Life Cycle Assessment
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Lecture – 34
Sustainable Engineering Design Principles

Welcome back to the next module as part of week 7 as you know we are covering the week 7 material right now. So, in the from the beginning of the week 7 we looked at some of the sustainable design, how to as a engineer what are the things we need to take care of when we are trying to make our design more sustainable and we also looked at if you remember from the last module, we looked at the example from the transportation industry how the transportation industry has taken the; how it works at different levels in terms of incorporating sustainable like sustainable aspects in their design. We also looked at the lead certification which is a big thing in terms of the green buildings a globally throughout the world in Indian context also we have the green building which is known as Gruha, you can go on website and look and do Google on Gruha, you will find the green building requirement as far as the Indian government is concerned which is very similar to the lead certification requirement.

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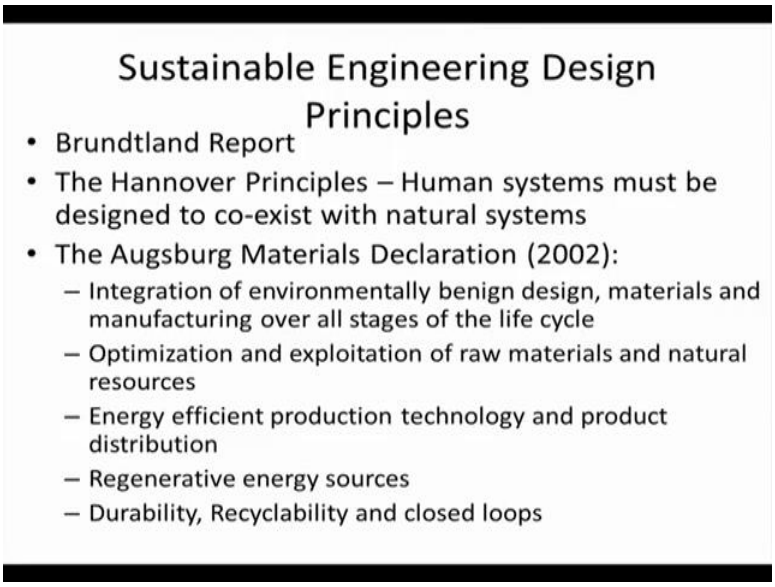

So, today we will start looking at some of the principles; sustainable engineering design principles. So, if you are going to do some design activities what are the things you need

to look at? So, little bit of back up in terms of. So, the background and then will start going into some of the newer material. So, if you remember from the very beginning of the lecture we had talked about this Brundtland report this is how this whole concept of sustainability started the Brundtland report was the first united nations sponsored study done in early nineteen nineties which came up with the definition of this sustainability and we which we have already looked at several times throughout this course. So, far then came the Hannover principle Hannover principle they were their main idea was that when we talk about the human system human system is always buildings and we are talking about the infrastructure or any activities that you do and we have come up with this beautiful buildings beautiful highways roads bridges and all that these are they must design to be co existing with the natural system.

So, that was the Hannover principle which came after Brundtland report which is a kind of if you think about it is kind of with the continuation of what was there in the Brundtland report in terms of the sustainability principle that we should be able to enjoy the natural resources of today without compromising the future generations ability to enjoy the same. So, say in along the similar lines the Hannover principle says whatever construction you do whatever infrastructure you develop do not disturb the nature. So, you do it while taking the nature along with it which is sometimes very difficult to do it. So, just recently as part of this new budget which was just happened just a like few days back and there is a proposal to make train lines between say I would say Tezpur to Twang in Arunachal Pradesh, Tezpur is in Assam, Twang is in Arunachal Pradesh and lots of money has been allocated that recently I happened to visit that area.

So, I can I can see I would like things are very clear like a it is a very fresh in my mind. So, so if you think about that there is lot of natural beauty there. So, although we need the railway line railway line were really be great, but or when because it took me almost it took me 2 days to go from Tezpur to twang. But railway line will make a great addition and it will actually enhance the tourist potential tourism potential of Arunachal Pradesh of that particular area, but at the same time we need to make sure the that happens not compromising the beautiful natural beauty the natural scenic beauty that we have in that region.

We do not want to disturb that and we have to come up with that would be a really a classic example where we should come up with a sustainable design of this railway

infrastructure railway will be great because we are using lots of vehicles now. So, vehicular pollution and if it is an electrified or even if the diesel because it can it can carry lots of people in 1 railway train, so all ultimately I am pretty sure if you do a life cycle analysis of that we will come up with that the railway will be a good addition and that will bring down the air pollution or other pollution that is happening in the area, but the same time when we are building this railway track we need to be careful that we do not do it in by disturbing the natural flora fauna hi like lot of waterfalls and other things that is present in that area.

So, that is the concept of this Hannover principle that do not whatever you make whatever the human system you come up with that should co-exist with the natural system then came this Augsburg material declaration which came in 2,000 2 they are kind of start look at how to say if you think about this Hannover principle like human system should co exists with the natural system. So, how will make it happen one of the one of the thing is that we come up with environmentally like benign design which is what does that mean means that you have come up with a environmental causes design. So, you make it something which is less harmful.

So, you make materials and manufacturing you look at the materials and manufacturing over all stages of life cycle you try to optimise there and exploitation of raw materials and natural resource you try to go for energy efficient production renewable energy sources durability recyclability and closed loop recycling and all those things that is the Augsburg material declaration again all these things came as part of some initiative of you and world bank and other global organisation. And as you can see gradually we are making progress towards going for more sustainable kind of a base system and some of these are there still kind of you can say that they are still in the report they have not part of regular practice it things do take time think about the 2,002 its only like fourteen fifteen years back. So, things do take time and industry sometimes takes to while to kind of talk to catch up, but things are happening in that area where we are looking at we are looking at many of these aspects in terms of our industrial activity.

In India as you know from very early 2,000s we have to have EIA to be done in any project which would be kind of similar and now as I hear that LCA will be made compulsory for any of the projects in India from for after couple of years which is under pipeline.

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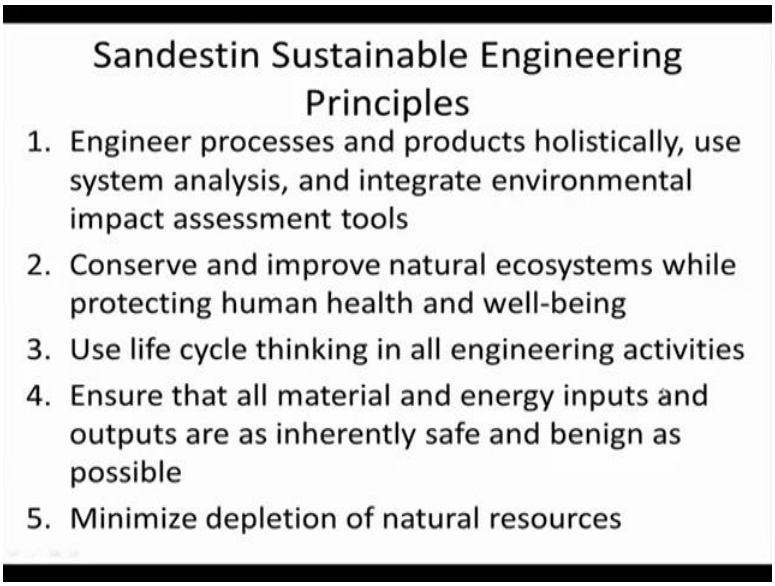

So, then kind of after this; what are these 3 things then came this Sandestin excuse me Sandestin sustainable engineering principle. So, here now say as a engineer what are the things we need to take care of what are the things we need to when we because when we start designing. So, far as we have been designing any product or services as an engineer the focus has always been that whatever the function it has to provide the product or process of what like process is also a product or any software packages or whatever you come up with. So, they should be able to provide that function that is the number 1 and number 2 as much as possible cost effective. So, it should do the function and it should be as cheap as possible. So, those were kind of the major like a driving force behind designing of any of these products processes and other stuff.

Now, the things has to move a little bit it is not only like a doing the function and doing having cheaper, but at the same time it should be environmentally better environmentally kind of causes taking care of the environment and as well as the social aspect that is how whole sustainability comes into picture. So, if you look at this engineering principle to in terms of coming with this sustainable engineering. So, first thing was we have to look things holistically now when we say holistically means do not look at things in one compartment look at the things in big picture.

So, when if you are trying to design a certain products even if you are trying to design a particular type of chair look at the chair in terms of its raw material acquisition all the

way to disposal not only look at raw material this is cheaper this manufacturing is cheaper that is great no because we have to look at its use phase as well as its disposal phase. Does it have certain harmful chemicals or certain things in present which will which will have its impact during the use phase whether people will get sick because of the certain things it being leaching out of it and when you dispose it what will happen to that when you when you dispose, whether it will be an environmental impact what is the environmental foot print when this product goes into a disposal streams.

So, that when you look at the whole big picture from cradle to crave or cradle to cradle and that is you are having a holistic approach and your systems analysis something like a different name for the same thing uses system analysis integrate environmental impact assessment tools look at the environmental impact for each and every process involved from the cradle to the grave and possibly for recycling now. Then other thing is conserve and improve natural eco system again very similar to what the earlier slide you saw in terms of the Hannover principle it is a same thing in the Hannover principle also said the that you need to go along with nature here it says conserve and improve natural eco system while protecting human health and well being.

So, we have to make sure we protect the natural eco system again it kind of goes back to the like a discussion we had earlier where we said that its see having a good GDP having a good of prosperity is always great, but not at the cost of people getting sick not at the cost of people having not having access to clean drinking water or having lot of polluted air around it. Because ultimately the its all this prosperity and GDP is for the people and if the people cannot enjoy it if they get sick if they cannot enjoy that thing what is a point of having it. So, and then use life cycle thinking in all engineering activities.

So, all of these as you can see they are kind of over lapping which each other each and this these different principles they are not kind of mutually exclusive principles they are again overlap with one another and just gives you kind of some idea about like kind of again if you go at look at of the basic point is take care of the environment have be responsive towards the social cause should provide the function and. So, those what are the things you need to do for that. So, then ensure that all material energy input and output are inherently safe. So, it is not safe and not the harmful.

So, again same thing you have to try to have safe sources of energy material with less toxicity or no toxicity if possible minimise depletion of natural resources. So, all these factors this I have listed each one of them because they are actually part of this Sandestin sustainable engineering principle if you pick up any green engineering book or pollution prevention book. There will be a chapter on this different principles of sustainable engineering and you will see that this Sandestin sustainable engineering principles are there. So, it is been taken from a book which was I think I refer I gave as a possible reference book which was sustainable engineering. So, it is basically taken from that book and these points were listed. So, I have kind of listed it over here, but as you can see most of these are over lapping with each other point is try to prevent waste we do not want much waste material to be produced.

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So, less waste try to and then you have to be sensitive towards the local geography aspiration and culture that is very very important.

See if you come up with this solution especially something where people lot of if I would say people's direct interaction is involved. So, if you come up with certain kind of a solution which has some sort of cultural significance social significance and then if you try to apply that principle apply that solution across the board throughout the globe using the same yardstick things may not work out very well for you. What I am trying to say let us selects as take an example until very recently I would say even today many parts of

our country people do not like to have the toilet inside the house and reason for that if you look at historical I think that reason for that was since the toilet if it is not kept properly it is starts smelling or if there will be some sort of foul smell coming out.

So, people are not and they will have kitchen in their houses and then they are not happy having that foul smell in the house. So, they want to build the toilet outside and they will use it outside over the years people have realised as we are having more older people in the house small kids ladies in the middle of the night if you have to go to for the natures call it was getting difficult to go in something which is outside it may not be safe it may not be safe from say snakes and other stuff because many places electricity is not always guaranteed and then you may have it may be too cold it may be rainy season. So, all those things taking into consideration gradually now people are more accepted to having the toilet build inside the house, but still today if you go to many of the rural area they may not like that idea.

So, if we come up with a solution and then we try to force that solution to the rural areas where we force people to have the toilet built inside the house a part of the house they may do it just because of the pressure form say government semi government organisations and at the same time they may do it because they are getting some financial incentive to do it, but at the end of the day we will see that they may not really use that. So, the what I am trying to say that we need to really understand the cultural value we need to understand the practices of that region and specially when you trying to do come up with some solution which is kind could be linked to that and then take the local population on board I you try to just throw out the solution. Just try to force the solution of any activities for the rural areas without taking those people local people local Panchayat and other people on board that what will work there what will not work there things will not go much longer then it may not be sustainable it will not be a it will not be a long term solution. So, that is that is always taking should be taken into consideration.

We should try to create engineering solution beyond current or dominant technology improve innovate in a way and invent same thing again going back to the same discussion of the toilet the problem with the most of these toilet design and why I am saying too much of a toilet stuff is because as part of the Swachh Bharat mission we are building lots of toilet today in India. And over the last couple of years it was being built

earlier to in the Nirmal Bharat Abhiyan or even before that, but this with Swachh Bharat mission lots of fan fair lots of kind of focus and I would say better implementation as being. So, this that is what it is like people are trying to achieve certain targets. So, in that aspect lots of toilets are being built, but the; and I will not go into the toilet design whether it is a good design or bad design. So, it is a good idea or bad idea that is that we can leave it for some other class, but for if you think about in terms of the sustainable solution what the worry is this toilets are very water intensive toilets.

So, it requires lots of water because it is a traditional toilets that you typically see in a household where you have a flush and the flush uses a lot of water it presses the system out, but this question is what will happen during the summer months today like as by the end of this course summer will probably start. And as if you go into the summer month what will happen whether this toilets whether if they have will have enough water what has happened in previously where the similar toilets were built the people have found that during the summer months because of the lack of water people are not using the toilets anymore and since they were not using this toilet they were just because of no water they were having little difficulty in getting water even for drinking and cooking purposes. So, there is no; who will use the water in the toilet at that particular time. So, they started using open defecation since the toilets were not used not flushed it is started then the there was no water going into the toilet because the microbial the microbial species inside they like to have some moisture and if over the time the moisture level goes down the bacteria are not happy and that relates that actually creates problem in into the anaerobic system that we have in terms of like a design of the treatment system as part of this toilet .

So, if you do not have the water going in what happens is that toilet becomes non functional and then it sometimes it starts stinking again. So, and the people since they start going outside they start again after even after when the rainy season other things come this toilet becomes like a either a secondary usage or sometimes even converted to a storage area another stuff. So, then if they does not become a sustainable solution, what I am trying to say as a point number eight or what tries to say that we need to come up with a engineering solution beyond current or dominant technology. So, these water intensive toilets are not going to work especially in many many parts of the country in our country. So, we need to come up with a better design we need to come up with a

design which can really work in out. So, it is a like a water less toilet or whatever we need to come up with design and there are some design out there we need to really pilot is test it out make sure it really works and then come out.

So, sometimes it is to rush things sorry I will say it is to do things fast, but we should not rush things too much. So, you need to look at whether this technology is really going to work I remember somebody mentioning that in one of the meeting which I really liked what it is in Hindi, those of you understand Hindi, the phrase was we should like [FL]. So, there is a difference there like you try [FL] like you can do things fast, but do not do things in haste. So, [FL]. So, that is that is the what we need to do like we need to look at the solution make sure it really going to work and then innovate it look go beyond current or dominant technology improve innovate invent and make things which really going to work in our context and that applies to each and every of the environmental aspect not only in the toilet even for solid waste and other stuff we there are lots of things that need to be done.

Another was saying earlier as the last bullet of the slide shows you that we should try to actively engage communities that is what I was trying to say that we should always get the stakeholders involved and that is that that will because we need to give the ownership any infrastructure what that you are trying to do its ultimately the local population who is going to use it. So, unless and until the local population are on board that solution may not last very long because especially when you have you need the cooperation of the local population to make it a success. So, in that case we need to get this local population on board get them make sure they are they are happy with the solution we have got their input to the solution if there is something if we do not agree with something over there we have convince them that why we are going the way we are going and then get their total buy in and then they will make it really a success otherwise it is very difficult to make anything successful. So, that was the Sandestin sustainable engineering principle along the same line.

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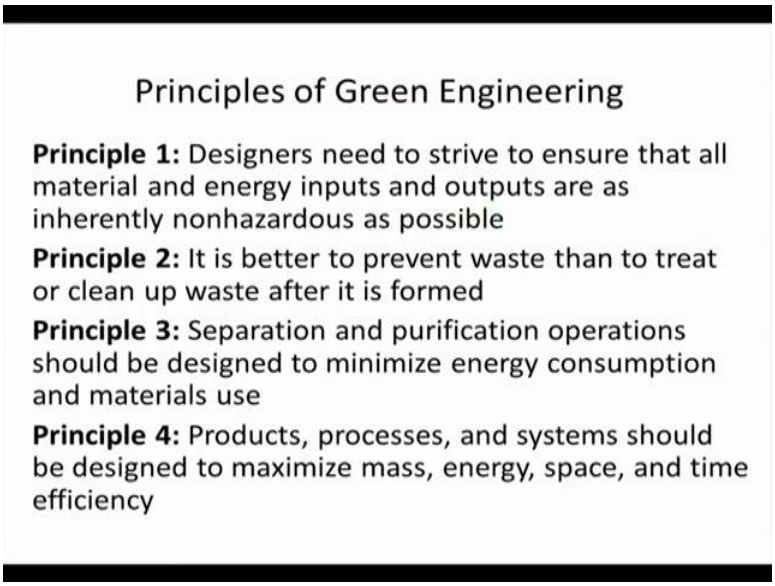

There is another list of principle that is being given is known as principles of green engineering and they are also again you will have the same stuff. So, I will just go through this really fast and just for you to you can as you know this material will be provided to you as a part of PDF as part of the reading material all these slides will be provided to you and also encourage you to look at some of the books on look at the books on life cycle analysis there are books on sustainable engineering.

So, get some books. So, there are even some books available through certain libraries like e books are available if you start going through Google or Google scholar you will find them. So, when engineering principle again came up. So, usually what happens there are different committees; different recommendations. So, like something like that here also we saw Sandestin sustainable engineering principle then another committee came up with its principles of green engineering green engineering as an green means you are trying to be environmental friendly. So, that is what and again its similar stuff just rephrased and regrouped in a different way. So, principle one designer needs to strive to ensure that all material and energy input and output as inherently non hazardous we already talked about that. So, it is you try as environmentally safe as possible prevent the waste rather than treating it after clean up.

So, rather than its better to be pro active rather than let the waste being produced and then we try to clean them up, it is better to be pro active minimum energy consumption

and material use. So, whenever like try to like again lower the environmental foot print and maximise the mass energy space and time efficiency.

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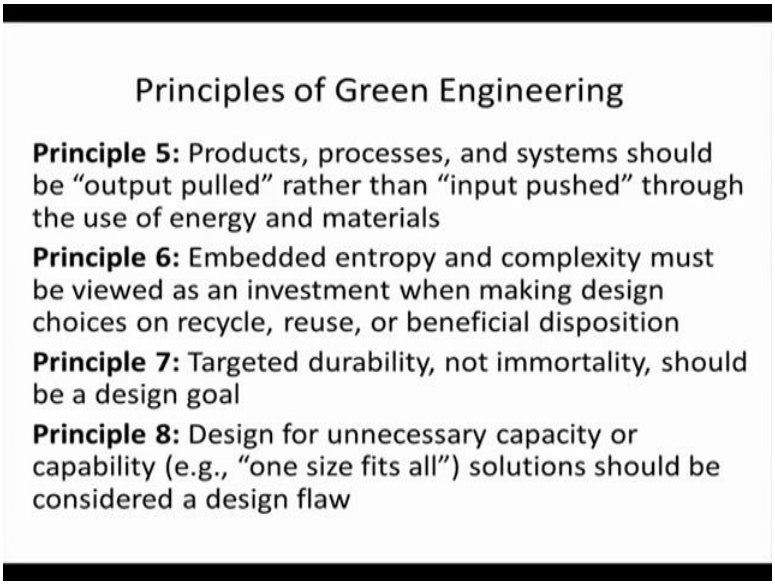

So, similar stuff that is product process system should be output pulled rather than input pushed. So, we should try to look at the through the use of energy material our goal should be more on what the output we are trying to get how to achieve that output and for that what input will be needed not that we have we want to make it service like too much of input into the system make it too heavy design make it over design and then the it gives you lots of energy and materials as. So, it should not be too much on the basis of input things should be more from the output what we actually need and what is the optimum energy and energy would be required to achieve that.

Then we look at the entropy and complexity of the system in terms of again decision choice recycle reuse beneficial disposition target durability making things durable you do not want to go for immortality which is not possible. In fact, durable means things lasts for longer period of time and that should be a designed goal we should not have one size fits all solution because that is considered a design flaw that is not going to work. So, we that is we should try to avoid that having a one side fits all solution material diversity should be minimized especially say if you look at that that really goes too much against when you try to trying to promote recycling or reusing those kind of stuff disassembly and value retention. So, we try to for the many times just to make things look little bit

cooler like look little bit more fancier we add lot of material together and that really becomes a new sense in terms of the recycling industry.

So, what is what has been proposed in this particular principle that you material diversity if needed we cannot avoid that, but if not we should try to avoid. So, much of say within one component if we have just one type of plastic or rather than having six or 7 eight type of plastic makes together as a blended plastic because that becomes a problem in terms of recycling.

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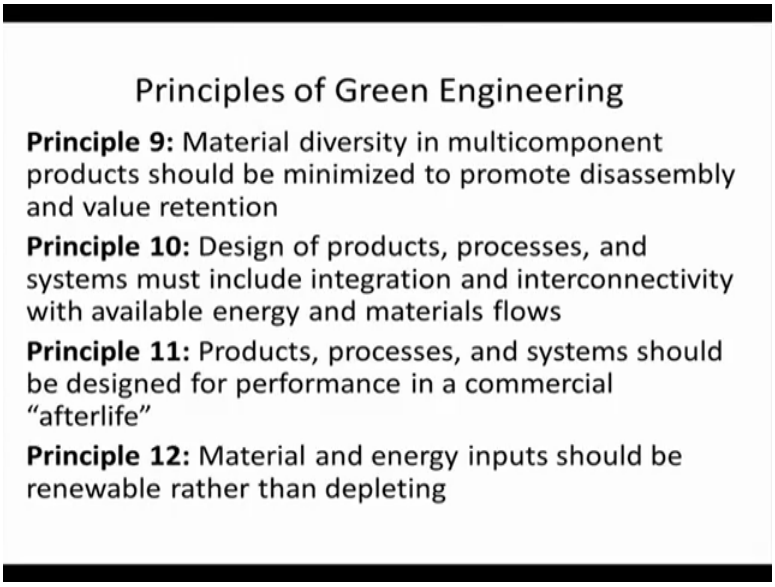

Then you design a product process or systems must be integration like both available material energy flow there should be looked into and they should integrate with each other that is always is there then we would look at what is the performance after life what is in terms of disposal what after life is over what how it will behave what will be done then should be renewable rather than depleting we should try to go for renewable energy recycling and all that.

So, if you look at these all these twelve some principles they are based on very similar to what the Brundtland report said or what we had the other like Hannover principles or Augsburg's material declaration or the Sandestin sustainable engineering principle. So, all these things are essentially saying very similar stuff and they are what they are saying is try to make things environmental friendly as much as possible taking into account that the performance of the product of the system is of course, the most important thing cost

is important, but we look at the we should not just look at the cost from like a economical cost there is a environmental cause there is a social cause associated with every each and every activity. So, we should look at those aspects as well.

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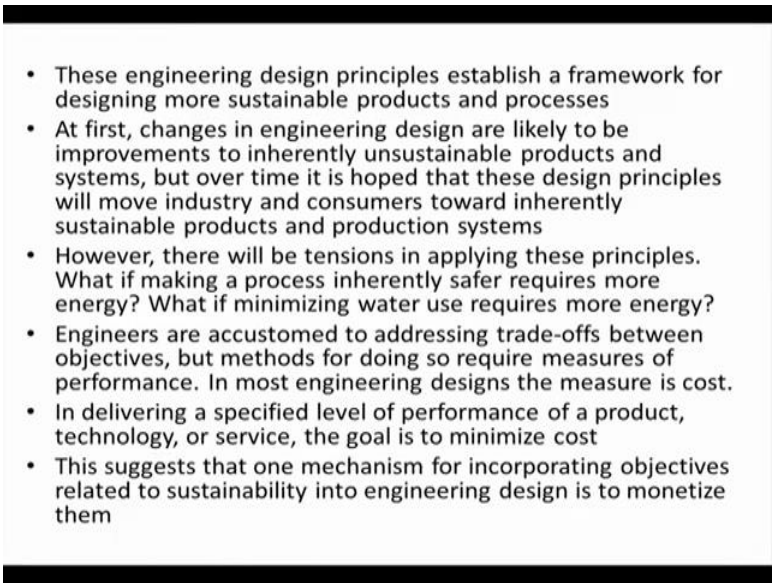

So,. So, these engineering principles, we looked at all those engineering principles over the last twenty five some minutes. So, this engineering principle they what they do they establish a framework for designing more sustainable product. So, what; how will go about that again this slide is too much text on this slide again I kind of give you to understand and you can you can read it, but I will just go over some of these basic take way message of these slide.

So, it is basically we need to start looking at there are we have the products which we have today how to make this product more sustainable how to move towards from this inherently unsustainable system to sustainable system. So, there will be there is a transition phase right now we are in a transition phase today we have a system which we know which is not going to sustain for a long period of time we know what will be the solution in terms of sustainable system we are we are discussing like how to move from this point to this point what we can do to kind of move from one point to another and that is where that is where we are that is where our industry is right now.

So, these designed principles which have been come up they will help industry to make this transition. So, that is what its it is all about and there will be when you try to apply

this principle of course, there would be some internal conflict there are always remember I was I do not think I have mentioned to you this to you one time when I was teaching in Canada you believe it or not McDonalds and Wal-Mart although they are not that environmental if you go through their profile they does not come out to be very good in terms of their social and other aspects, but we will not go into that aspect, but they have been trying to incorporate some of these sustainability principles in their in their in their organisations.

So, one of the gentleman who was a sustainability kind of director or sustainability in charge for this good at in this anterior region he visited and I had him in my class as a guest lecturer in my life cycle analysis class and he come up he told as that the many times they come up with a better solution in terms of how the food should be packaged how the things should be put together, but then the marketing people they over rule the environmental decision because what the environmental force said that does not look very fancy it does not look eye catching. So, that is where things get stuck. So, there would be as I said there will be some principle there will be some tension there will be some inherent contradictions, but we need to move towards it to have a better like less energy less water usage and then we have to come up with a trade off.

We have to have a trade off between the different objectives what will be what better which will work not and we need to start looking at the cost of not only economic cost, but social cost and environmental cost and to in the next module we will start talking about that cost in the some of few slides.

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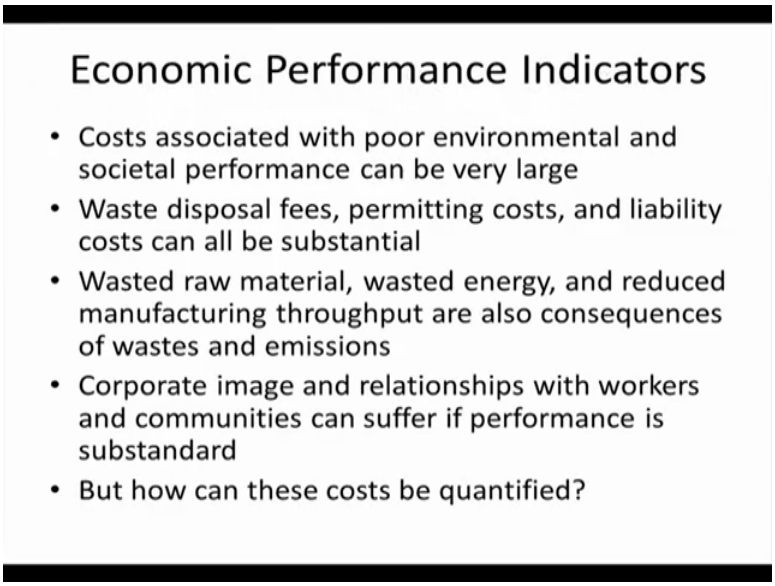

So, what we need to do is we need to incorporate objectives related to sustainability into engineering design and try to monetize them put a money value because as we know as an engineer or as a industry we always look such things from a monetary point of view how much it is going to cost. So, it is not only the immediate cost, but also the long term cost and what we mean by immediate cost and long term cost will cover that in the next module. So, I hope that you are enjoying this course. So, far it is 7th week. So, it is almost there we have another week left after I think this is the fourth module of seventh week. So, there will be one more module in 7th week and then we have the last week.

So, with that let us close this particular module and then we will look at the carry forward the discussion in terms of the different cost economic social and environmental cost in the next module.

Thank you.