Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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Week 06

Lecture 24

PLM Integration (Part-1)

Welcome to week 6 of the course Carbon Accounting and Sustainable Designs in Product Lifecycle Management. We have discussed multiple facets of carbon accounting in the previous weeks. Professor Deepu Philip has given a detailed information on what carbon accounting is and what are the various models in general which are available.

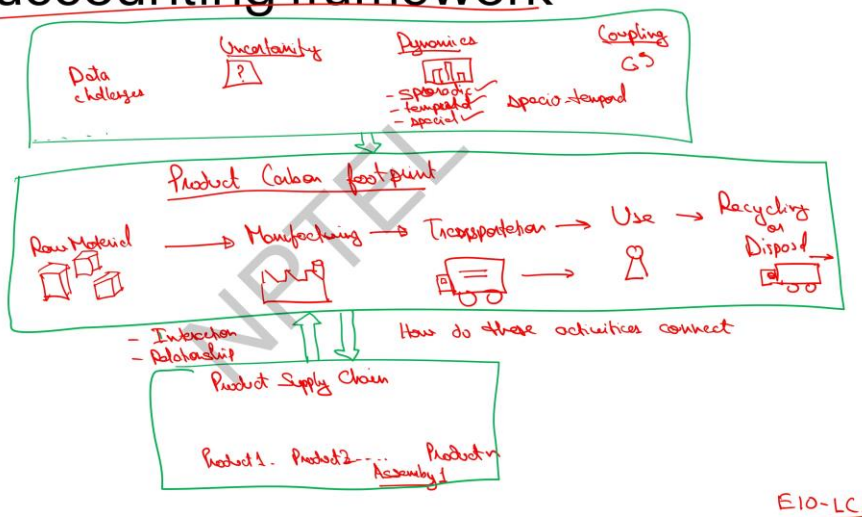
Certain relationships are also given, certain data points are also given for some example that he has quoted. Further we talked about PLM (Product Life Cycle Management) and I gave you introduction to the components of PLM in the last week. I will continue with PLM and its integration with certain other management concepts. So, this is PLM integration.

Contents

- Levels of PLM
- Integrations with PLM
  - ERP
  - MES

I will talk about levels of PLM different levels starting from the beginning to the end point, what do we expect from PLM and how does PLM integrates with different systems for example, enterprise resource planning and MES.

Carbon accounting framework



Let us try to talk about the overall framework that we are going to discuss throughout this course. We are trying to understand carbon accounting, carbon credits, carbon sequestration and multiple things. So, there are certain frameworks available. Majorly what do they wish to try to understand is product carbon footprint as we can mention here. Which means from the very extraction of ore that is the raw material acquisition. I have raw material with me different sizes of raw material are available.

Then we have to have a manufacturing concern what is this a processing system a manufacturing system that turns your raw material into a finished product this is my factory. Now, once the manufacturing is done, when we are talking about the complete supply chain of the system.

Definitely, we are also talking about transportation, the green transportation, the vehicles that we use, the sizes, the lot sizes that you try to deliver to the different wholesaler, the users, transportation systems. I have my transportation vehicle that tries to deliver your goods. Now, the product is used that is, it comes into the final use phase.

PLM helps here that when the product is being used by the consumer in a multiple ways and finally, we try to dispose it off or we call it recycling or disposal. So, this also is again a transportation system that takes it to the disposal places and you try to see where do you finally put your product.

There are certain challenges when you try to understand when we try to collect the data for the carbon accounting. The data that you try to acquire with different databases are available in the secondary form. There are certain databases available.

For example, EIO, LCA is one of the databases economic input output life cycle assessment. Life cycle assessment as I told in the previous fix as well was the term that had been used and it is still being used to assess the overall life cycle of the product in the terms of its carbon footprint.

They talk about the overall consumption. The consumption comes in the modes of material. In the modes of the energy being consumed and in the modes of the pollution that the waste is that is being produced or being created when we try to work upon any process.

Now, when we have a carbon footprint of the product to be assessed, there will be certain challenges, there will be certain uncertainties. What is there? When we have a carbon

data I would call it as data challenges. So, we have uncertainty in data that what the data is this. Data is uncertain.

Enterprise resource planning, manufacturing execution system, the part of those manufacturing resource planning, all of them needs data. Data has to be maintained. Data has to be taken from the previous records, has to be avoided in the current requirements, has to be saved for the future use. So, there are certain uncertainties because a lot of changes in the new products that do come are always there. Then, there are dynamics in the data.

When I say data dynamics it means data keeps on changing and there are certain outliers there are the certain points. The new product development is there when the product is completely new, there is no record available. It is not even uncertain the dynamics the way the data is changing, it could be. I would say the data is sporadic and there are temporal changes, there are spatial changes and we also need to have a coupling of the data. Coupling of the data means data is not available in isolation.

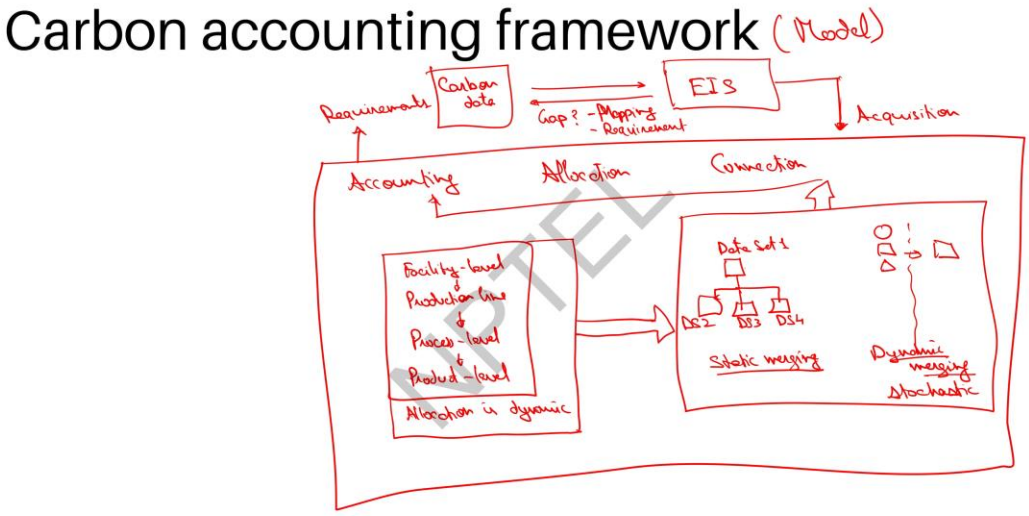
You need the specific carbon footprint for steel being used in manufacturing of a car. When we talk about manufacturing of a car steel being used specific car that you are designing.

What is the amount of steel specific you are using there, amount of aluminum, amount of polymer you are using there that is a different part. But the data that would be available would be a general car designs and people keep using different, now mix of the materials composites and many other things in their own designs. So, coupling of the data that is data is available in a mixed form.

So, this coupling of the data is there that is also a challenging data. That is data is being mixed at multiple points. Now, this is one part when data is there that is the challenge in the data. Another component in the framework is the product carbon footprint. Data has to be an input to this system.

There are certain other components, certain other entities or elements here such as we have product supply chain. What is supply chain? That means we have maybe number of products, it could be product. I would say product 1, product 2 and so on up to product n and these number of products goes through your supply chain system and there are assemblies here, assembly 1, assembly 2 and so on. When the supply chain system is there I will try to make an envelope over it.

This also has to interact to certain activities with the above manufacturing system that is there is one way and the other way interaction always there. So, this is I would say interaction and these are the relationships we need to understand. Let us try to see through this lecture the how do these activities connect it is a question. And when these activities are connected, we need to now see what method are we going to employ to work in these systems.



So, when you talk about models in carbon accounting framework, I would like to just put one method here. Let me say there is a carbon accounting system in which I need to allocate, I need to account, I need to correlate the data with various stakeholders and various levels here. Has to have the data from product level, product level gets the information from the process level.

When you say process this means my equipment level this gets the information from production line. And production line when we talk about it is one of the components or one of the parts over overall facility level. That is my complete organization.

This is my complete organization where the information flows from the facility down the product level that what is to be overall developed. So, this is again I would say an allocation which is dynamic. So, the model or the method I am trying to talk here is talking about accounting, is talking about allocation. it is talking about correlation or the

connection of different data points. At this level when the allocation is also part of it here we need to have the different methods of data analytics.

So, I would put here we have a certain sets of data I would say this is my data set 1 and this is connected to another data set. So, data sets further getting generated through it could be data set 2, data set 3, data set 4 and so on. So, this is what a specific set of the data that is being merged statically. Static merging is you have final product to be developed. For example, you need to develop or manufacture a mobile phone.

You have a data set available for the screen of the mobile phone. This is the overall carbon footprint that comes for it. For the ICs, this is the carbon footprint that comes for it. For the other components, I am only talking about the material. This is the carbon footprint.

You only try to put them or segregate into different forms, different kind of the material types for which it is being available. So, this is only static merging of data. So, this is static merging of data that is there along with it there are certain data points which are available. In which, we do not have the data directly for example, the energy or the indirect data in of the carbon footprint. For the development of the softwares, the operations, the people who are working the facilities which were there.

Overall carbon footprint of that the third parties who were given the systems to be taken, already ready made from them. What were their overall carbon footprint? So, that means there is always dynamic merging as well. When I say dynamic merging, so we have the data available in various forms. It could be let me say I am putting various forms of data here and these are to be finally merged to get the data that I could use.

So, this is dynamic merging and static merging. So, there are static merging methods for example, traditional methods. So, when I am talking about dynamic merging, I am talking about the temporal form of data. I am talking about the other than static the things which you have mentioned in the previous slide, the sporadic data, the temporal form of data, the spatial, the spatiotemporal form. I would put it here spatiotemporal.

The data could also be stochastic. Stochastic means the data is having random probability distributions. It can be definitely determined through various statistical techniques, but still accurate form of the data accurate output is not available. So, data changes with time, changes with other variables. So, there are always dynamic merging when we are talking about the data analytics.

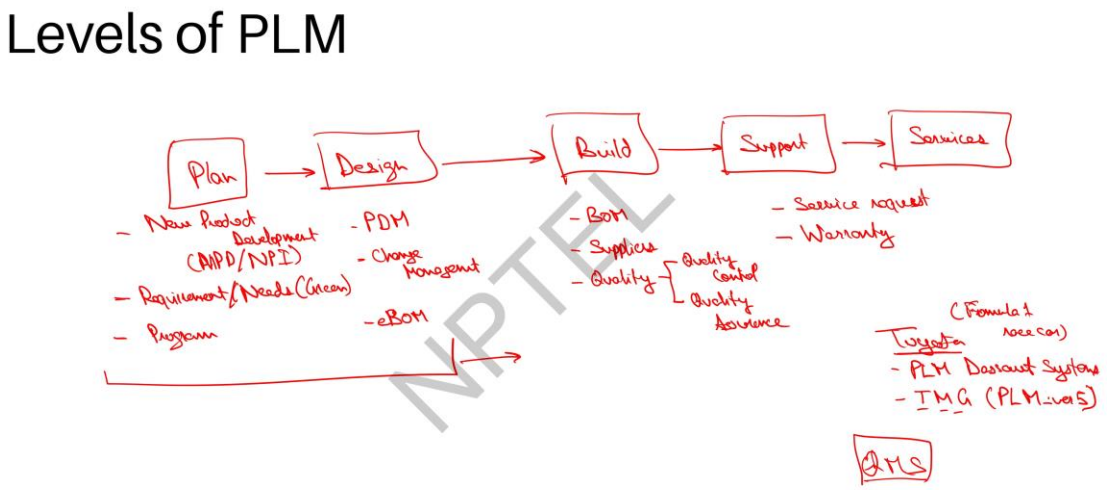
So, here all the points that we have gotten through various forms or that we have collected. These are connected here from the various levels the static merging the dynamic merging this could be there that means, the merging of the data is there.

So, that means, now we can have the data available in some form and we can account it this is accounting. So, here what we need to finally, get out of all the system is we need to get carbon data. Carbon data and we have our EIS, EIS is enterprise information system and the carbon data that we have gotten has to be put as an input to the information system to run the overall enterprise.

In enterprise system and there is always a two way interaction. So, there is something that we need to reuse is if there is a gap that is to be seen mapping has to be taken care of then we have to see what are the requirements of the data. So, I get requirements. So, in a way I could put we take requirements from here. And we put the acquisitions here and from EIS, I put the acquisitions here.

So, this will be more clear when I come with certain examples, I will be coming with examples in the coming week. Here I am trying to just give you what is the overall framework to have this framework understood in a detailed form. We need to understand what are the different other concepts or other overall roles of the management system. That is the enterprise resource planning that is the manufacturing execution system and how is PLM integrated with them let us try to see those. So, PLM levels to have the understanding of the integration of PLM with ERP with MES and also we will try to talk about the SLM the ALM in the forthcoming weeks.

We need to understand what are the levels of PLM. We talked about different components, different roles of different stakeholders.



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Let me see PLM starts from definitely plan, planning whatever you call it. From the planning we try to create a design. When you try to talk about planning that means either it could be new product development.

That is NPD or it could also be NPI information only. Then we have the requirements or needs of the design that we are going to develop. Here in the requirements or needs when I am trying to talk about the carbon accounting as well. I will put it here requirements which are green that is greenness or carbon performance in the overall system or the program. That means, we need to identify and reduce inefficiencies in the product manufacturing process.

Benefit of using PLM in the modern technology is that it allows the manufacturers to improve the whole management of product creation, development, building, support, maintenance. And these are only the points or the levels of the PLM. So, when I talk about the creation that means product planning or design, that is creation of the product. When I talk about development, I will put it as building of the product and when I talk about the support. This includes the service warranty, all those things.

And after that definitely the services could be also put here services are maintenance. Here when we talk about design, we talk about product design and manufacturing PDM. Then as we talked in the previous week, change management and we have our design that

means definitely bill of materials has to be there. And when I am putting bill of material, we are talking about E bill of material. This bill of material goes as input when we try to manufacture or build so this becomes my bill of material as first point here,

Then we have the availability of suppliers, then we have to have, when we talking about suppliers, we need to have a quality control system. That i will put quality in which i have quality control and to make sure that quality control system is itself running in a precise way. I need to have a quality assurance system.

So, we take into account the early process of transferring information and overseeing product designs in the beginning itself. So, we try to develop the bill of materials specifics with the product lifecycle management itself and we try to transfer this to the building system or manufacturing system.

To enhance the effectiveness of the organizations, we introduce core protocols alongside modifying commercial operations. Core protocols, that means, we try to put our PLM system and we try to for instance in support, we try to create a system so that each service request is catered in time. Because we have the full data available from the very beginning itself where the system or the product is being developed.

Track of each component, the vendor who has delivered the component, the people who have worked upon them, the operators, the machines which the components has gone through all those parts are there. The service request whatever we get suppose if it is a big breakdown or lot changes, something has to happen.

That could be taken as a study and it could be definitely tracked where the issue was, this is what our QMS system helps us. QMS, I talked about the ISO and other QMS system in the previous week. So, this is quality management system and here when we test support PLM level also helps you to have a In services. I would definitely say services are difficult supports are there, services are always there. So, we need to make sure that what you are trying to deliver is delivered in a way so that the customer has full confidence in using it.

These are our levels of PLM. Certain multiple examples could be quoted here. For instance, we talked about the Toyota car, the carbon footprint and that. way before the current times 2 decades ago in year 2000 or in 2000 itself in may be in year 2003. Toyota used the PLM dissolved systems. This was specifically used for the formula 1 cars.

So, this was for, I would put it here, formula 1. Race car where you cannot afford a second a millisecond of the delay if you say. So, Toyota used the PLM dissolve system so that they can completely have a track of the any failures in the system. Nowadays definitely digital twins are coming lot of things are coming you try to run the system in the simulation. So, the Toyota they call it as the Toyota motor support.

They call it as TMG Toyota Motor Support GMBH. It is a generative car industry that used solutions to develop Formula 1 car designs for their 2004 season. So, TMG helped them to have a generative car design solutions in the product lifecycle management version that is PLM version 5 what they call this PLM version 5. This was one the PLM became an inherent system in designing any automotive systems. So, this was an again an initiative taken by Toyota.

So, I will take a small break here and this is first part of the lecture where we are talking about the integration of the PLM. I will talk about the integration of PLM with the manufacturing execution system with the enterprise resource planning in the second part of this lecture.

Thank you.