Product Design and Manufacturing
Prof. J. Ramkumar
Dr. Amandeep Singh Oberoi
Department of Mechanical Engineering & Design Program
Department of Mechanical Engineering
Indian Institute of Technology, Kanpur

Lecture – 20d
Design for Environment (Part 2 of 2)

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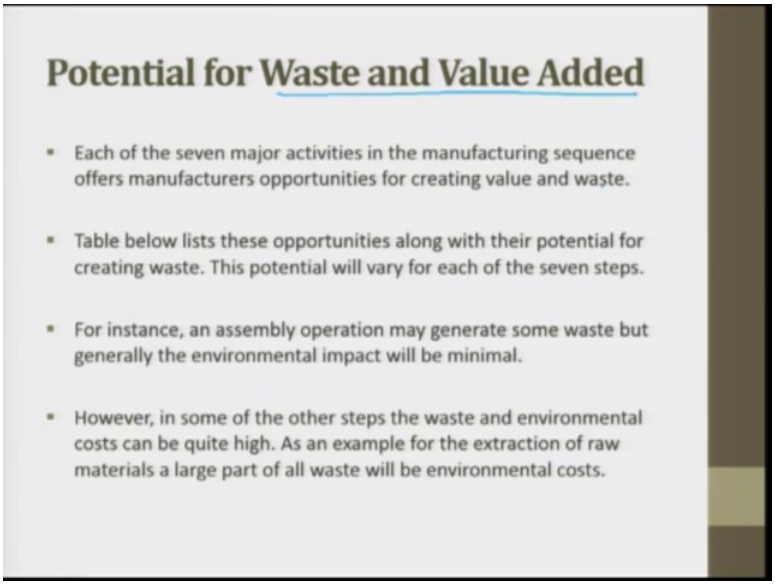

So, next discussion is going to be on the potential for waste and value added, today what is happening people are started generating products out of waste whatever gets generated. In fact, a country like Finland starts getting waste from various places and now what they do is they convert this waste into a useful product and then they sell it back into the market. So now, people have started talking about waste management and the next thing is waste getting converted into value added products.

For example from PCBs people have started making key chain holders, it is a killer, but still at least what is happening is it is getting re-used into a useful product. So, each of the 7 major activities in manufacturing sequence offer manufacturing opportunities for creating value and waste, the table below lists some of the opportunities.

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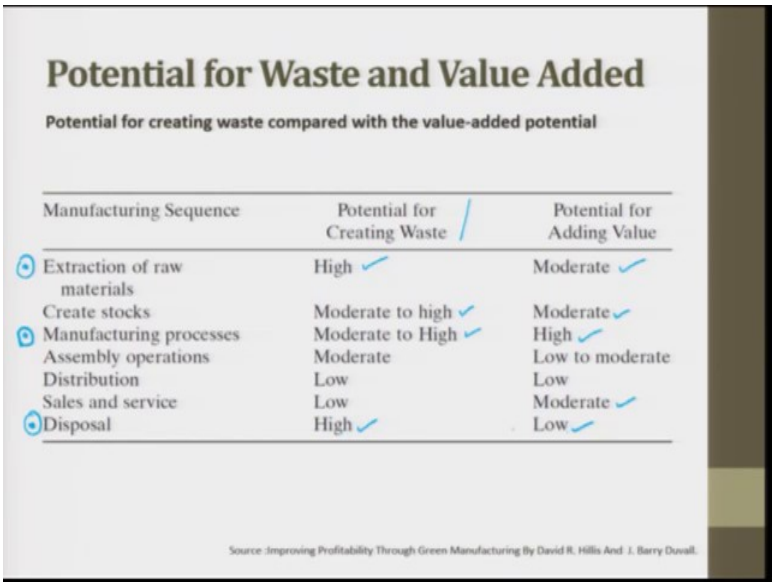

These are the 7 which we are looking at it. So, extraction from raw material, create stock, manufacturing process, assembly operation, distribution, sales and services and disposals. So, if you see look at the potential for creating waste, raw material it is going to be extremely high. So, the potential for value addition at this extraction process is going to be moderate, then create stocks it is going to be moderate to high waste you are going to hold inventory. So, it is there is going to be waste creation is going to be moving from moderate to high. So, the potential for adding value is going to be moderate, manufacturing process, it is the same, it is going to be from moderate to high and in manufacturing process potential for adding value is very high.

So, this is where people are more talking today for converting waste into a value added product. Assembly operations it is going to be low to moderate, distribution it is low, the creation of waste is going to be low, sales and services the creation of waste is going to be low and the potential for adding value is going to be moderate, disposal creating of waste is going to be high and from here getting converted into a value added product is going to be low.

And this is the next region where people are working very hard, for example, the carton boxes which are used people are looking forward after the process is over what can we do with a carton boxes which are available and primarily it is used for packaging and people are looking for other products which could be made out of this carton box. So,

these are the 7 major activities in manufacturing sequence the table below lists these opportunities along with the potential for creating waste, this potential will vary for each of the 7 steps.

For instance and assembly operation may generate some waste, but generally the environmental impact will be very minimum ok. So, that is what we are looking at it so, here if you see moderate to high and the environmental impact will be minimal. However, in some of the other steps the waste and environmental cost can be quiet high, as an example for the extraction of raw material, a large part of all waste will be environmental costly for example, today people use cyanide for extracting material from the ore. So, those cyanides are getting dumped somewhere in the world in a soil and that soil the cyanide gets diffused or the rare earth material gets diffused into the soil and slowly slowly over a period of time that soil becomes little potoxic for even agricultural applications so, this is what we saw in detail.

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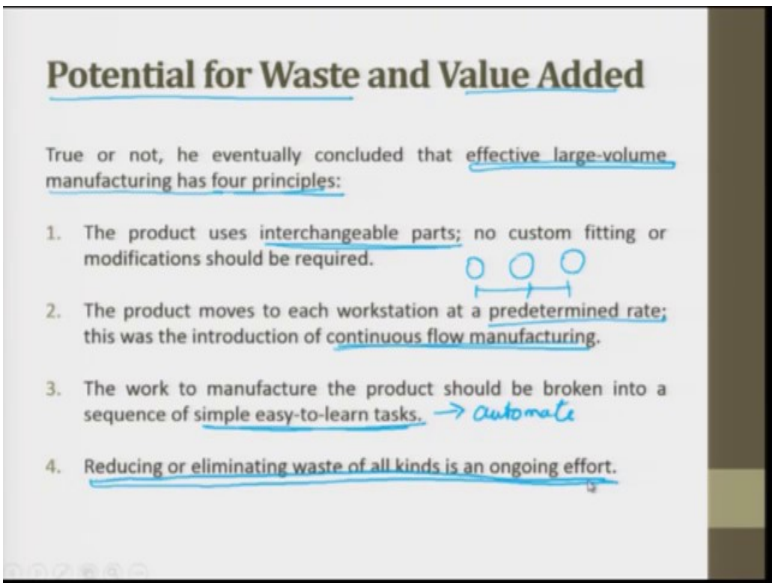

The true or not, he eventually concludes that effective large volume manufacturing has 4 principles effective large volume manufacturing has 4 principles. The product uses interchangeability parts no custom fitting or modification should be required. So, what is this, if you want to reduce potential for waste and value addition. So, the first thing is in your product whatever you develop it should have a concept of interchangeability, moment interchangeability comes into effect, then the cost slash down and the waste also

which is getting generated is also reduced why because almost all the manufacturing processes are stand products are standard standardized and month moment the product is standardized the process is also standardized. So, low custom fitting or modification should be required at so, that is what people are looking forward for interchangeability.

The product moves to each station at a predetermined rate so; that means, to say from one workstation to the other workstation the cycle time, we will try to balance or it will the number of operations will always be equal. So, that it goes in a predetermined rate this was the introduction for continuous flow manufacturing. So, what we are trying to say is, let all the process products be developed through continuous flow manufacturing currently assembly happens like that now we are talking about manufacturing processes also like that.

The work to manufacture the product should be broken down into sequence of simple easy - to- learn tasks so that what happens, we can easily go automated and we can also understand the process more and then get it done. Reducing or eliminating waste of all kinds is an ongoing effect it is not a saturated one, it is always ongoing, it is like creative thinking. So, every time when you start thinking looking at the same problem looking from a different perspective or from a different customers angle you will always have a creative solutions. So, the 4 principles are very clear interchangeability, continuous flow, simple and easy to learn and reduce or to eliminate all kinds of ongoing efforts.

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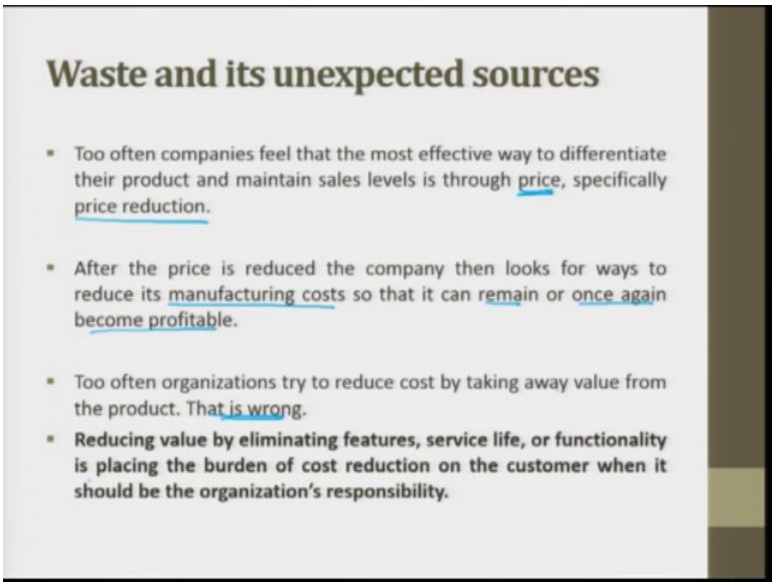

Waste and it is unexpected sources too often companies feel that most effective way to determinate their product and maintain sales level is through price. Specifically price reduction, this is what is, companies always thought about so, they always think of reducing the price. After the price is reduced the company then looks for ways to reduce it is manufacturing cost so that it can remain or once again become a profitable organisation.

So, what happens is first the companies, to sustain they look at the pricing and after maintaining a very low price then they look for profitability. So, they cut corners and they do not give lot of importance to design for environment. Too often, organisation try to reduce cost by taking away value from the product that is wrong, please understand you are trying to cut corners, when you try to cut corners you are going to make an impact on the environment because of your product. Reducing value by eliminating features, service life, functionality is placing the burden of cost reduction on the customer when it should be the organisation's responsibility.

So, today what is happening you get up you get a product which is very economical, a toy for 5 rupees and if the toy keeps breaking very frequently every time you have to replace the same toy or buy another toy, and keep the child happy. So, in that case what has happened you have reduced cost you have also started eliminating features service life is also reduced, functionality is also reduced and then what happens you put a huge burden on the customer to buy new one and because of this buying he is adding more and more waste.

So, when the company should take it as a responsibility without sacrificing the features, without reducing the functionality, without reducing the service life, they should be able to reduce the cost and they should keep the customer happy.

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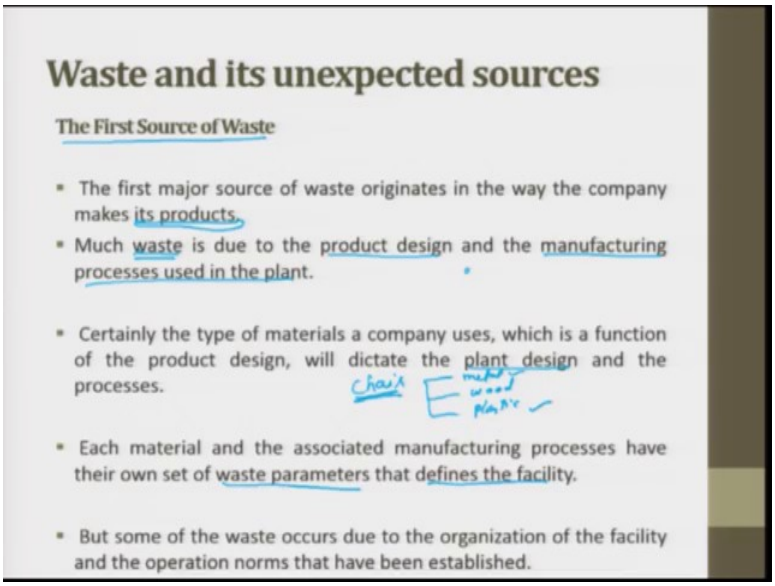

The first source of waste; the first major source of waste originates in the way the company makes it is product. So, even I cook and my wife cooks, my wife is a professional cook. So, she makes things very tasty and she organises the kitchen in a very nice fashion; when I enter into the kitchen I also do the same cooking, but my taste of the food is less and the organisation what I do in the kitchen is also bad.

So, what has happened, I as a manufacturer in producing a product and making a delightful customer I fail why because I have not organised my kitchen properly, once if I am not organised my kitchen properly, so while cooking I do not give enough time for enough time for converting the raw material into a useful product, the value addition whatever I put is not revealed out in the product. So, many a times the customer are unhappy, when I cook, my family is unhappy with the taste, but when my wife does it they enjoy.

So, you should understand the way a product gets evolved reduces the waste also, if you can organise if you can buy exactly what you want if you can cut exactly what you want so that it can be converted into a food product then it is good. The first source of waste is going to be how do you make the products, much waste is due to the product design and the manufacturing process used in the plant and many a times if you see in a manufacturing plant the for the part moves up and down left and right frequently and

then it is at after doing so much of moment it gets processed step by step very very slowly.

So, now the manufacturing process, product design, plant layout design, all these things play a important role in reducing waste, first it that is what we say originates from how do you make a product. Next certainly the type of materials a company uses which is a function of the product design will dictate the plant design and the process. For example, if you are objective is to make a chair, the chair can be made by 3, wood, it can be made by metal, it can be made by plastic, just by looking at the functionalities a chair.

So, the product design by choosing the material whatever it is like wood or plastic or metal, the entire plant design is dictated by the process what you choose to make a product. Each material and the associated manufacturing processes have their own set of waste parameters that defines the facility. For example, moment you have started using plastic so it is injection moulding process, moment you go for metals then you have a series of machines the series of machines will have coolants, will have lubricants.

So, in order to maintain the coolants and lubricants properly you should have proper ambience for doing it. So, you should have a high ceiling roof for it so that the vapours, move up and then you have exhaust proper. So, you see now because of the choice of metal you have to change your plant layout that is what is told here. So, each material and the associated manufacturing process have their own set of waste parameters and define the facility.

So, as I told you coolant is used in injection moulding, you do not use coolant in metal cutting you use a coolant since you use a coolant the machine size becomes large look at it. But some of the waste occurs due to the organisation of the facility and the operation norms that has to be established ok. So, once you have a large machine and you need a very high power. So, it is also necessary that you should maintain safety norms make an expanded a space for running away from when there is a fire or something the operator should be given enough space to run away from the machine to a safer zone.

So, you see because you have chosen metal you are now making using metal cutting machines and since you are using metal cutting machine, it are it has hazardous things you are supposed to maintain a safety norms. And because of the safety norm your company becomes large, because of your company becomes large you have to use lot of

lighting, because you have to use lot of lighting your energy consumption goes high, see one leading to the other leading to the other leading to the other. So, that is what is said as the first source of waste.

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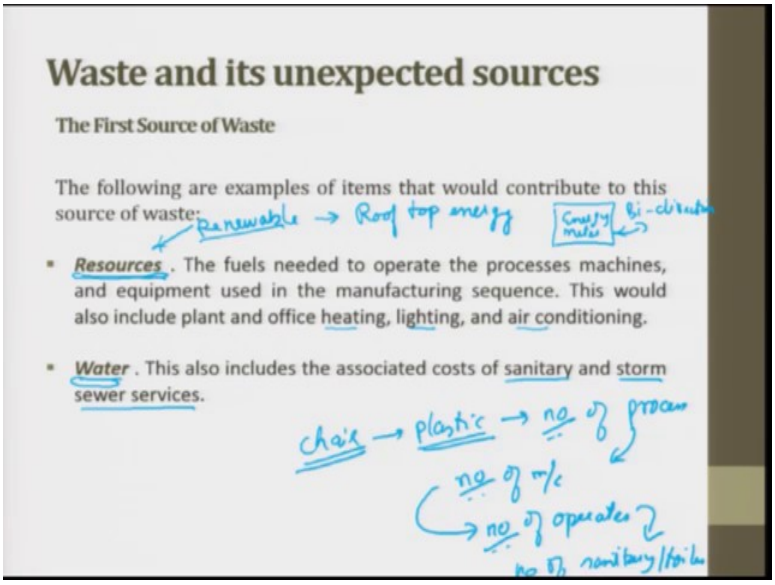

The following are the 2 example of items that would contribute to the source of waste one is resources, another one is water. The fuel needed to operate the process machine and the equipment used in the manufacturing sequence. This also includes the part and the office heating, lighting and air conditioning present. The resources is very very important that is what, when we talk about energy today I was talking to you about renewable energy.

So, today what is happening people are talking about rooftop it is otherwise called as rooftop energy is you produced for yourself and if you produce extra or excess please give it back to the grid. So, today we talk about metres energy metres which are dual energy metres which can run in bi direction bi direction running. So, you can you can consume the metre moves in the forward direction and when you try to generate and deposit it goes in the reverse.

So, what happens, the unit gets subtracted so this is what people are trying to use. So, people are trying to say please reduce the using of energy and if at all you want to go for renewable so that you can reduce the waste. The next one is water, water is also water

also includes the associated cost of sanitary and storms sewer services, sanitary is another thing which is very important.

Since you look at it chair you have moved is made out of plastic so the number of processes are reduced, so number of machines are reduced, number of machines are reduced, number of operators are reduced, then number of sanitary or toiletry whatever you say is also reduced. You see by a proper choice of the material you have reduced all these things. So, this is what I said very clearly the first thing you should look forward is the way you are trying to make a product this is very very important the way you are trying to make a product is very important and the next one is water.

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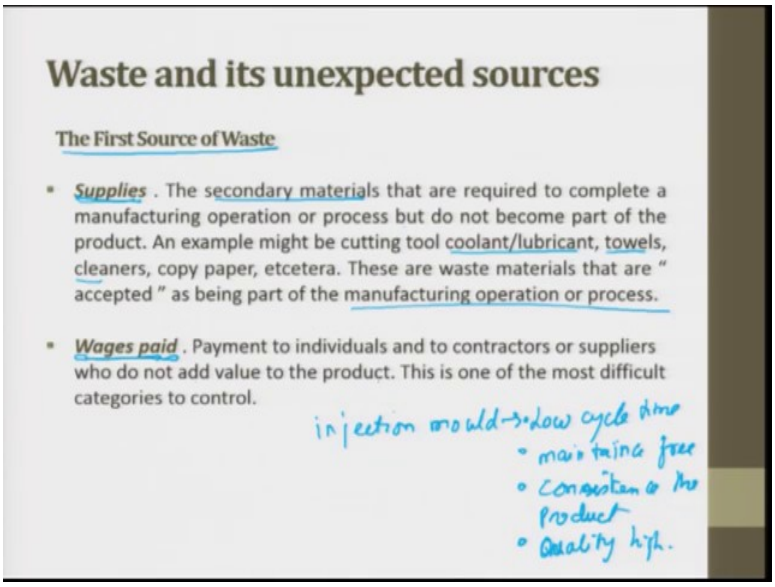

The next is supplies and wage paid; the secondary material that are required to complete a manufacturing operation or a process, but do not become part of the product is called as secondary material they do not become part. So, for example, packaging and example might be cutting tool coolant lubricant, towels, cleaners, copy papers, etcetera. These are waste materials that are “accepted” as being part of the manufacturing process or operation, ok.

So, since it is metal lubricants you are using and since lubricants are there you are giving towel, since you are giving a towel, since you are using lubricant, you are also giving cleaner. So, and then because you are using an oil environment. So, you have to appoint more cleaners for cleaning ok. So, look at it so it keeps on be expanding it like a vicious

circle it keeps going. So, suppliers supplies are the other things where in which we talk about secondary material.

The last one is going to be wages paid, the payment of individuals and to contractors or suppliers who do not add value to the product is also getting is also getting added. So, since I had more number of machines I need to maintain these machines so I have a maintenance cell separately and in the maintenance cell I appoint I appoint engineers or technicians so, there salary goes. If the entire process would have been made by injection moulding machine, injection moulding machine has a lower processing time, has low cycle time. So, the production is very high and the second thing is maintenance, it is to a large extent it is maintenance free of course, and the die cost is there.

But, apart from that once the die is set on the production is start then the cycle time is too less and there is a lot of consistency, consistency in the product, moment there is the consistency in the product the cost or the quality is very high, ok. Consistency and quality of the product is very high. So, you look at it if by choosing a proper product and the material the way it is manufactured you have been able to reduce the waste to a large extent, these wastes and it is unexpected sources. The second source the first source we have seen 4 points one is resources, water, supplies and wage. Water is also something which is very alarming more and more damage you do to the earth.

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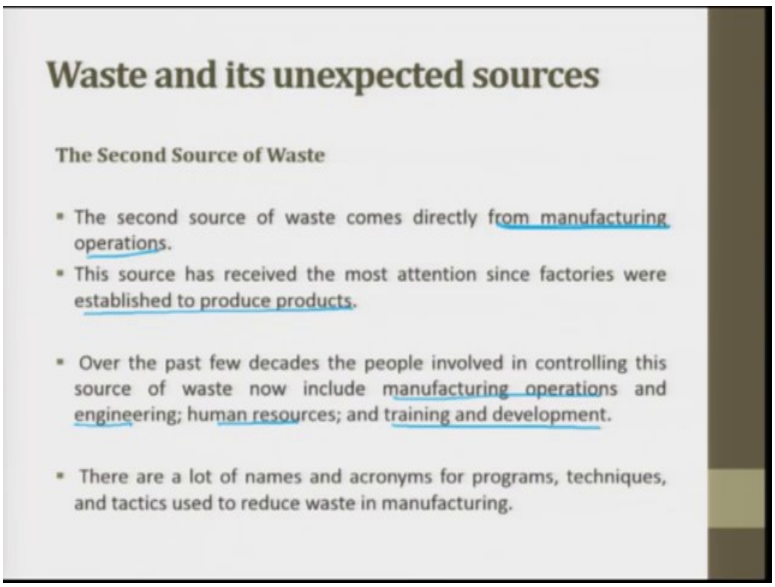

Sustainability we are not looking forward, the mother earth water is getting more and more infected and it becomes more and more toxic. So, drinking water is going to be a challenge for the next generation. The second source of waste, the second source of waste comes directly from manufacturing operation, ok. This source has received the most attention since factories were established to produce product, manufacturing operations. Over the past few decades the people involved in controlling the source of waste now include manufacturing operation and engineering, human resource, training and development.

Maybe my technician does not do the operation, in a very efficient manner, he lacks training he has to be upgraded and he has to be told what are all the problems if you do not have if you do not try to use optimally all the other parameters. So, then he will also understand and start appreciating. So, training and development is also one thing where in which the waste our reduced. There are a lot of names and acronym for programs, techniques and tactics used to reduce waste in manufacturing.

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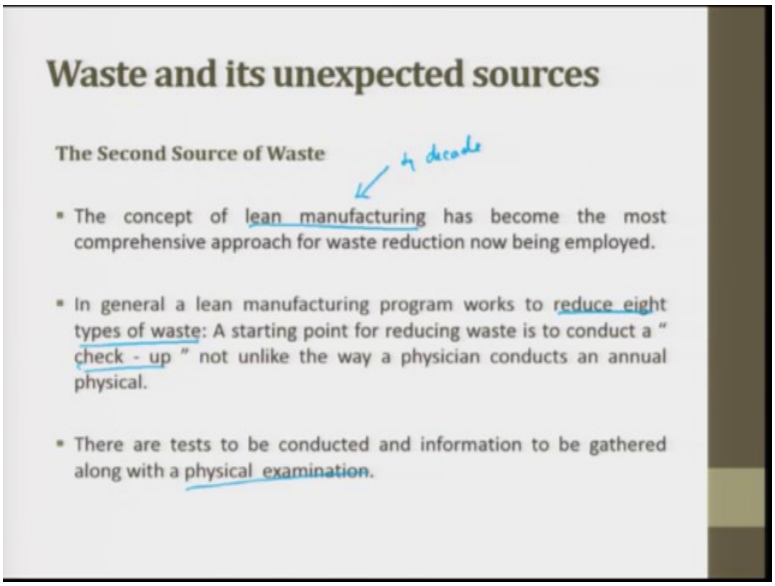

The concept of lean manufacturing has become the most comprehensive approach for waste reduction and now being employed, lean manufacturing is being taught, is being taught for the last 4 decades. In general a lean manufacturing program works to reduce 8 types of waste. A starting point for reducing waste is to conduct a “check - up” not unlikely the way a physician conducts an annual physical thing. There are tests to be

conducted an information to be gathered along with the physical examination. So, there are 8 to reduce 8 types of waste.

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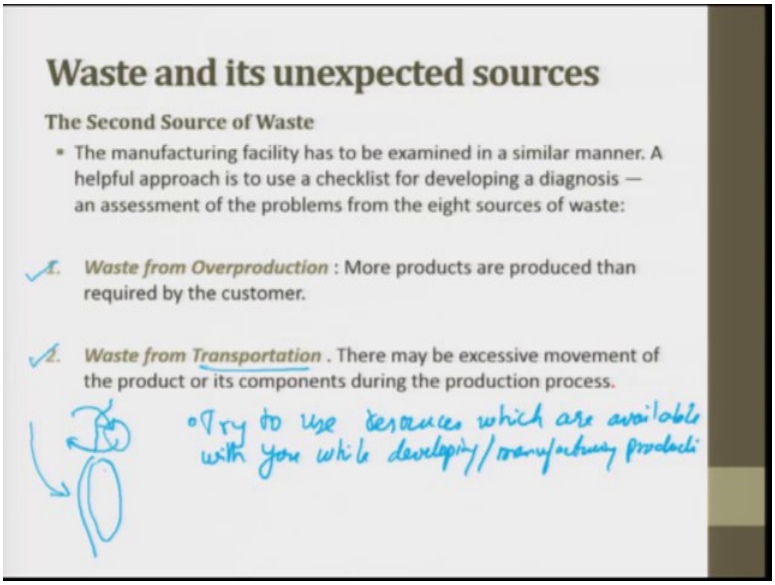

The manufacturing facilities have to be examined in a similar manner, like doctor examining the manufacturing facility also has to be done. A helpful approach is to use a checklist for developing a diagnosis, an assessment of the problems from the 8 sources of waste. Waste from overproduction, that is one of the very very important thing you generate waste; more products are produced than required to the customer. So, you produce more hold it in an inventory, maintained the inventory and later it might get waste. So, first is never over produce. The next one is waste from transportation there may be excessive movements of products or it is components during the production process it can be within the factory or outside the factory.

So, what basically it says is try to use resources which are available with you available with you, while developing products developing or manufacturing products it is very important. See if you see the countries like Hong Kong, Taiwan, Taipei and all these countries what they do is, they try to have their thermal power plant very close to very close to the sea shore because they do not have the coal as a as a major resource. So, the coal comes from various countries and it is getting dumped along the seashore along the coastal area region.

So, very close to a port and then it is all getting dumped in a port and a thermal power plant is very close by. So, the water for running the thermal power plant and re circulating is also taken from the sea and it is used for various thermal power plant applications right. So, if you see here if the location is not planned properly or if the product is developed from a resource which is not available with you, so, naturally the transportation is going to be very very expensive and this transportation is going to lead you for or more release of carbon dioxide when you try to move in trucks. So, this is another big waste, waste from transportation is to be controlled.

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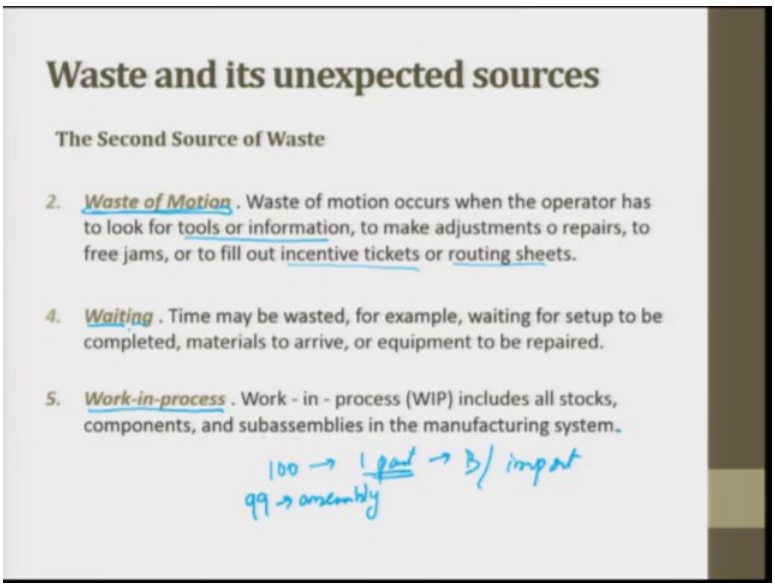

Waste of motion, the waste of motion occurs when the operator has to look for tools and or information to make adjustment, repair, to free jams, or to fill out in incentive tickets or routing sheets, for this it is all waste of motion. So, here what happens? So, that is what I said an example of a kitchen. So, try to organise your kitchen properly such that you have everything at a hand pick distance and then organise it whichever you use regularly front and which you do not use regularly little back side and if you can use a 3 dimensional space it is going to reduce the waste for motion.

Next one is the waiting, waiting is another thing which is which is deadly time may be wasted. For example, waiting for setup to be completed, material to arrive, equipment to be repaired, waiting is something very big recently in one of the factories which I visited they are trying to make products and in their products, they had 100 products, they forgot

to order one part which is a bought out item and which has to be imported. They forgot to order or it was a slip on their side so, 99 parts were ready and they were all assembled, but because of the because of the one part which is required they had to wait and when they had to wait for 3 months they realise the products which are manufactured all went, all got corroded and it lost the quality check.

So now, there is there is a loss of all the products which are produced and 99 parts which were made could not be used, the company went for salvaging, again for salvaging they had to spend money. So, waiting is something which is very deadly which has to be reduced. Work-in-progress, work in progress includes all stock component subassemblies in the manufacturing system, they have to be seen very seriously and the work in progress should be as minimum as possible such that the inventory is not very high and waiting time is not there so, plan in such a way WIP is reduced.

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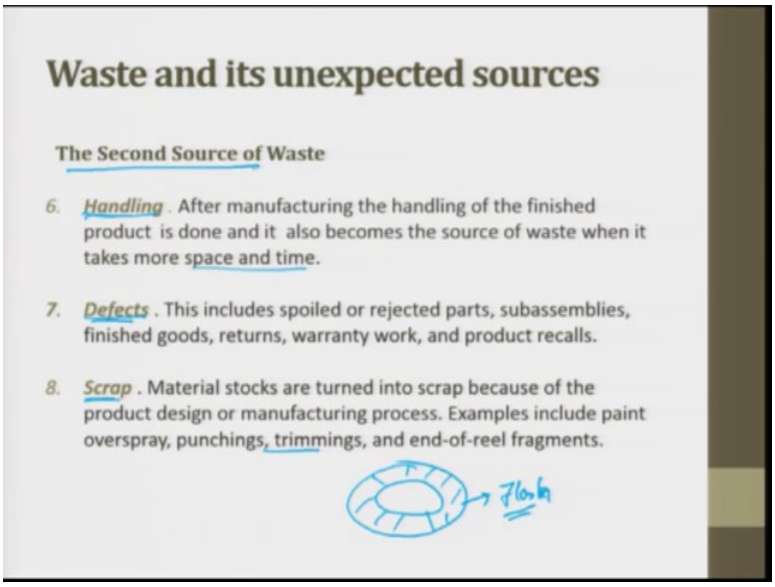

Next one is handling, after manufacturing the handling of the finished product is done and it is also becoming the source of waste when it takes more space and time. For example if you are making a heavy part if you want to make a small cuboid which is made out of led it is too difficult for a operator to move. So, naturally what happens you have to use an automatic handling device moment you put an automatic handling device. This automatic handling device has safety norms and it occupies a space. So, this tries to expand your company size so that is what we are saying handling.

Next is defects, do not produce defects this includes spoiled or rejected part, subassembly, finished goods, return, warranty work and product recall, all these things are defects. So, try to reduce defects as much as possible and the last one defects are possible, there can be salvaging. But scrap whatever you produce it is not possible for you to for you to salvage. So, when you try to produce a scrap because of trim because of a flash which is getting created in a product, this flash in metal forming, these are flash, ok, they are required they are required because they try to maintain the product quality.

But if you have more number of more amount of flash then all this flash will be trimmed and again energy has to be applied it will be recycled and you tried to make a fresh billet for another product. So, scrap also has to be reduced in a big way when we talk about the secondary source of waste all the 8 has to be reduced. So, one is waste from over time, waste from transportation, waste of motion, waiting, work in progress, handling, defects and scrap all these things have to be reduced.

So, we saw the first source first source was water and then we also talked about energy, we talked about resources, we talked about water, we talked about supplies and we talked about wages. So, these are the first source of waste and the 8 are the second source of waste, now let us talk about the third source of waste.

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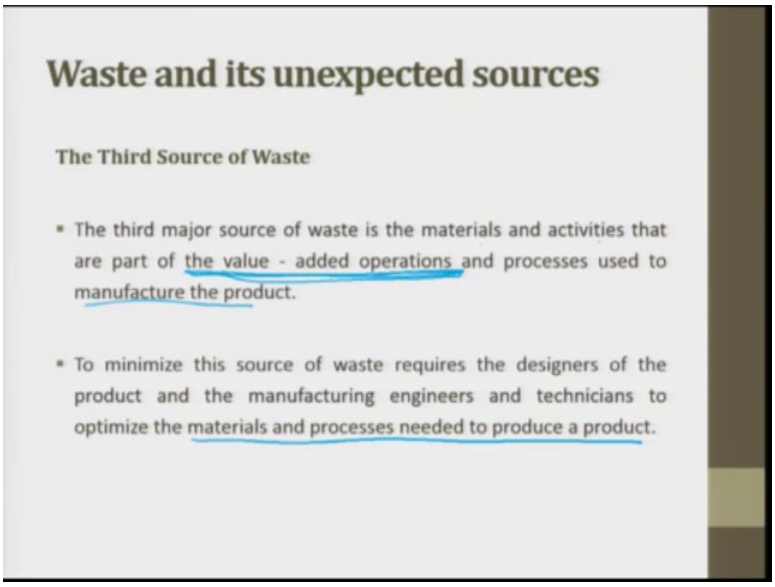

The third source of waste major source of waste is the material and activity that are part of the value added operation and processes used to manufacture the product, these are

nothing, but value added operation. To minimise the source of waste requires the designer of the product and the manufacturing engineer and technician to optimise the material and process needed to produce a product. So, here we try to work on value added operations.

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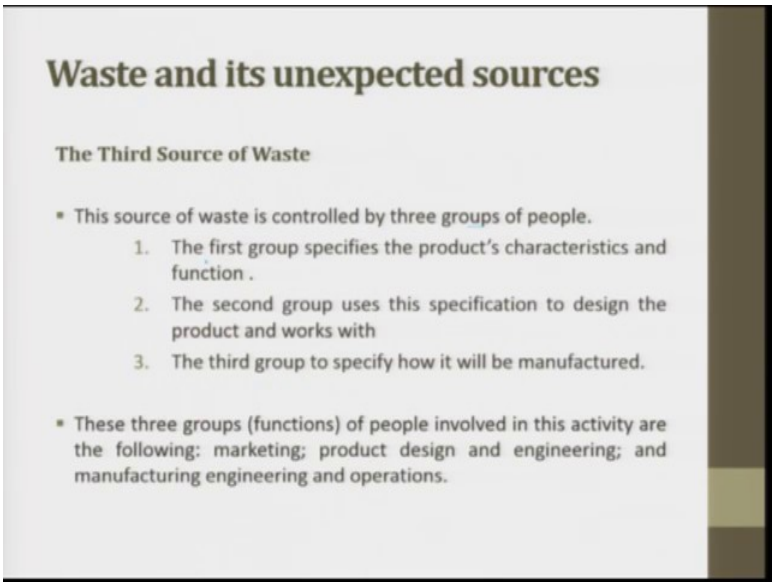

This source of waste is controlled by 3 groups of people, the first group specifies the product characteristics and function, the second group uses this specification to design and the product and work with, the third group to specify how it will be manufactured. So, these 3 groups work together and try to reduce the third source of waste.

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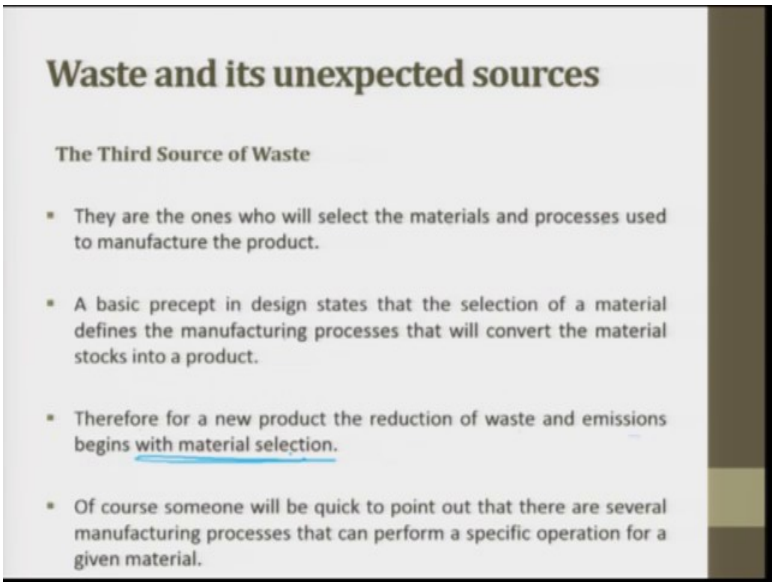

They are the ones who will select the material processes used to the manufacture the product. A basic perception in the design states that the selection of material defines the manufacturing process that will convert the material stock into a product. Therefore, a new product for a new product the reduction of waste and emission begins with material selection so, I gave you a chair example and that you should always remember.

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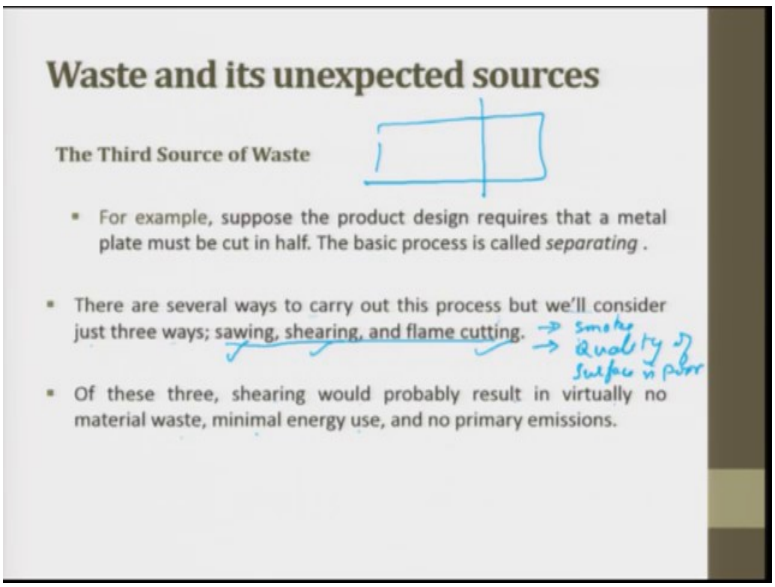

There are several ways to cut out this process but we will consider just 3 ways sawing, shearing and flame cutting. So, this is for cutting a piece from a metal thing, of these 3

shearing would probably result in virtually no waste generation, minimum energy use and no primary emission. So, here what they are trying to talk about is, you are trying to take a metal piece and you are trying to cut the metal piece.

So, the cutting can be done by sawing, it can be done by shearing, it can be done by flame cutting, flame cutting it will lead to it will lead to smoke, it will lead to improper smoke and it will have a, the quality of the surface generated is poor quality of surface is poor, generator and it also smoke is there it is also not very energy efficient. When you talk about sawing you might use a coolant and you might get a good cut, but still shearing is a better operation, shearing involves lot of energy at the initial thing, but the quality of the output is good the product is also sound, ok. So, that is what we talk so, choosing the material is the first thing.

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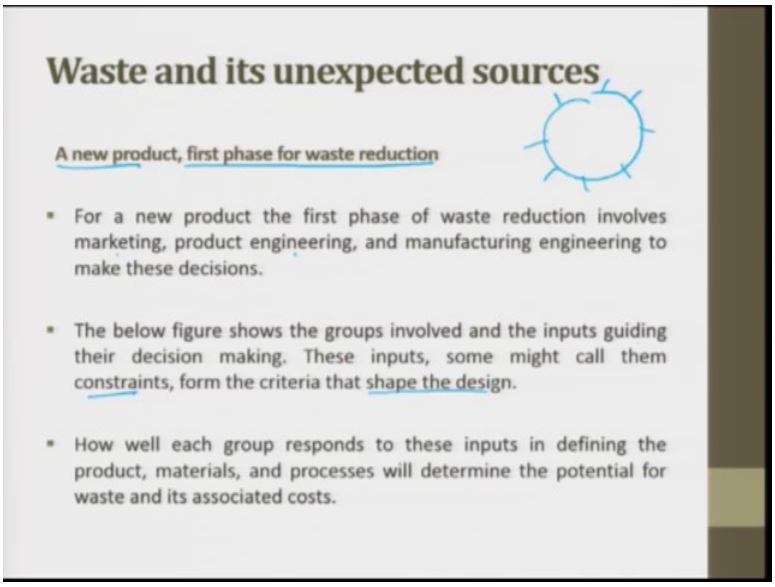

A new product, first phase for waste reduction; for a new product the first phase of waste reduction involves marketing, product engineering, manufacturing, engineering, to make these decisions when you talk about concurrent engineering we involve all these engineers to sit and discuss about the new product. A below figure shows the group involved and the input guide and inputs guiding the decision making. These inputs sometime call them for constraints form the criteria that shape of the design.

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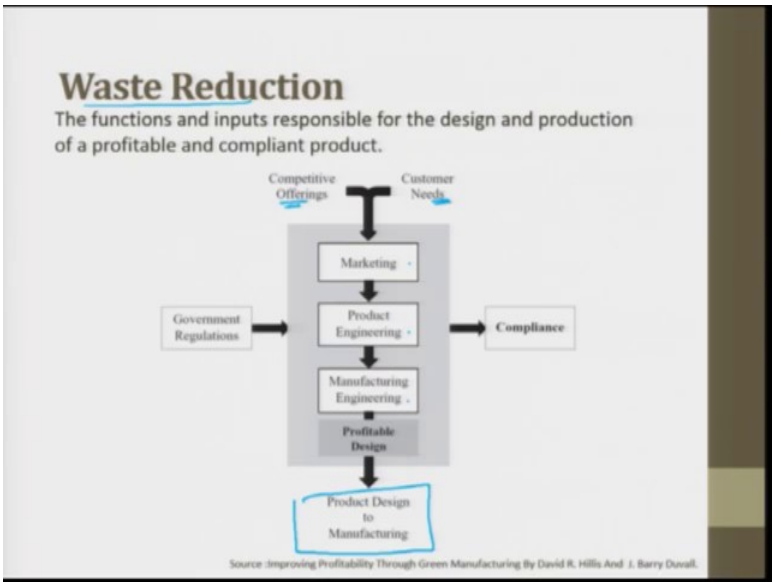

So, these are the different waste reduction which is done. So, here it is the competitive offering, customer need is put together, then we do a market search, then we look for product engineering, then we look for manufacturing, then we look for profitability design, we develop a product or, to manufacture product design to manufacture, government regulation and compliance government regulation for product engineering and compliance are made. So, this itself make sure that the waste is reduced to a large extent the functions and the input responsible for design and production of a profitable and the complex product is given below.

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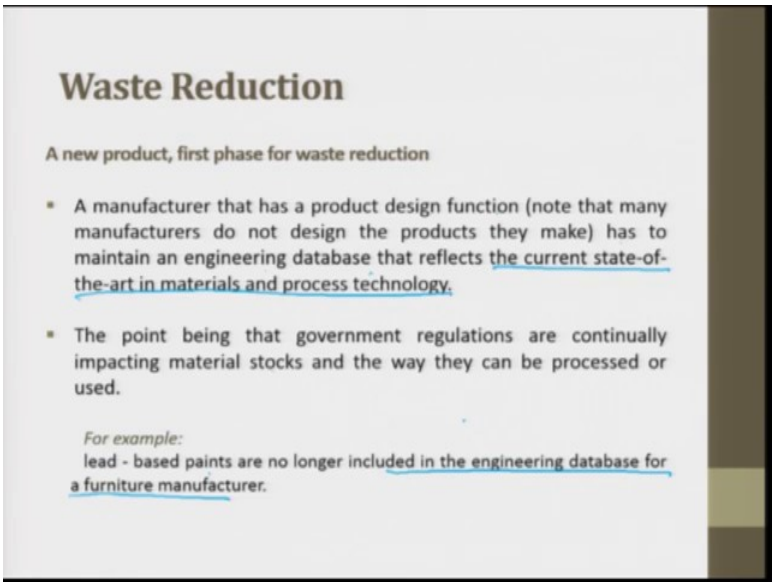

The manufacturer that has a product design function has to maintain an engineering database that reflects the current state of the art in materials and the process technology. Today new and newer and newer materials are coming into market because of this newer and newer materials the manufacturer should have everything in his database and the current state of the art should be very good. The point being that the government regulations are continuously impacting material stock and the way they are being process to use.

Lead - based paints are no longer included in the engineering database for furniture manufacturing, earlier lead was also add in steel so that the machine from the machinability point of view it was very good, but then later it was realise that these leads when it create fumes are toxic for the operators. So, it is now been removed so, today whatever steel we get it is lead free steel and the paint is lead free paints we get.

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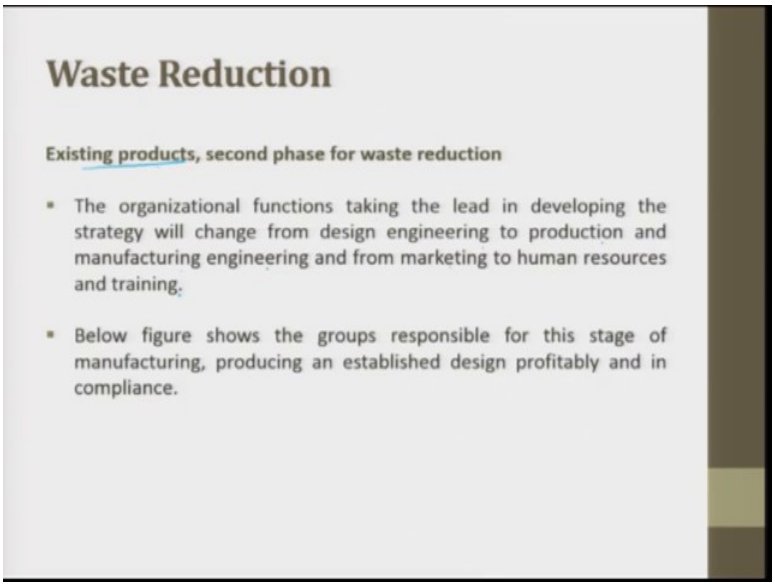

So, the existing products, the second phase of waste reduction, the organisational function taking the lead in developing the strategy will change from design engineering to production manufacturing engineering and from market to human resources and training. So, this is about an existing product what all things to be done for waste management.

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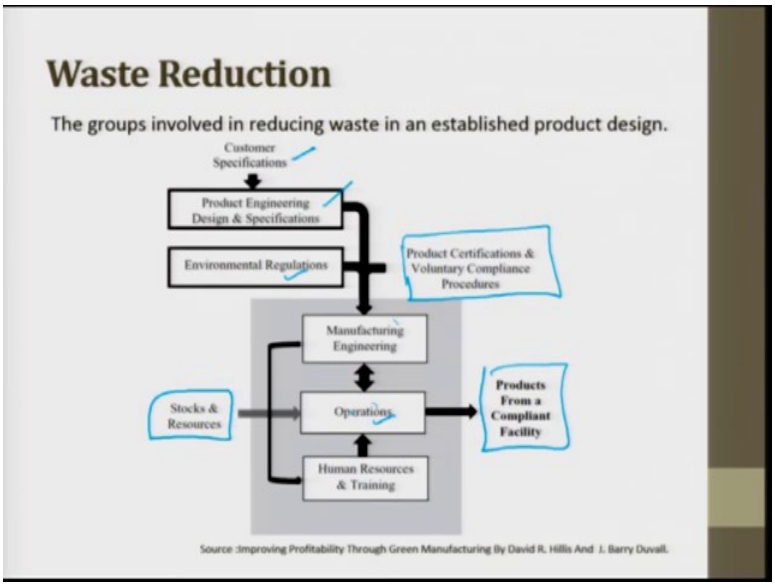

So, for the existing product so you see that customer specification, product engineering, and design, specification, environmental regulation you will see. So, the product certificate and voluntary compliance procedure is all seen and that is given as an input, manufacturing engineering is done, operations are taken care, human resource training is done. So, the operations are good and the product from a complaint facility comes out, this is the safety stock which is a stock and resources which is given to that.

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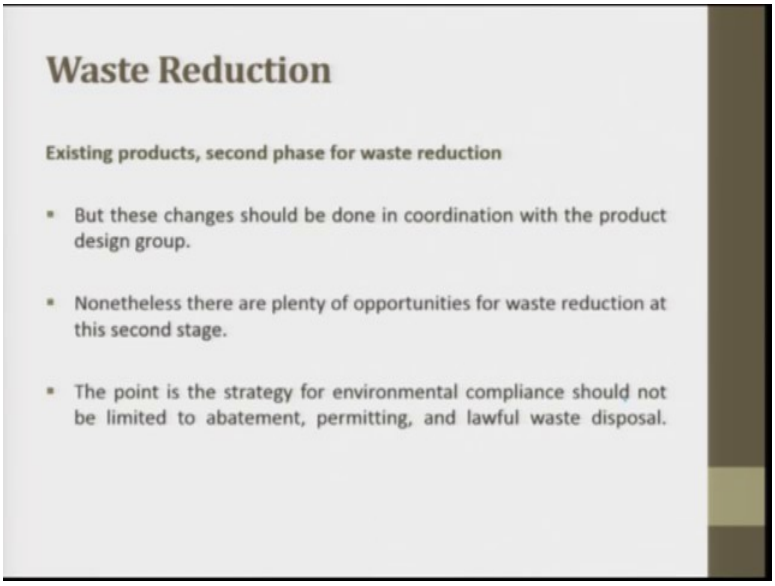

So, the secondary resource is existing product, existing product the first one what we discussed was a new product next one was existing product which is where the waste reduction is done. So, this is stocked here also.

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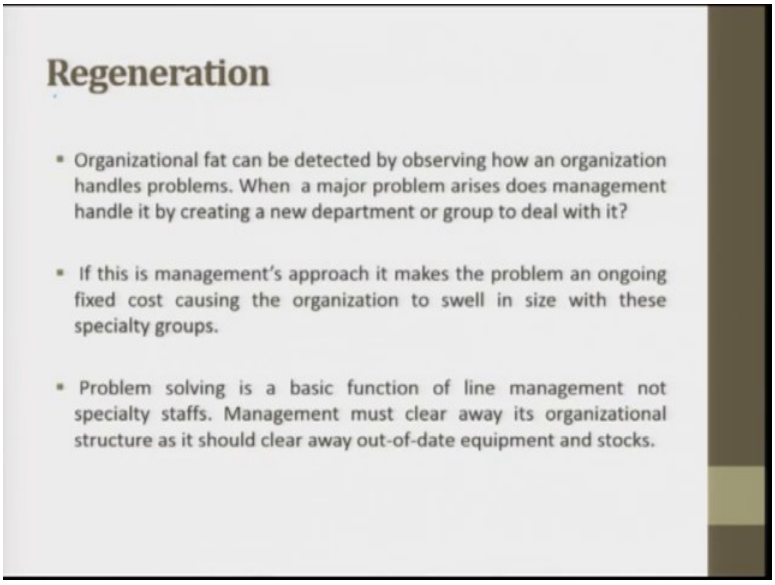

And the next topic is going to be regeneration; organisational fat can be detected by observing how an organisation handles problem. When a major problem arises does management handle it by creating a new department or groups to deal with it. So, this is going to organisational fat when a new problem arises are we going to create a new department or the existing fellow are we going to retrain them and use it.

If this is management approach it makes the problem an ongoing fixed cost causing the organisation to swell in size with this specialist group, ok. So, whenever you have a problem if you start the forming new groups or new departments then the organisation is going to be fat, so that leads to regeneration. The problem solving is a basic function of line management not a specialist stuffs. Management must clear away it is organisational structure as it should clear away out-of- date equipments and stocks.

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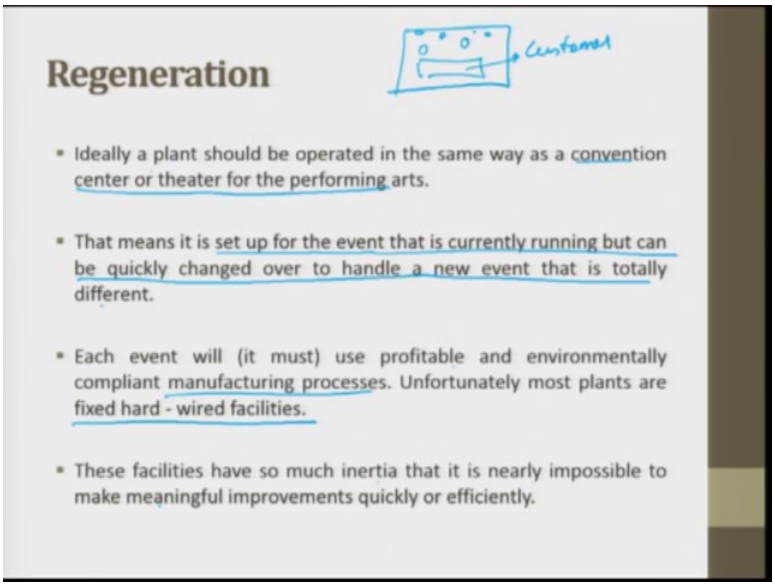

Ideally a plant should be operated in the same way as a conventional centre or a theatre of performing arts so; that means to say, what we are trying to say is this stage will be constant the artist come and there is customers there or audience are there. So, the artist comes and dance or do performance, but the auditorium is the same. So, it can be used for singing, dancing or a dramatic play. In the same way a company also should be in such a way such that depending upon the products they should be able to change the machines, upgrade the machines and make their factory efficient towards an output.

This will try to reduce waste in a large way; that means, it is setup for the event that is currently running, but can be quickly changed over to handle a new event and differences. Each event will use profitability and environmental compliance manufacturing process; unfortunately most plants are hardwired facility. These facilities have so much inertia that it is initially impossible to make a meaningful improvement quickly and efficiently.

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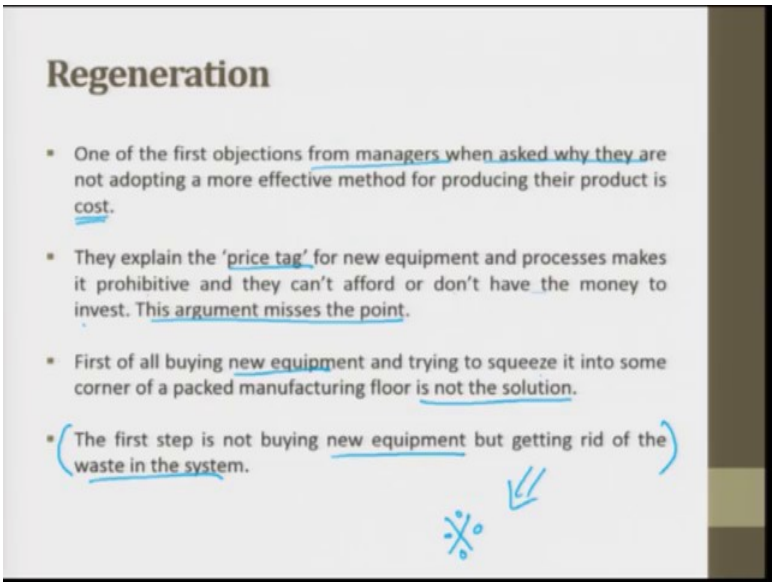

One of the first objective from managers when asked why are they not adopting a more effective method for producing their product, their product is cost. Because if they have to change the factory and recover the cost naturally per product cost goes high. So, they always justify saying that the cost will go high if I make it more agile. They explain the price tag for new equipment and processes make it prohibited and they cannot afford or do not do not have the money to invest, this argument misses the point. First of all buying new equipments and trying to sequence squeeze it into some corners of a packed manufacturing floor is not the solution.

So, when you try to buy new equipment try to buy the entire factory a set of new equipment so that can be used. The first step is not buying new equipments, but getting rid of the waste is the first thing you have to do keep this in mind. This you should also do as an individual if you have a bicycle and if you know frequently the bicycle is going to keep giving you problems and you keep spending money every month 100 rupees or 200 rupees.

And if you do it for one year it is around about 200 rupees, one year it is 2400 a new cycle might cost you 3000 rupees. So, first thing is you have to get rid of the old and buy a new one and moment you start buying it the maintenance goes low and the comfort is high the customers are happy. So, this is what is very important when you look at from the company perspective.

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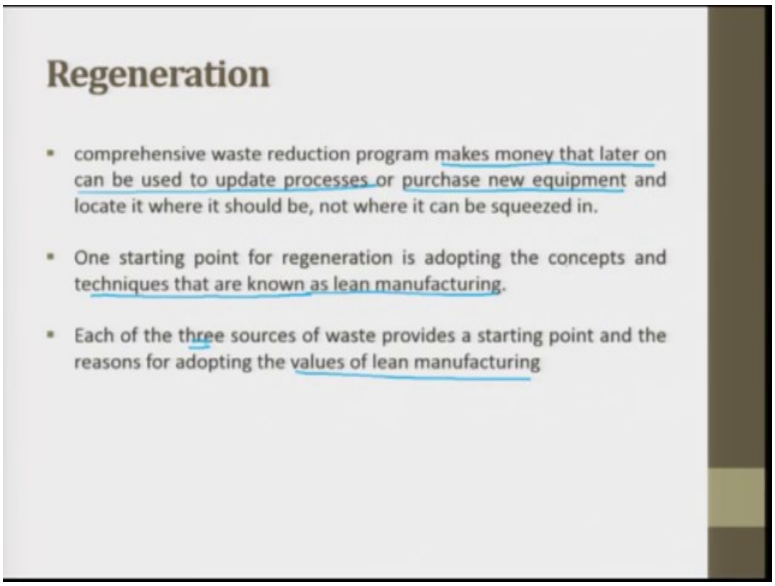

Comprehensive waste reduction program must make money that later on can be used to update processes or purchased new equipments and locate it where it should be. One starting point of for regeneration is adopting the concept and technique that are that are known as lean manufacturing. Each of the 3 sources of waste provides a starting point and the reason for adopting the value to a lean manufacturing. So, 3 sources primary, secondary and tertiary.

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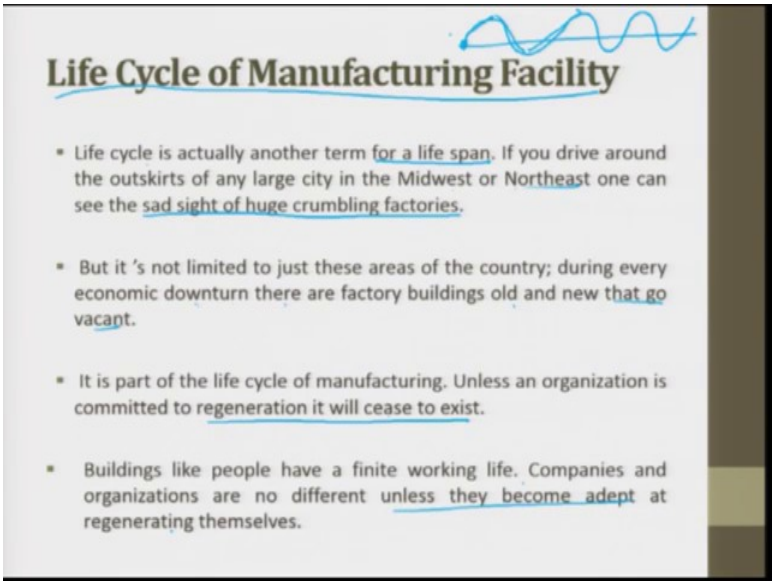

So, the life cycle of manufacturing facility, the life cycle is actually another term for a lifespan. If you drive around the outskirts of any large city in the Midwest or the Northeast one can see the sad site of huge crumbling factories. But it does not limit to just these areas of the country during every economical down turn, there are factories build old factory buildings old and new that go vacant. It is part of the life cycle of manufacturing.

So, they always say a manufacturing goes like a sinusoidal wave, today you are here you might go to the top you have to come down and then you will have to go up. So, you keep going like this. So, whenever there is a turn down whenever there is a new product coming you have to see a life cycle of the manufacturing facility. So, it is part of the life cycle of manufacturing unless an organisation is committed to re generate it is it will cease to exist. Buildings like people have a finite working life, companies and organisations are no different unless they become adaptive and regenerate themselves.

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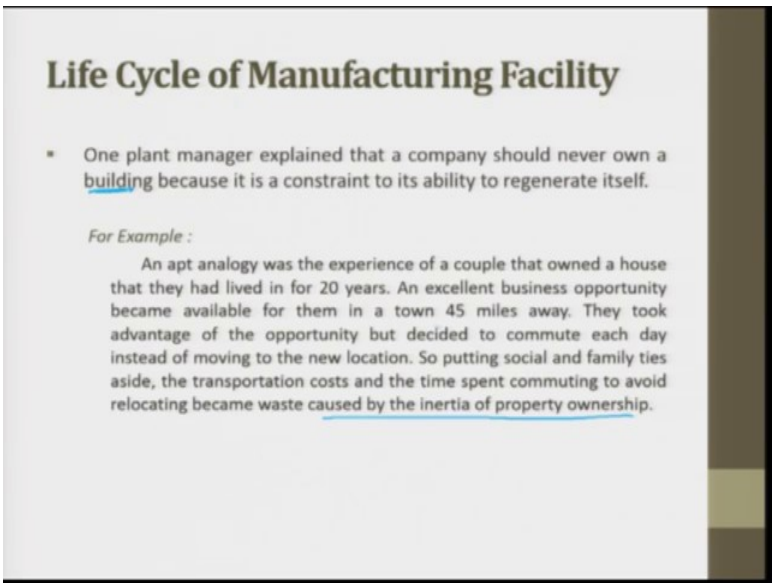

One plant manager explain that a company should never own a building because it is constraint to it is ability to regenerate itself. An apt analogy was the experience of a couple that owned a house that they were they had lived for 20 years. An excellent business opportunity became available for them in a town 45 miles away. They took advantage of the opportunity, but decided to commute each day instead of moving to the new location.

So, putting social and family ties aside, the transportation cost and the time spent commuting to avoid relocating became waste causing by the inertia of the property owning. So, that is also true this where they say if there is a good business proposal for the existing building you should always try to sell it and recreate and regenerate new manufacturing facilities such that you can do, to meet out the requirements.

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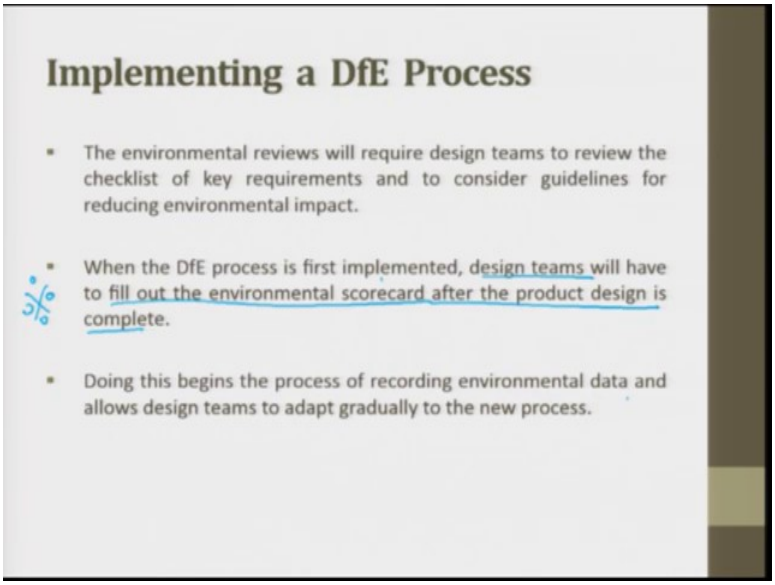

The last topic of discussion is going to be implementing DfE, the environmental review will require design team to review the checklist of key requirements and to consider guidelines for reducing the environmental impact. When DfE process is first implemented, design team will have to fill out the environmental scorecard after the product design is complete, very very important, ok. Doing this begins the process of recording environmental data and allows the design team to adapt gradually to the new process.

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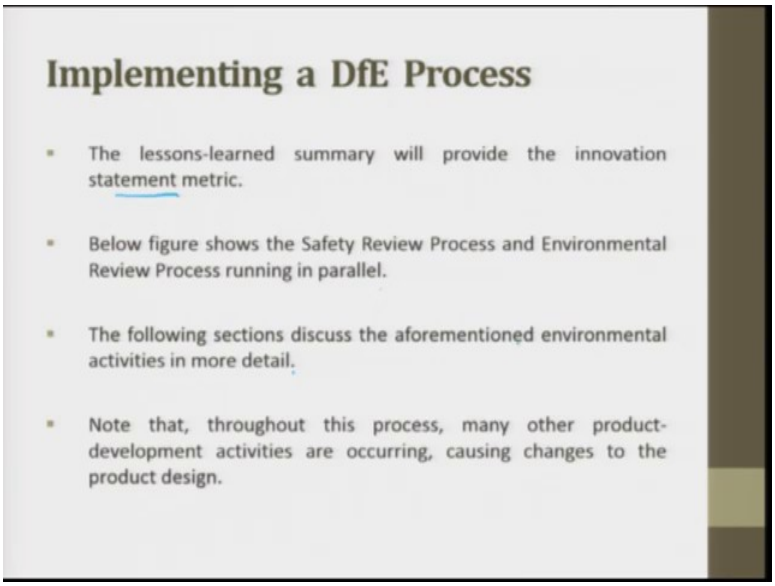

The lesson learnt summary will provide the innovation statement metric. Below figure next we will see shows the safety review process and environmental review process running in parallel. The following sections discuss the aforementioned environmental activity in more details.

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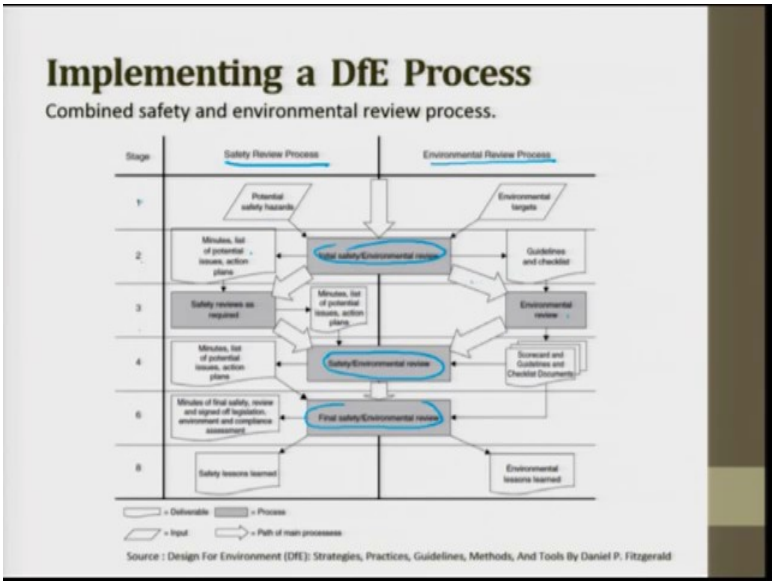

So, if you look at it these are the stages, 1 2 3 4 5 6, these are the safety review process, these are the environmental review process, in a safety review you have potential safety hazard, minutes list of potential issues action plan.

Then you have safety reviews as required, minutes list of professional issues and action plan, you have safety environmental review, initial safety review and final safety review, when you look at environmental, it is also the same, environmental review environmental review, these are deliverables these are deliverables, these are processes, these are inputs and these are the path with which you have to go.

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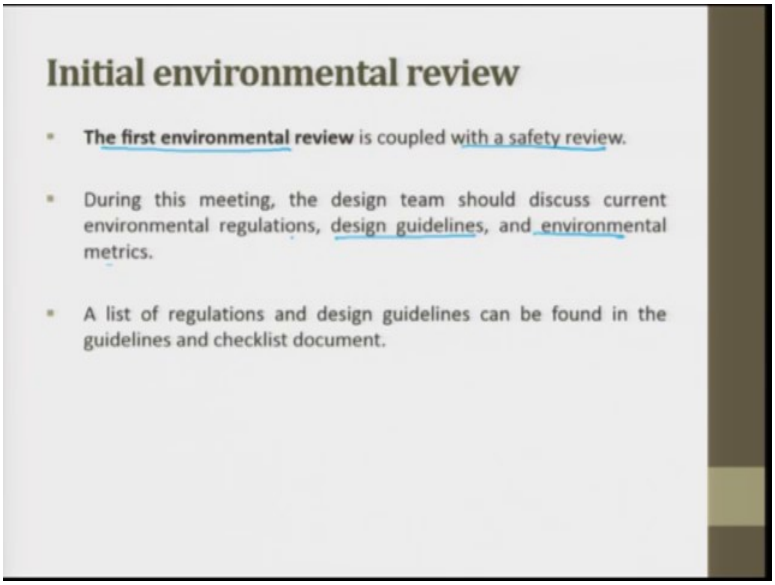

The product initiation document, the product initiation document is a document that Black and Decker used to benchmark competitors define performance target and predict profitability. The first environmental review is coupled with a safety review so that is very important, we saw that. During this meeting the design team should discuss current environmental regulation design, guidelines and environmental guidelines matrix. A list of the regulation and design guidelines can be followed in the checklist of the document.

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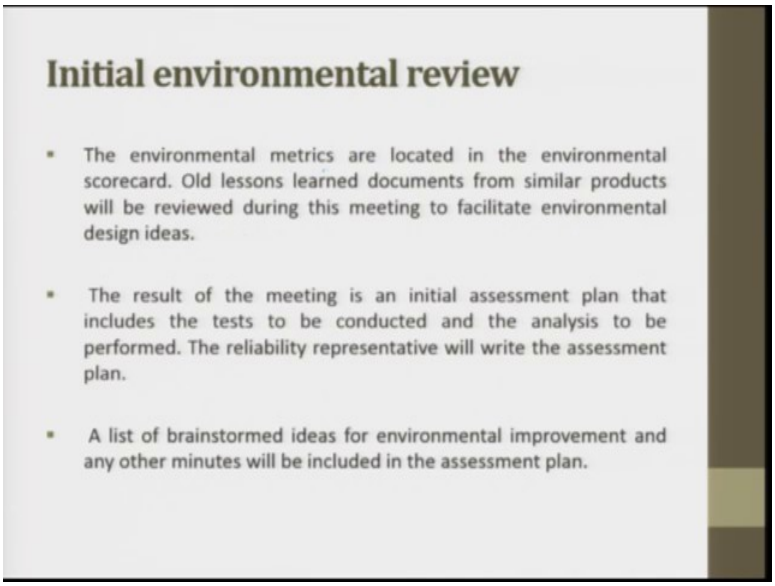

The environmental metric are located in the environmental store scorecard, all lessons learned document from similar products will be reviewed during the meeting to facilitate environmental design ideas. The result of meeting is an essential assessment plan that included the tests to be conducted on the analysis to be performed. A list of brainstorming ideas for environment improvement should also be considered.

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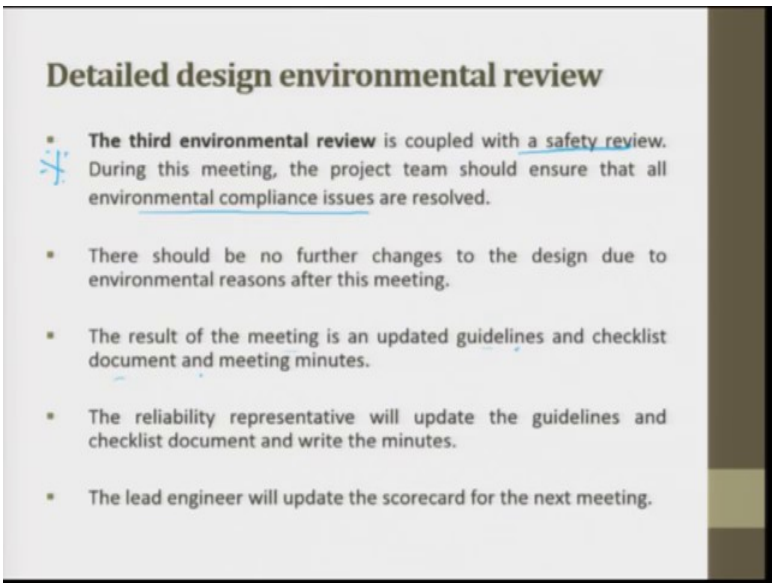

The second environmental review is held separately first is held, then it is from safety review so, first is held, with is, coupled with the safety review. The second is held

separately from the safety review, the second conceptual idea is evolved and it is used. The third one is coupled with safety review during this meeting the project team should ensure that all the environmental compliance issues are resolved, so this is very very important, ok. The results of the meeting is updated is an updated guidelines and checklist document and meeting minutes.

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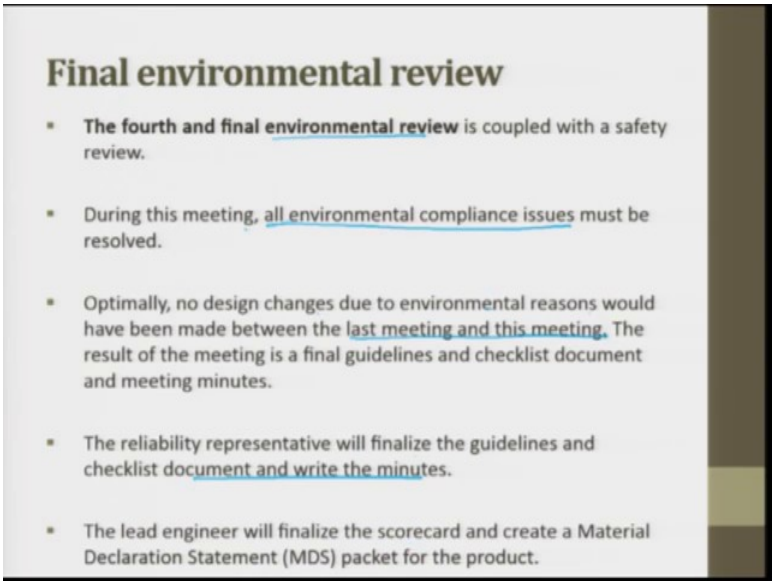

The fourth and the final environmental review is coupled with the safety review during this meeting all environmental complaints issue must be solved. Optimally, no design changes due to environmental reason would have been made between the last meeting and this meeting. The reliability representative will finalize the guidelines and the checklist document and write the minutes. The lead engineer will finalize the scorecard and create a material declaration statement packet for the product.

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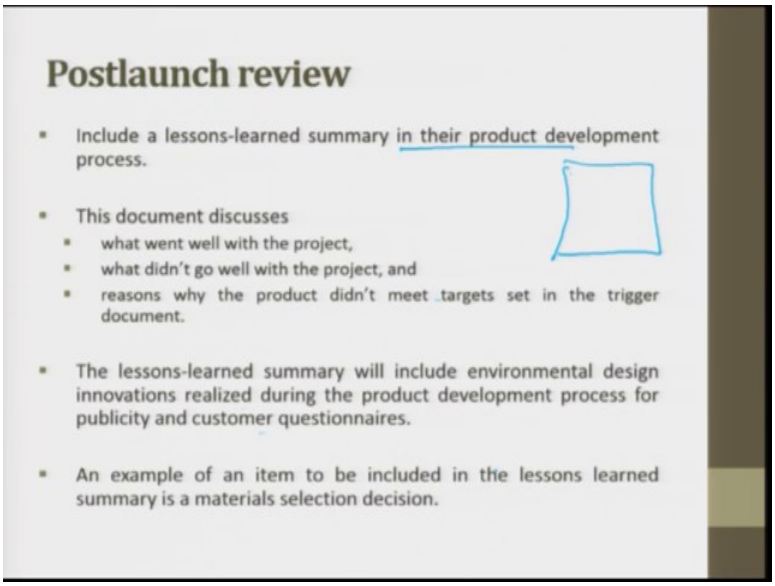

The post launch review includes the lesson learned summary in their product development. This document discusses what went well within the project, what did not go well within the project, reasons why the product did not meet the target set in the trigger document. So, you list down everything and put it black and white and keep it in a separate place.

The lessons learned summary will include environmental design innovation realised during the product development process for publicity and customer questionnaire. An example of an item to be included in the lesson learned summary in the materials index.

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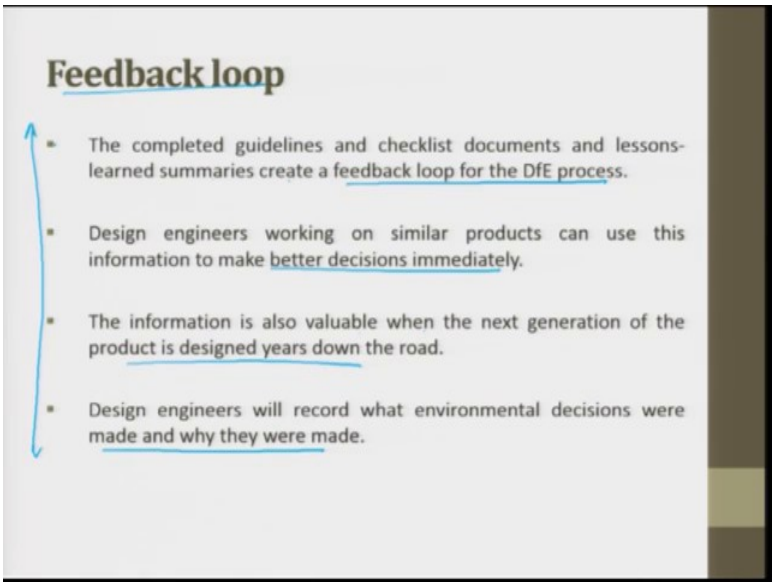

There is a feedback loop, the complete guide lines on the checklist document and the lessons learned summary create a feedback loop for DfE. Design engineer working on similar products can use this information to make it a better decision making. The information is also valuable when the next generation of the products are designed. The design engineer will record what environmental decisions were made and why were it made. So, all these things you take a decision you will not be able to meet out in the first version.

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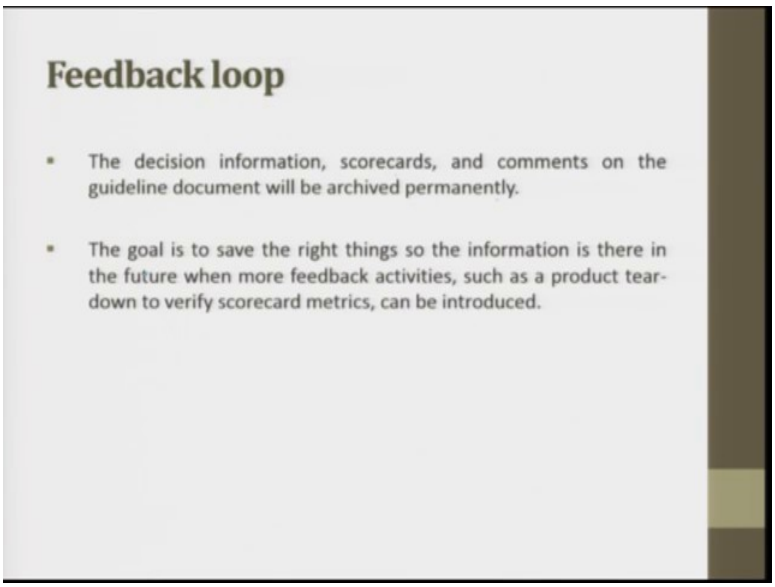

But in the later version you will be able to meet out the decision information, score card comments on the guideline document will be archived permanently. The goal is to save the right thing so that the information is there for the future.

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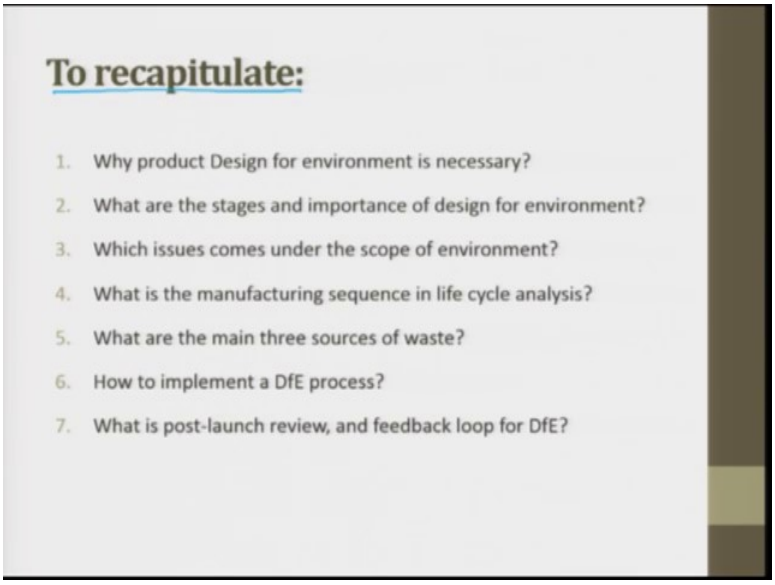

So, to recap whatever we have done, why product design for environment is necessary? We saw, what are the stages and their importance? Which issue comes under the scope of environment? What is the manufacturing sequence in life cycle assessment? What are the main 3 resources of waste? How to implement DfE? And what is the post launch review and feedback loop for DfE.

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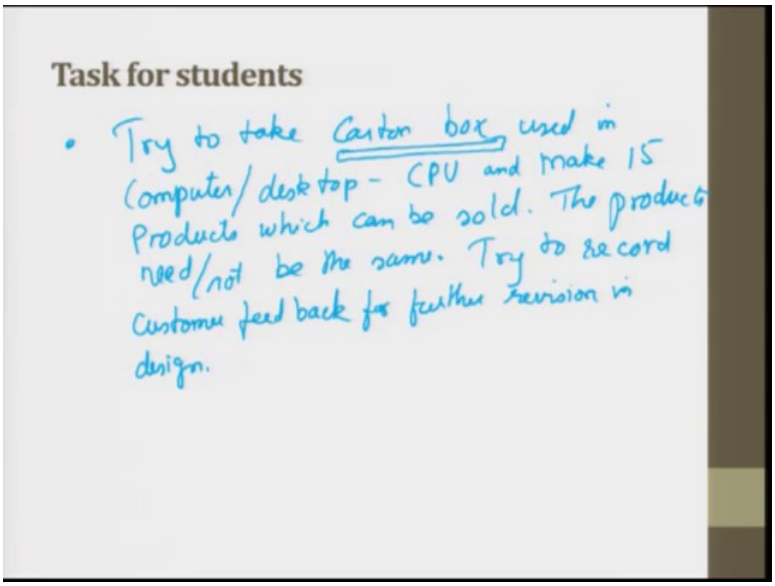

Task for students; try to take carton box carton box used in computer slash desktop. So, where you have a CPU, ok, take that carton take a carton box and make 15 products which can be sold. The products need not be the same, say for example, if you have made a spoon you cannot make 15 spoons and then give it you have to make spoon, fork whatever it is. So, this is an assignment please try to do what we are trying to do is we are converting a waste box into a value added product and that can be sold. Try to record customer feedback for further revision in design, ok, try to do this exercise you will try to appreciate how to convert waste into a useful product.

Thank you very much.