As I gave you example like just a before the different parameters we need to look at. What we have to look at the complexity of the lifecycle? How complex is life cycle even for simple products. So, I will give you some samples and you will see that.

Explain why environmental problems like physical products are complex and they require and require broad thinking and boundary that include all stages of lifecycle. And also we will look at what kind of outcomes we might expect if we fail to use the life cycle thinking. So, this is kind of the learning object will be picture learning object out say for this particular course. So, again the concept I can explain to you like what is the sustainability; now will look at why LCA.

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As the sustainability definition told us what we want is we want to meet needs of the present without compromising the ability to meet future needs. So, whenever you try to do that there will be some obstacles, there will be some corporate and social pressure, there will some government and regulatory barrier, there would be uncertain objectives goals things are not clear, there is no lack of tools; for example you want to say I come up with this process b now which is better than the process a that we have been used so far in my factory, but process b will meet the needs of present without compromising the ability of future.

As an engineer you know when we need to look at numbers, great if you can process b is better, but how much better and how we can say that the process b is better. Sometimes our intrusion is not a sufficient framework for analysis, either should be an intuition else this term should be anything one we say recycle or its great we are going to recycle it. But if you want to recycle in the process of recycling if you are ending up using a lot of power, lot of energy, and lot of material. And as compared to what is needed to making a origin material you are probably not environmental friendly. And there are situations like that too.

So, when we do this LCA exercise, when we do this LCA lifecycle assessment what it does it is a systematic method of comparing product policies and also I would say processes. So, you can compare and like a numerical way as well.

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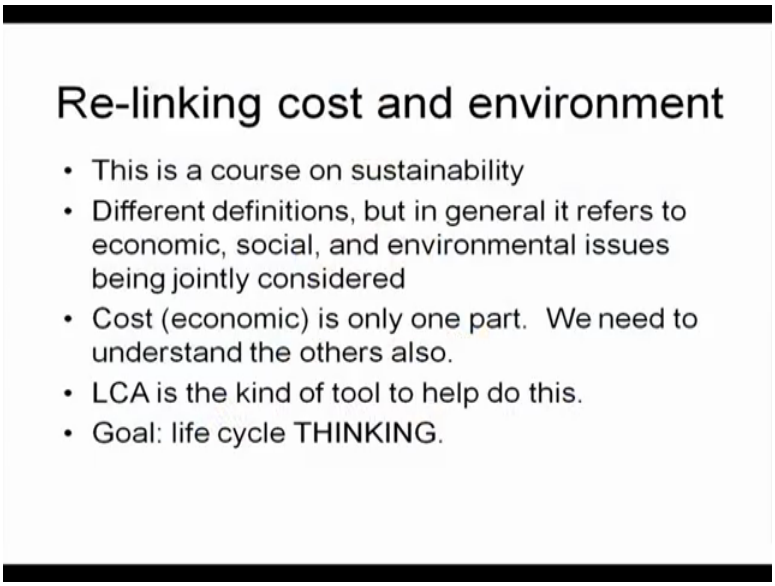

And then we need to look at the cost and the environment; cost is also important. We need to look at the lifecycle cost not only cost in a short term basis, but a long term basis. This is a course which is based out of like a sustainability concept. So, we will look at the sustainability aspect as well which is I will see as a tool for measuring sustainability. We will look at the different definitions, but in general it refers to economic, social and environmental issues.

Cost is also one part; we need to understand the other parts as well. And LCA is a kind of thing to help us to do this. And ultimate goal at the end of this course those of you talking this course if I can get you at least thinking in a life cycle way, for any problem does not matter which background you come from, and in any spear of your life when you look at those problem start thinking in a lifecycle perspective. Lifecycle means when you look at in totality, look at in whole the whole sum in a going from very begging to the very end from cradle to grave.

So, if you can get that that I think would be a very good achievement for me in terms of instructor for this course.

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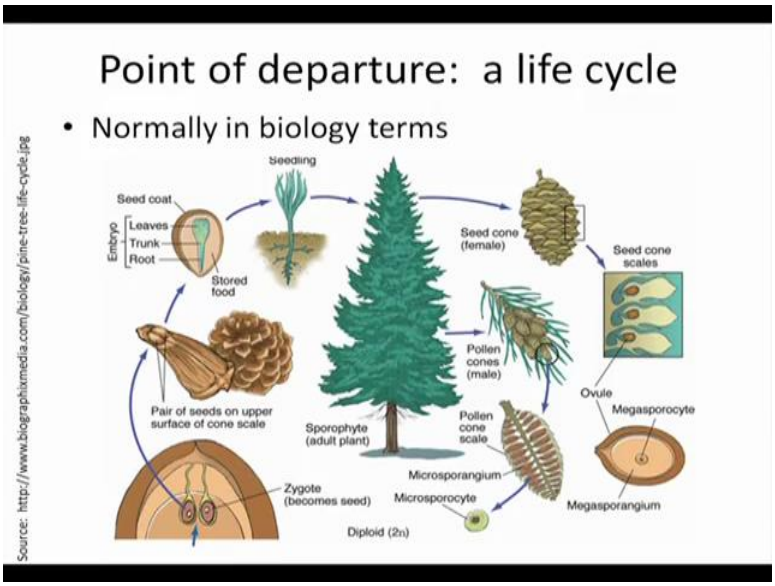

So, lifecycle it is not a new term, we have been using it in biology term for quite some time. You have heard about lifecycle of a honeybee for example, life cycle of frog, life cycle of these and that. In your biology class, probably in your primary school and middle school and those who are biology you might be looking working on this area as well. So, when we talk about lifecycle we talk about things from very begging from the seed, you have your seeds and then from the seed you get the seeding and you get the plant, plant goes up you make some product from the product, from the fruits, again you have seed and the cycle keeps on going on and whatever is the rest goes into the environment and the environment take cares of that. So, and the cycle continues; so from birth to the end.

In a human life concept from our very begging like when we are born to our death. So, that is why many times you hear the term cradle to grave. Cradle is when the baby is born it is put in a cradle and grave is when somebody dies, they are buried into the grave. Since the concept came from western countries when people gets buried over there also supposed to you like a cremation that we do in India for some of our depending on which part of like a religion other things belongs to. But again the basic concept is from the very begging to the very end. So, that is the lifecycle.

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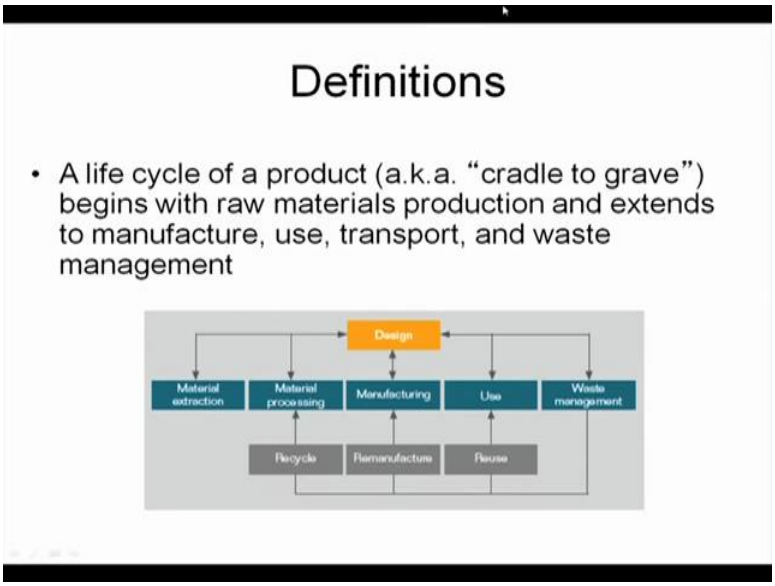

So, lifecycle of a product that is as I also known as cradle to grave begins with the raw materials, production and extends to manufacture, use, transport, and waste management. So, you go from a material extraction all the way to waste management, and as you can see over here from the material extraction, material processing, manufacturing, use, even for waste management all these are same can go into the orange box which is listed which is called design. So, the input from all these can go into the design of the product.

Same thing when you try to in terms of the waste management you want to reuse it, you want to remanufacture, you want to recycle, and you can put these things back into the same supply change. You reuse can go back into the use, remanufacture can go manufacturing, recycling can go to material processing. And if you can come up with a product or process where we can reduce this waste thing generated or whatever is the waste generated we can recycle it back that is very good, we are we are having minimum environmental impact.

So, this whole concept where you are trying to take this waste management to waste material many places you do not even call the waste they are actually resources we office waste management has been renamed as office of resource management now. So, this resource can be put back into the system that is the concept of the circular economy. You hear the term these days circular economy where whatever is the waste you extract the resource put it back into supply chain. So, that is your circular economy concept.

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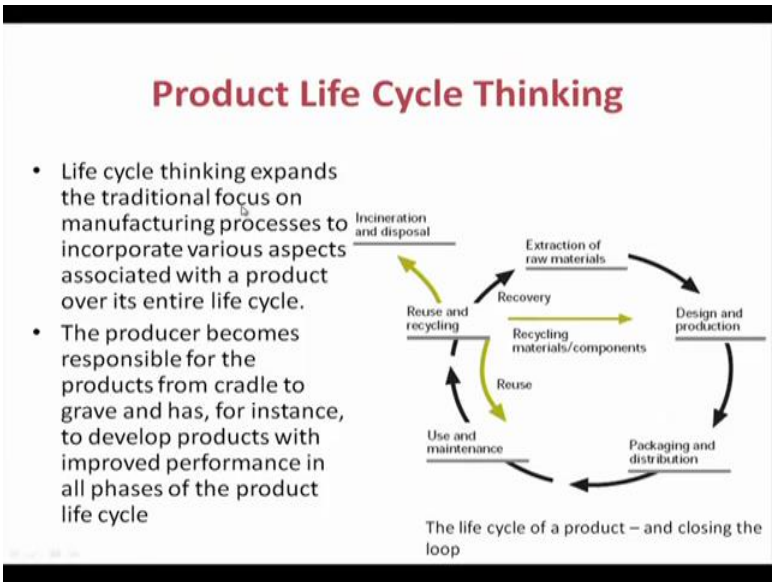

So, product life cycle thinking: life cycle thinking expense the traditional focus and manufacturing processes in corporate various aspects. You look at the entire life cycle, you start from your extraction of raw materials from the top over here as you can see extraction of raw material, goes to design and production, packaging distribution, use and maintenance, reuse and recycle; so the reuse can come back here, the recover that can go into the recycling materials components and extraction of again part of it which cannot be reuse cannot be recycle goes for (Refer Time: 25:10) and disposal.

So, the producer becomes responsible for the product from the cradle to grave. And enhance for instance develop products with improved performance in all phases of the products lifecycle. So, that is how the concept of this lifecycle thinking is coming.

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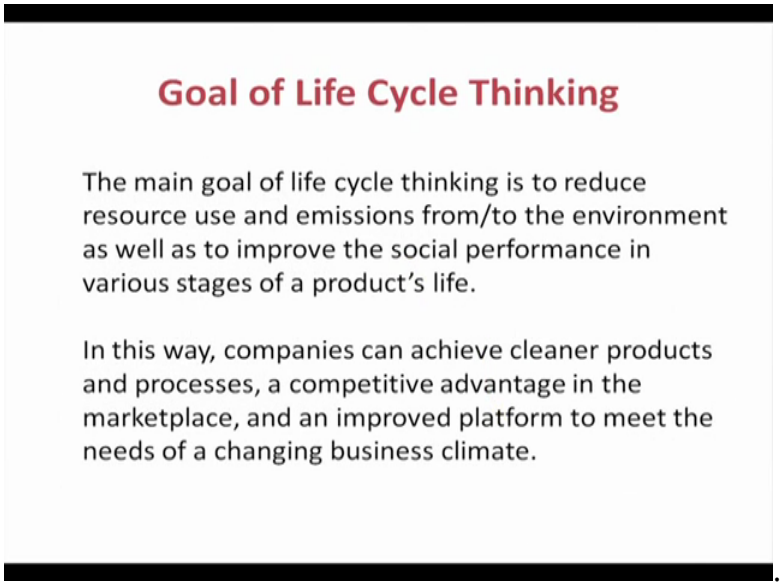

So, the goal is: the main goal of the life cycle thinking is to reduce resource use and emissions from and to the environment as well as to improve the social performance in various stages of products life. In this way the companies can achieve cleaner products and processes; a competitive advantage in the market place and an improved platform to meet the needs of a changing climate.

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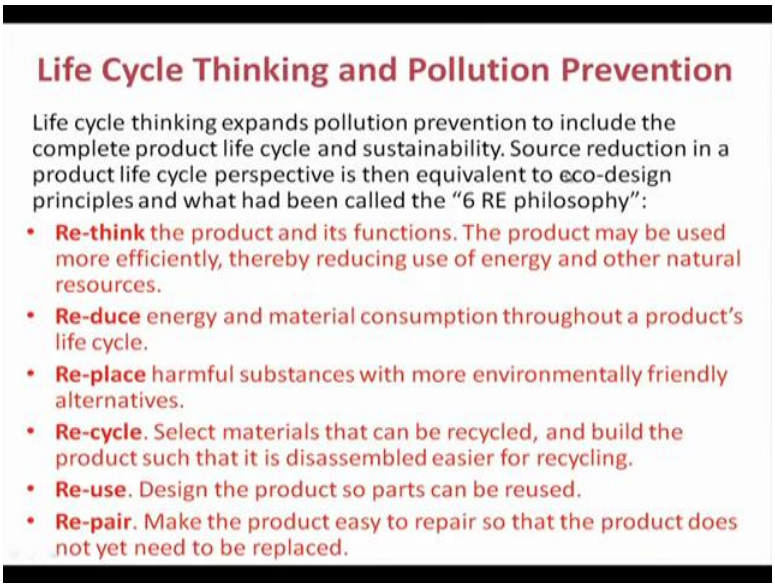

So, life cycle thinking in pollution prevention again as you can see over here you do not have to read the whole slide. It essentially comes from this "6 RE philosophy". So, that is

a 6 RE philosophy. What are those 6 RE philosophy? Rethink, reduce, replace, recycle reuse and repair. So, if you can design your product taking this 6 RE philosophy you will move towards pollution prevention and more sustainable products.

So far what just kind of summarise what we talked about that in last 25-26 minutes: sustainability is a concept, it is a newer concept, highly used and highly abused. We need to be very careful in terms what is the sustainability means. And what is actually means for engineers or for scientist? What are three pillars of sustainability, we talked about that social, economical, and environmental. What is LCA? LCA is a tool which were helps measure this measure the sustainability parameters. LCA is such as measures the environmental parameters.

For social parameters there is a concept is actually gets more complex, because social norms and social values changes from place to place. So, the social LCA its still protocol with is being developed, like the protocols are actually out there now. You can download it from the C-TAC e one v p website, where for the social LCA. And the social LCA there are ways of doing that, and then there is a way of doing life cycle costing analysis as well which is a LCCA. So, but since this course is focused on life cycle analysis which is the environment aspect will cover mostly LCA part, but will also look at social and LCCA as you make progress.

So, in terms of big picture when you look at try to have the lifecycle thinking and pollution prevention. So, what was happening earlier as a environmental engineer or as a environmental professional our role is to come towards an end of the life or product, or when the pollution has been already created. So, we were more trying to solve the problem form an end of pipe approach, but now we are trying to get into the design of the product, we are trying to get into design of process and try to put input there in terms of how you should design this product or how you should go about this process so that the environmental impact is minimum.

And that is the kind of concept of life cycle thinking coming up. When you look at the things in a volatility no all silos approach, but a big picture broad approach. And there are different philosophies out in terms of eco design and eco design principle and we will come back to some of these things in the third week. But this rethink, reduce, replace,

recycle, reuse and repair those kinds of things you hear again, again and again in terms of the life cycle thinking and pollution prevention.

So, with that we will conclude this part of this module, which is the third module for the week 1, and then will carry over our discussion on the week at the fourth module.

Thank you.