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

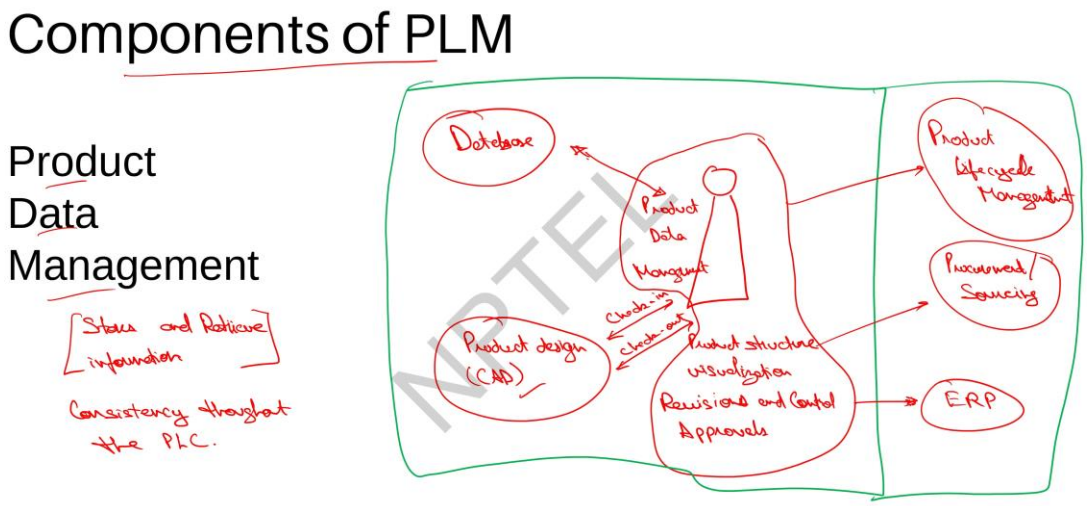
Indian Institute of Technology, Kanpur

Week 05

Lecture 23

PLM Components and levels (Part-2)

Welcome to the second lecture on the Components of Product Lifecycle Management. We are discussing the Product Lifecycle Management in the course Carbon Accounting and Sustainable Designs for Product Lifecycle Management. I am Dr. Amandeep Singh.



Product data management is the component that I will discuss first. In today's lecture, we talked about the different components, product data management, manufacturing process management, change management, supplier management.

Overall managed by the project management system. And we also saw the different stakeholders there, customers, people, business strategy, they all participate in the overall PLM system. Now, when we talk about product data management, definitely there would be a database. Database means it has information about the customers, the previous experiences, the vendors. So many entities are there for which it has the information.

Throughout the product design process, product data management is a process that stores and retrieves information. And this is done storing retrieving information to ensure that the details remains consistent throughout the life cycle. I am putting PLC throughout the product life cycle. So, using the simultaneous engineering that is the concurrent engineering. Is one of the advantages when it is required as it follows the immediate dissemination of information to those who require it while also maintaining a control over it.

So, that is why a database is there which has information about the different stakeholders, different entities which are participating in the product. Definitely, one of the major data that you get in the beginning is the CAD data. I would call it product design or I will call it CAD (Computer Aided Design). So, I have here my product data management. It interacts the database, it gets the information from database, it keeps on giving the feedback and also there is iterations of the design.

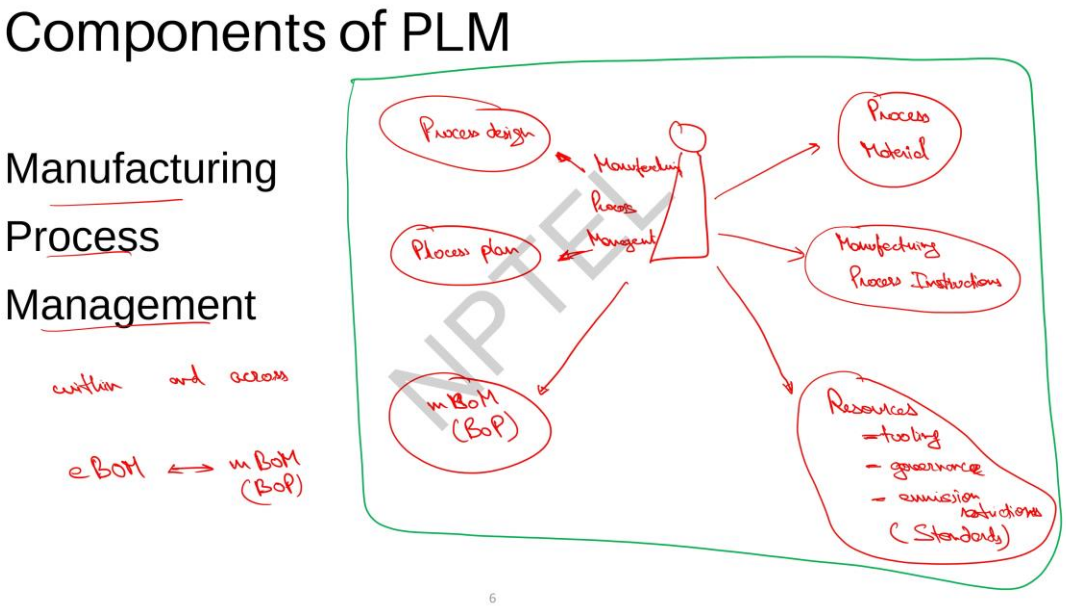
Designs would keep on changing as and when it goes through certain steps. When it goes to the designer, it goes to the engineer, it goes to the final user for use, certain designs would keep on coming. So, we have here the product structure. We have the visualization because we are talking about the CAD, the rendering. Rendering means you can look at your product being kept on your own table.

You can look at the car being parked in your own parking space in your house itself. The visualization, otherwise the features of the car, the different curves, different colors that you wish to see, all would be part of it. Then definitely because we are checking in and checking out. I will say this is check in the data and this is checking out the data right data in data out or a feedback out that means, you are having different revisions. When we have revisions in the database in the overall data management, definitely we will have to have a control.

And after revision and control finally, we always have to have approvals. So, this has to communicate this whole system product data management system has to communicate with our overall product lifecycle management system. And because we are talking about the product structure, we are talking about visualization, different components should be there. Vendors always have to be part of it. So that means sourcing the information or sourcing or procuring the components or procuring the materials.

That is also important. I will put it as the procurement or sourcing. This will be more discussed by Dr. Prabal Pratap Singh in the coming lectures. So, how are we connecting this or we making an envelope over it? I am putting it like this.

This connection has to be made here and also enterprise resource planning. Which is a complete enterprise planning that includes human resource, funding, all these parts will also give an input or the information here as well. The people who are responsible for policy making, the people who are responsible for financing the product and everything. So this is how it goes. So this will be more discussed in the forthcoming lectures. This is just an introduction.



Next is Manufacturing, Process, Management. Once the design is ready, once the database is there, second component is manufacturing process. When we talk about manufacturing process, I will talk about this in detail. When I talk about manufacturing

process, as I said, there are softwares which try to manage your overall product manufacturing.

That is Siemens example, if I say NX is a component that talks about the product design. That gives you visualization, that gives you the simulation result as well, but with the performance of the product in the specific environments also. Then, in manufacturing process management also we have the process of manufacturing. Process of manufacturing means the layout, the span between machines, material handling, all those parts. So, this is managing the process of manufacturing.

So, if I put it here, my manufacturing process management involves application of enterprise business process and management tools to the management of manufacturing. Management of supply chain activities within the system or across the comprehensive enterprises.

I would say here within the system and across. So, manufacturing process management integrates the E bill of material. That is engineering bill of materials that is bill of materials of your product that you wish to manufacture and the M bill of material that is manufacturing bill of material.

Or we also call it as bill of processes which are required when we try to structure or completely manage your product using the given eBOM. That means as we already have the product design here, now we need to have a process design. A process design and this process design will always have a process plan in which we will have our manufacturing. Bill of material you call or bill of machines, whatever you call. This is also known as bill of processes, right.

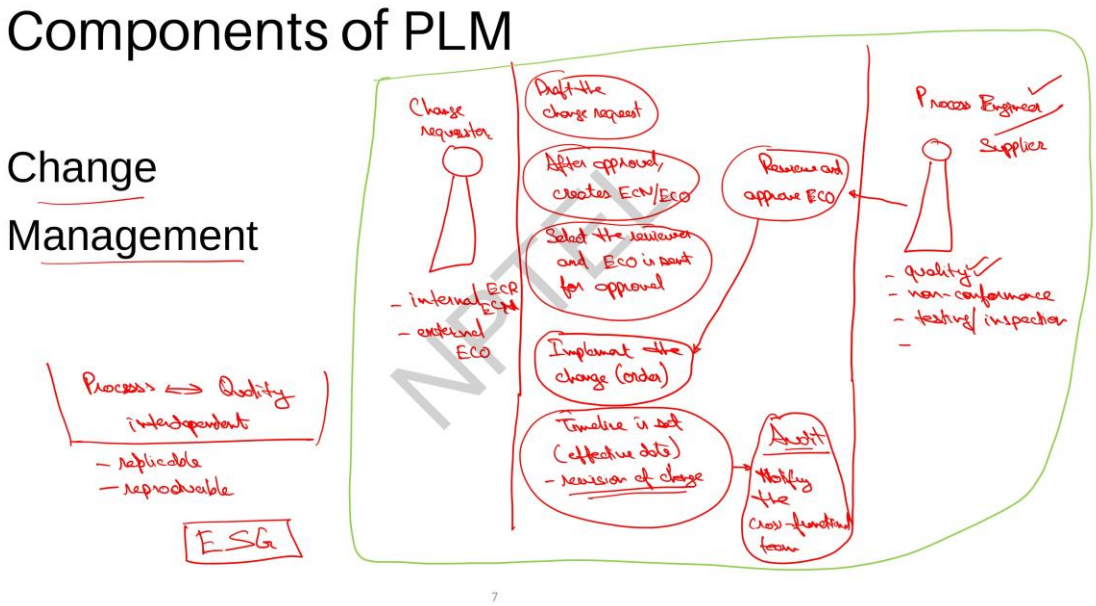
Then the materials being used in processes, the tools, the fixtures, the consumables, everything. That is process material. This process material is part of it and manufacturing process instructions as it was also mentioned in the previous slides. Manufacturing process instructions. That is the sheets that we give to the people who are going to develop the product.

For instance, if it is a software lifecycle management, if it is a service lifecycle management, if it is an application lifecycle management, the complete pipeline. The responsibilities which are given to the different people, people who are going to design the user interface, people who are going to design the GUI. But that is the calculations

which are happening behind. So all the people are given the process instructions. So this is a manufacturing process.

In those cases, those would be the service process instructions. So here definitely other than the regular process material, we will also have to have many other resources such as tooling. Tooling you can put it in the process material or you can put it here in the other resources as well. Then we have to have the information about the governance models. I am talking about governance here because we are talking about the carbon accounting, the emissions restrictions.

All the documents are there or I can put it here as the standards. These all become our resources when we are talking about manufacturing. So, I will put this into an envelope.



One of the most important component is change management because change is something that is rule of nature and it is an unchangeable rule of nature. So change request has to be given, change process has to be taken.

So I will draw a two stakeholder systems here. One is a person who requests the change. I will call him change. Now it depends whether the change is internal or change is external. Change in internal means within your factory, within your room itself the change is there, within your machine system a small change is there.

That the worker or the operator itself can do or the operator has to only refer to the supervisor to make small change. If the change is external, from your department, the change is going to other department. That also becomes external. Another level of external is a change in the material, a change in the manufacturing system overall. That goes outside your factory, outside your unit where you are trying to develop your system.

That is external change. So it could be, I would say, either internal or external change, internal or external. Here only the things which I discussed previously like whether it is engineering change request. Or it is engineering change notice or it is engineering change order depending upon the level of the change. Whether it is within the system or across the systems or in the system of the systems it is going out of your overall system of the systems.

So, it depends upon the level or the size of the change that is going to happen. So, this external is generally given by ECO. This could be by ECR or ECN. Request and notice, external is an order. But order is not given by the change requester.

ECO definitely would be given by the process engineer, the person who approves the change. That will come here. I will put it in between. So, now, here is a process engineer. Process engineers who try to understand the quality of your product or who tries to understand the non-conformance that means he does testing or inspection.

It could be test engineering manager, it could be production supervisor, it could be your EHS manager or if it is external, it could be even your plier. Now, here we draw the boundaries and let us put the process in between. What does the change requester does? He draft the change request attach a problem report with it. Then after approval once the change request is approved by the first level he creates either an ECN or ECO, majorly ECO would be created.

Then reviewer is chosen between the process engineer, the supplier, the manager who shall work here we choose the reviewer or we say I select the reviewer and ECO is sent for approval. Once this approval goes here, so I would say review and approve engineering change order that is the responsibility of the process engineer.

Or the supplier or the manager or the supervisor whosoever is the person working in this manner. Now we have to implement the change or the change order right now once the change is implemented. We now know the change is there the material which was selected is not accepted by the people who are working on it.

The machine is not able to do that specific work or the coding, which is given to the specific person, the person is not capable to do that. Or we do not have the lessons available for the software, where this coding is required. Or maybe some rendering in the visualization is not happening that has to be taken care by having the help of the third party. Now, this change order has to be taken is implemented, I have said. We have to put the timeline.

By what time would you do it? So, we try to put here the effective date. Timeline is set. That is, I try to put the effective date. This date is put for what?

That is, today, maybe it is 15th of August, I have implemented this change. I give you two weeks. Now, 15 plus 14 by 29th of August, the change would be reviewed once again and that should be reflected to be corrected. So, I would put here, this is the effective date for revision of change. This is there when we are talking about the implementation of change, the review and approve is always required, not only implementation would happen.

And once the effective date is put there, so there is always because change is there, change should not happen time and again. Otherwise the systems definitely are having something on stake. When we are doing something, time and again, the resources which are incurred in that, the time, the money, the human resource, everything is incurred in that. So, all those is going waste. The change, once in a while is okay, once or twice iterations are definitely would be there.

When we try to have a system that could be completely having a carbon accounted for as minimum as possible or as per what is required or standards. Now, this should not happen time and again. We need to have an audit team. So, we say audit is happening. That is, we notify the cross-functional team.

This audit happens only after the timeline is set. That is the next revision of change that is happening that could be taken by the process engineer. And along with it, a person from a cost functional team, a representative would come who will help us to have the audit of it. So, this is the overall envelope of the change management process. And this is very important component when we are talking about the components of product lifecycle management.

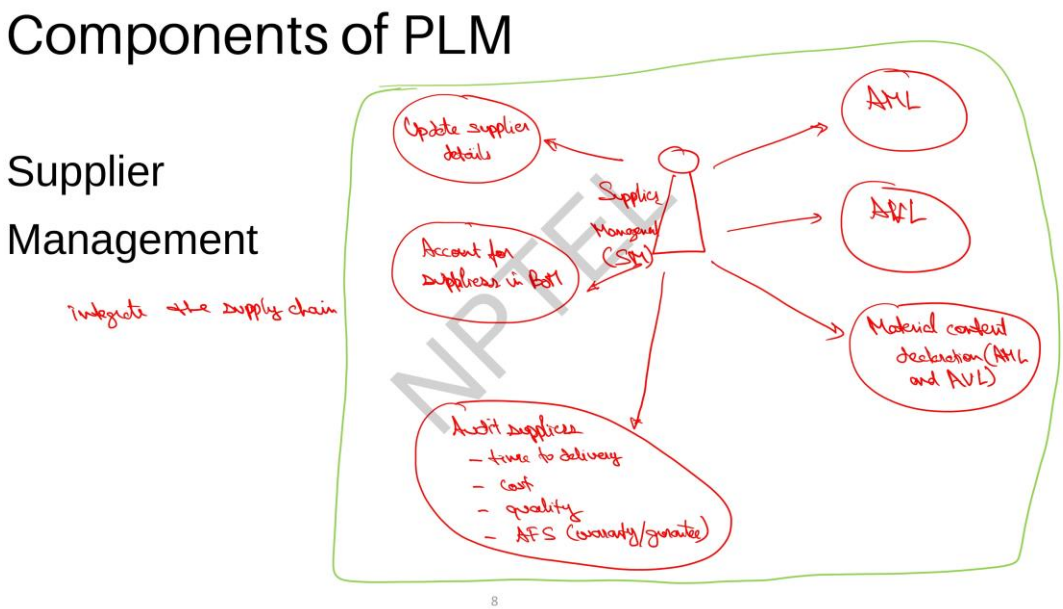
After change management, definitely quality management is always part of it. When we talk about change, the quality, when I am talking about the people who are working here.

I am talking about the people here who could be quality engineer, it could be the quality management. Maybe the bill of quality could be prepared, where quality improvement is there, where design for quality could also be there, quality planning, quality execution. So that the change is acceptable.

In order to accomplish the desired objectives in PLM, the manufacturing process and product quality are independent. So, I would say process and quality, they are interdependent. So, they also depend upon reproducibility, whether what you are producing is it replicable, is it reproducible. This is what determines the quality. A PLM system is implemented by enterprises to streamline the product growth process.

The primary objective of any manufacturer is to ensure the integrity of their product manufacturing and they have to follow the norms. For the sustainable manufacturing processes, that is, the carbon footprint has to be within the norms. And definitely, if some carbon sequestration could happen, carbon credits are earned. So, in order to guarantee that system is having a success in this, quality procedures are to be well developed. It has to be identified, rectified at right time, and we have to maintain the standards.

I will talk about the ESG in the coming lecture. We will see different norms which are there and different standards which are there which determines the quality of the systems.



Now, one component I will now like to discuss is supplier management. When we talk about supplier, definitely we need to have a full detail of the suppliers who are there. We need to have products.

We have to have the updated information of the vendors. Suppliers are businesses that market product and also offer solutions to other companies by maintaining their own products. So supplier management is the process that ensures that a business obtains a value for money it spends on its suppliers or with its suppliers on its materials. That they are procuring so maybe to put it in other words suppliers helps to overall integrate your supply chain. So they help to integrate the supply chain.

This is there to facilitate the supply chain into the PLM and this enhance its ability, The ability of the overall system to facilitate the part selection process by providing manufacturer and vendor information at an outset of that design phase itself. So, that is we try to maintain supplier parts in our bill of material. That is when I create my bill of material, we take into account for suppliers in bill of material. So, as I said in the previous slides, we have our supplier.

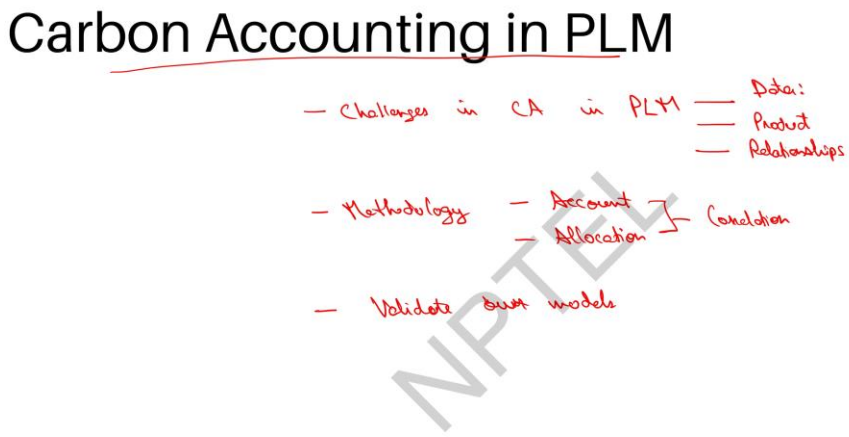
That is approved manufacturers list of parts. Then we have approved vendors list of parts. So, those are put here. That is I put my approved manufacturer list of parts. I put my approved vendors list of parts here.

Finally, these two are to be taken together to develop a material content declaration which involves our AML and AVL information. When supplier is there and these are all taken into account or maintained with their availability of the material whatever they have and supplier details are regularly updated.

We have here supplier audit that is we audit suppliers at periodic intervals, right. We order suppliers with their different performance parameters may be their time to delivery right, their cost of components. Their quality of components, their after sales services that means, their warranty guarantee anything or this is suppliers audit.

So, these are all managed by our Supplier Management System, I will call it SMS. So, when we are talking about suppliers, they are to be managed, I talked about already the ISO standards or the different quality management system that suppliers should also have when we are trying to get the materials or the processes through them. So, this all is managed by our project management system. As now I have explained the components of

the product lifecycle management system which are managed by overall product management. So, these are to be taken for the carbon accounting as well.



9

So, what I will be covering in the coming lectures is in carbon accounting in PLM. In the coming lectures, I will try to discuss about different challenges in carbon accounting in product lifecycle management. For instance, there could be challenges in data. That is, data could be uncertain, data could be not clean, data could be having some dynamics or so, we do not know.

Then, we will talk about the challenges in the product carbon footprint that is raw material which are being acquired, manufacturing system which are there, transportation, then recycling, disposal. There could be challenges in the relationships between the supply chain and the product. This we will discuss.

Then we will see what methodology could be followed, so that we account the carbon footprint, so that a proper allocation of system is there. Allocation in a way so that the energy consumed is minimum, so that the product, the inventory that is being kept is minimum.

So, a lot of things would be taken care and the correlation between various points we will discuss. Then also we will see that how do we validate our models once we develop. This all would be covered in the coming weeks where I will give you the different problems or

challenges in carbon accounting when we talk about. In the product life cycle management the sustainable designs how do we do and the design for environment part will also be touched. Then we will talk about methodologies, different models will be presented, models which could be implemented.

Which could give the accounts, the allocations, the distribution in the system in such a way so that the overall carbon footprint for the product life cycle is optimized. Then we will try to see how to validate our models and you will also see the models which are developed. Which are available already in the existing softwares.

I will give you a small demonstration or introduction to different soft systems which are available, which helps you to evaluate your product or your design. This all will be covered in the coming weeks.

Thank you.