Carbon Accounting and Sustainable Designs in Product Lifecycle Management

Prof. Deepu Philip
Department of Management Sciences

Dr. Amandeep Singh Oberoi
Imagineering Laboratory

Dr. Prabal Pratap Singh
Department of Management Sciences

Indian Institute of Technology, Kanpur

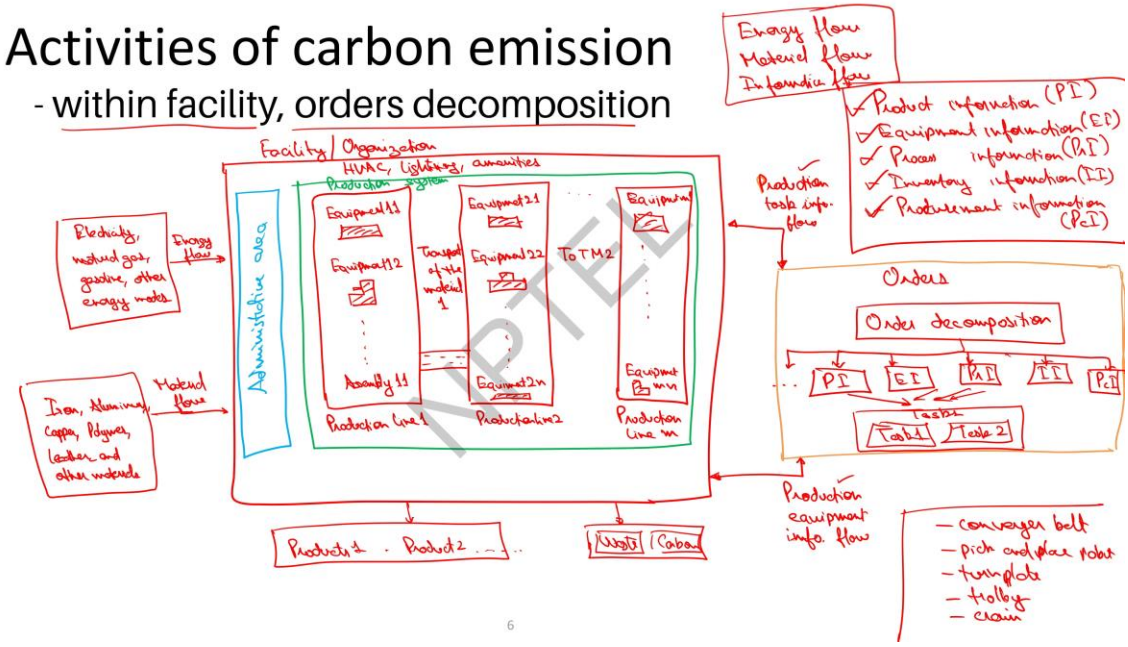
Week 06

Lecture 27

Activities of Emission (Part-1)

Welcome back to the next lecture in the course Carbon Accounting and Sustainable Designs in Product Lifecycle Management. This course is being designed by Professor Deepu Philip, Dr. Amandeep Singh oberoi and Dr. Prabal Pratap Singh. I am Amandeep. I had discussed about the levels of the manufacturing organizations and the corresponding decisions. We tried to discuss about the temporal level and spatial level activities and their decisions.

And we tried to also see the activities for the carbon innovation in which we saw the consumer and the manufacturing organization connections.



Where the connections are taking the same things forward, here I will try to talk about within facility, How do we decompose the orders from the upstream of the supply chain? If you look at the levels of manufacturing design here that we discussed in the last lecture. One thing I would like to discuss or put here is that when we move diagonally above in this chart, you know that the decision flexibility is decreasing.

I will put it here, flexibility is decreasing the case we are moving above number 1, from the unit cell to the overall system design. This is one point special point if I say or the flexibility is decreasing because we have the most control at the product design level itself.

Product design level when we have the product design we can make any adjustments in the CAD itself once the process is designed based upon the product design. Then the control becomes little lower though we still have a big control at the process design level itself. Then, when we go to the process adjustments, those are only major adjustments setup or establishment of the process is there already.

It is done. That is why the decision flexibility reduces. And when we go from spatial from the product level to the supply chain level, the product level small decisions could be adjusted more readily than the overall supply chain. So, that is why when we move

diagonally, the decision flexibility is here reduced. That is why we need to understand the orders that we take from the different suppliers.

What are these orders connected to? And we need to decompose the orders as per our requirements in the very beginning as far as possible. So, what are these? Before initiating any order, it is imperative for an organization to verify several production details which includes the product information. We need the equipment information along with it the process information, inventory information.

And the procurement information, I will put it as PIEI, PRI inventories II and procurement PCI. These sets of the details or the information we need to have when we are trying to put our system or design our orders within the facility. Subsequently, once we have gotten the information, we try to then proceed to develop our production tasks, assign production equipment. Based upon the process information, execute the relevant process or processing activity. And we try to utilize energy and materials accordingly.

So, let me try to draw another example, block diagram here where I have my organization. This is my organization or my facility in which I have certain systems different production lines or department whatever you call. I will call suppose, if I have equipment 1 1, here there is a machine that you have here and there could be another equipment 1, 2 another machine, right. A drill machine or so. And so on you could have finally an assembly 1, my production line 1.

So, it can have another production line similar to this in which I have my equipment line 2 first equipment. Similarly, I could have another equipment that is line 2 second equipment that could be maybe another 3D printers or so. And there could be assembly that might not be there. It could be only n number of equipment only equipment 2n, right. This is my production line 2.

Similarly, I will put it as n number of production lines production line m. So, this is my equipment, M1 equipment, M2 and so on up to equipment MN. How do the production lines communicate? There is something known as material handling. This is a material handling system that is the transport of the material from one line to another.

I will put it as transport of the material, right. This is one I will put it at transport of the material to here. So, there could be different phases could be conveyor line to conveyor belt. It could be robot this material hanging system. I will put it here, it could be conveyor belt, it could be pick and place robot, it could be turn plate.

Turn plate is a kind of a plate where the materials are swapped. One material that is here has completed its operation, another material has completed its own operation. These are then turned. So, this material goes to the this process and it is this material goes to the process in the right hand, this is swapping. So, turn plate then it could be maybe, lot of number of products.

So, if the number of units that you have developed are high maybe that could be put in trolley, it could be trolley even. It could be a crane, crane could be an overhead crane as well. So, any way we can use any mode we can use to transport a material from one production line to another. So, what is happening here? So, within organization, this is my production line or production system, I would say.

But other than the production system, the facility also have the areas such as it has an office or I would call it as administrative area. Why I have put in the overall red envelop and created two sets here administrative area in blue and production system in green. Because the heating ventilator system that you are using would be used by both.

So, here I have my HVAC system or you call it overall lighting design overall other general facilities would be given to the whole facility. I have my HVAC, I have my lighting, then I have my amenities, mean like you need to provide washrooms and anything.

So, that would be here for the overall facility, this is my facility or my organization. What are the inflows here and what are the outflows here and how is the interaction between the orders that we are trying to place here going to happen here? This is my orders for the system where I need to decompose my orders. These are orders I need to decompose. I will try to put here as orders decomposition in which I put all the sets of the information.

I have gathered here like, I put my product information, I put my equipment information. Then I also have information from the process. Then I have information from inventory and the information is also taken from the procurement cell and many other sets of information would be taken not only these they could be. I would put a dot dot dot because we are trying to decompose the orders and we need to have an information flow from my organization. So, let me put my system of orders into a cell.

So here the flow of information between two big envelopes would be there. So facility would communicate with my order cell and I have my production task information flow.

This is a two-way flow. Please watch the direction of the arrows. Also, I have production equipment information flow, this is again a two way information flow.

It is the process of product creation involves utilization of energy materials which in turn leads to waste and carbon emissions. I would like to put that here as well a strong correlation between the organization business operations and order information is there the orders.

Or order induced modification in organization business operations can have a dynamic influence on the carbon emissions of organization. That is why I am trying to focus it more here. Whenever we order something, the reversal of order in itself is a task that includes a lot of carbon footprint.

So, the production task information flow, production equipment information flow and just ordering right thing at right time. So that it reaches and inventory costs are not very high this is very important. So, another flow or inflows that goes into this organization are electricity natural gas or CNG whatever you call then any fuel gasoline and that means all the energy sources. So, this is my flow of energy I will call it as energy. Similarly, we will have material flow that could be depending upon the organization.

That is there it could be iron, aluminum or any metals that you call anything copper or you can call any polymer materials. Or maybe for a leather intensity, leather industry in Kanpur is very famous. Kanpur is also known as leather city of the world where the inflow is not the metals. It is the raw hides or we call it leather blue, blue hides. So, which also goes as material for example, it could be anything.

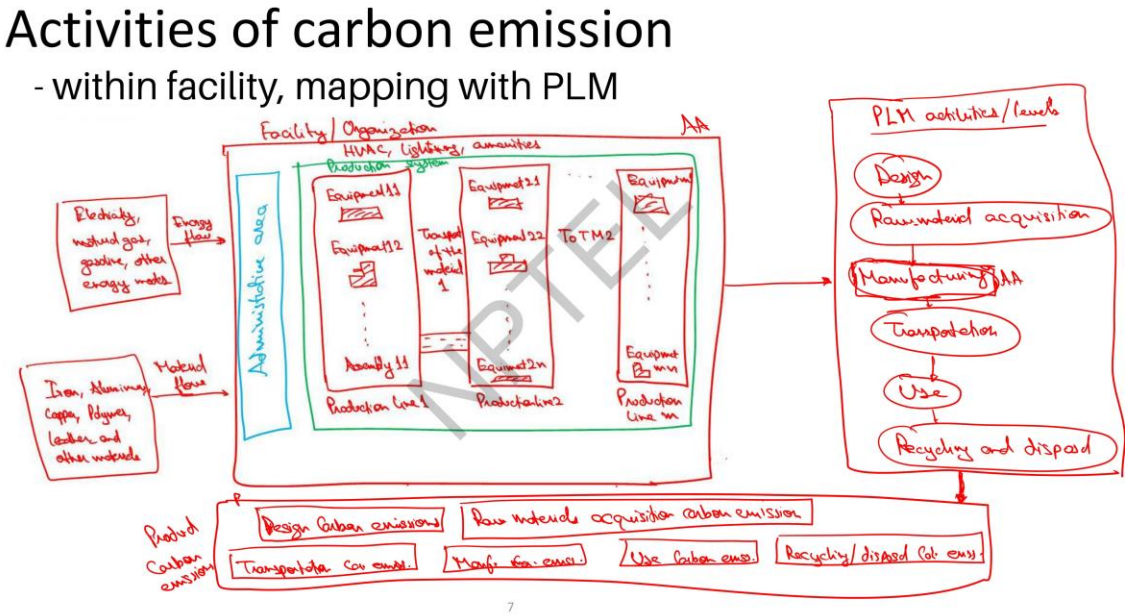
It depends upon what kind of industry that is there. So, in leather industry, it is known as the material intensive industry. It is though energy is there but it is more water intensive industry. Water that is consumed in cleaning the raw height then the water pollution that is generated or created through the processing of the raw leather. Here that is chroming 6 get mixed into the river Ganges all points are there.

So, depending upon what material is there definitely, I will put here other materials. So, this is my material flow, right. So, what is the output here? Output is we get products, product 1, product 2, so on. This is what we get, shown up to product N.

Though this was discussed, I am still putting here, I wanted to talk more about the orders here. The waste and carbon are also output. This comes out of the system. So, this is a product structure T, I develop this structure T and I would like to now map this with my

activities of the PLM. So, let me try to reproduce this ah picture in the next slide and try to see when we try to map it with the PLM (Product Lifecycle Management).

What are the activities in the product life cycle management and what are the carbon emission that we need to capture when we try to talk about the carbon accounting.



So, here I have reproduced my facility and organization with all of its components. With administrative area, with production system and ah this facility organization also having input as energy flow, material flow. So, there was also the exchange information between orders that is the production task information, the production equipment information which was there. Here I have tried to create some space so that I try to put the activities of life cycle.

I would like to say product life cycle or PLM activities here. Or whatever you call activities or levels which try to communicate with my facility that means I have design then raw material acquisition.

Manufacturing put circles here, design that communicates with my raw material acquisition, then we have manufacturing, then comes transportation. And then comes use is the same which I tried to talk about in the previous lectures where I tried to had the

connection between the facility and the consumer. So, now we have reached the user after user you could definitely recall we had the recycling and disposal I just put it in one step.

So, this PLM activities and levels take input from my manufacturing concern that means this manufacturing system here is it is AA. Now I would like to now jot down the product carbon emissions. So, what are the carbon emissions, we get the power carbons in the design itself, I would say design carbon emissions.

Design carbon emissions means when we try to design and redesign and we try to run a facility and systems of simulation where we are trying to design. Carbon definitely is also used here and consumption is also happening there.

Then we have raw materials acquisition, carbon emission, raw material acquisition, alright. Then we have transportation, carbon emissions, then manufacturing carbon emissions itself after manufacturing. Corresponding to the activities in the PLM, we have huge carbon emissions and carbon is also generated when we try to recycle or disposal of carbon emissions. So, these are my product, carbon emissions. So, these come from my PLM activities we find.

So, each organization is involved with production of products, functional modules and parts contributing to carbon emissions during the life cycle activities. So, here life cycle activities of a product that is functional modules and parts in each organization influenced by energy flow, material flow also we should not miss here the information flow that was here.

So, that means, I have three flows here I will have to just put it here once and it is energy flow. Material flow and here we have production task information and production equipment information that is information flow, right. So, here what we have discussed is the facility or organization has certain inflows energy, material information and it interacts with the order decomposition system.

In the order decomposition system also we have certain tasks which are there when we try to really generate a purchase order, there are certain tasks. Here, I would say tasks are there this could be task 1, task 2 and so on. So, these are here, taking information from product, equipment, process, inventory, procurement or anything that is required to place the final order. So, I would like to now take a break here and we will try to talk about the activities within an organization and try to see and understand the activities at the unit

level. And then in the forthcoming weeks, we will try to see the carbon accounting models for them.

Thank you.