Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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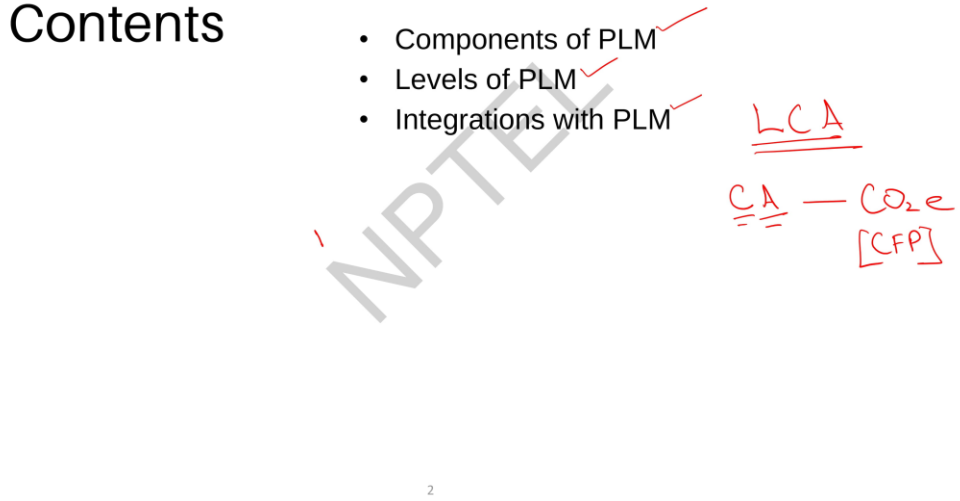
Week 05

Lecture 22

PLM Components and levels (Part-1)

Welcome back to the course Carbon Accounting and Sustainable Designs in Product Life Cycle Management. Till now, Professor Deepu Phillip has given a detailed introduction to what is carbon accounting, different kinds of the systems that is productivity, sustainability concepts are also introduced.

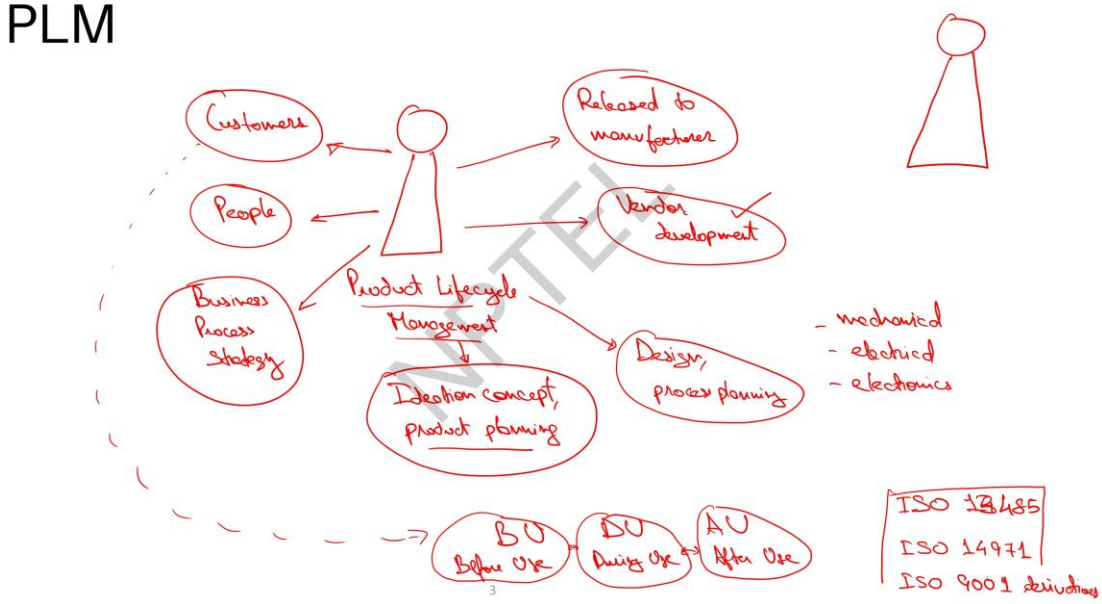
Carbon accounting models are also given. And some introduction is given to product lifecycle management. Certain examples are also discussed, certain case studies are also discussed and PLM components and levels is one, that I will discuss today. I will take further, what Professor Deepu Phillp has discussed in the product lifecycle management.



And I will try to discuss the components of PLM, levels of PLM and integrations of PLM of different other management systems. PLM as a system, now we understand is managing the life cycle of a product. The product could be at any stage. A stage is there when the material for the product has just reached the manufacturer.

And there is a stage when it leaves the company or a factory, that is another stage gate, we call. So there are different stage gates, but from the cradle to grave. When we design the product in such a way that till grave when the product is totally disposed of. It is completely accounted for its LCA, that is Life Cycle Assessment. These were the few words which were being used previously a lot.

Now what we do, because now carbon credits, carbon sequestration, a lot of things are there. Now we use the word carbon accounting. Because finally, what is the amount of different other gases equivalent to CO_2e or total carbon footprint. What are we producing could now be calculated or could be quantified. And this course is helping you to understand, how do we account the carbon throughout the life cycle of a product. And how do we design the products in such a way that those are sustainable.



So, let me have a quick review of the PLM, what Professor Deepu Philip has already discussed in the last few weeks. So, there were different stakeholders in a product lifecycle management system. So, I will keep drawing the major stakeholder. This would be a symbol for stakeholder.

I will keep drawing throughout this lecture. So, this is a complete product lifecycle management. Product lifecycle management was previously restricted to designers only. What they used to do? They used to safeguard the design information.

Now, PLM must connect facility connected to the products that consist of mechanical, electrical, software, any components. So, we need the connections other than the basic requirements from customers. Because finally, what we need to have is quality conformance as per the customer's requirement. So different people other than the direct use customers are also there and we have a business process strategy. These are all connected to PLM.

Previously, as it was already said to the designers, they used to play the major role in designing, what the product is, that is the ideation concept or the product planning. This was all taken care. Now, different systems are there. For instance, it could be mechanical,

You know, each of the cars that we have discussed, smart cars, whatever those are, we call it AI.

What is AI? We are definitely working on the hardware in AI. When we talk about IOT (Internet of Things), or we talk about IIOT (Industrial Internet of Things) always there are three components. One is the sensors, which are the hardware. Which are always electronics, electrical, mechanical components.

Major electronic components are there. Then we have the user who has to interface between them and the final result, the AI, what we output that we require. So, these components are always part of it. So, when we talk about PLM, so we need to release the things to the manufacturer. So, whatever product planning the designers are doing, those are released to manufacturer.

When those are released to manufacturer, definitely when product planning is there, when we talk about people, there are vendors that whom do we order, whom do we get the materials from. That we call it vendor development. For instance, we are running a facility called as MedTech (Medical Technology), IIT Kanpur. Where we design the medical devices which are generally known as medical devices.

This is an ISO 13485 facility. So, here when we talk about vendors, vendor development is very important to maintain the ISO standards. So, the vendors should have ISO 14971. This metric facility is though not a complete manufacturing facility because we only design the prototypes. Then we send it to the clients or we leave it to the clients to take it to the manufacturing for approvals or so.

But whatever material we produce, whatever materials we procure, all the materials should be gotten from an ISO certified. Whether it is ISO 14971 or those are the other general ISO systems. I am writing ISO 9001 derivatives. I am calling derivatives because different class of the component. Different kind of the materials are having other than the regular 9001 derivatives, which are derived from this only.

Now, when we are talking about the vendor development, if there are vendors who are not having this specific certificate, we have to develop the vendor's information. Now, if I am saying carbon accounting for a complete cycle or the life cycle of a product. The raw materials that I am getting should also be certified in such a way, so that I calculate or put the carbon credits into my present use. It is always in the three phases. When we say before use, during use, after use.

But this is from the customer's perspective. I am talking about customer here. So during the use of the customer, when you have purchased that Toyota, Innova, High Cross car, you are the customer. You are using the car. For next five years, you will drive the car.

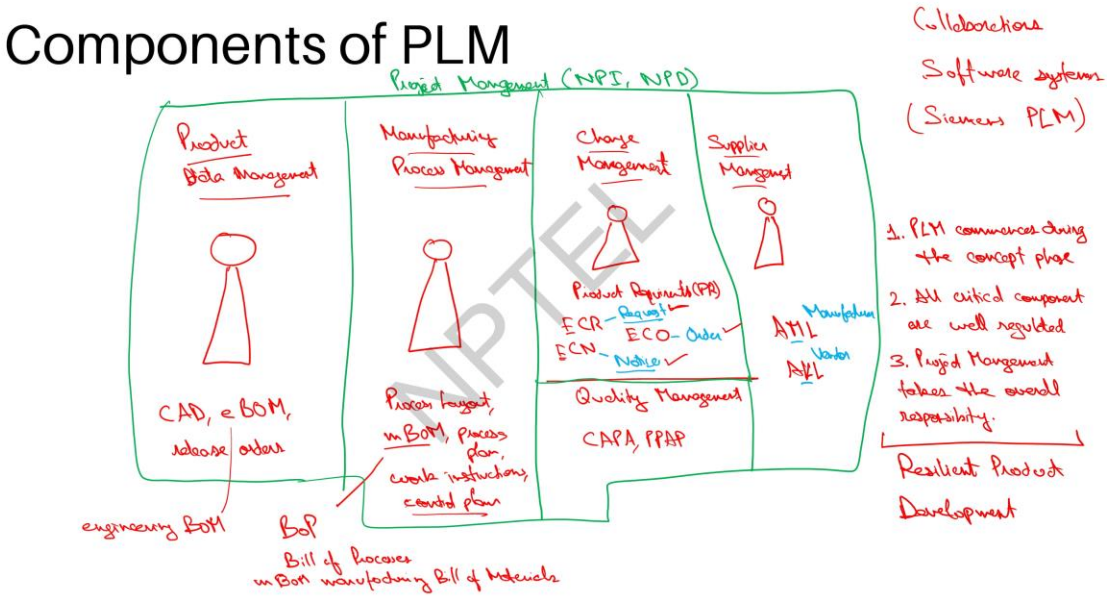
That is a during use phase. Once you sell the car or you resell the car, the car becomes a used car. It is reusing. Then further it goes to recycling phase. That is after use.

Anything that manufacturer is doing is before use. Even whatever is happening before manufacture that is also before use itself. So, these phases we will discuss in the forthcoming lectures. The point I am trying to tell here is vendor development, evaluating the vendor with the experience of the vendor. For example, many vendors are there, those who are supplying to IIT Kanpur for more than 10 years and the materials that they have supplied, there are questionnaires which are developed.

So, how are the materials and so go. So, those vendor development systems are to be developed. This always becomes the stakeholders of the total or complete PLM system. And definitely when we are talking about product planning, ideation, design, we cannot forget. When we are talking about product planning, process planning would come definitely following the product planning.

So, these are the major concerns which are there in a PLM system. Other than this, because we are not talking about digital devices, we are not talking about software applications, we are talking about many other electrical electronics components.

We will talk about SLM (Service Lifecycle Management), we'll talk about ALM (Application Lifecycle Management). And how do we finally try to have a carbon accounting throughout the lifecycle of any service, product, application, whatever we are developing. So we'll talk about all these things.



Let me try to see now the components of the product lifecycle management. When we try to develop a bill of material or when we try to develop a total requirements for our product, there always has to be collaborations. So these collaborations are social collaborations of the things that exchange of information by means of mobile technology within an extended business processes in PLM to utilize a single source of the information.

A single source of the document that helps us to totally put the information within the PLM system. So, as products becomes even more complex, a technically advanced in the era of the internet of things, these things are mandated.

So, there are certain softwares which are available that we can use. I will call software systems. For instance, Siemens PLM. So, here, I'll talk about the Siemens PLM system in detail, the NX that designs, the Technomatix that makes process planning for you. Then team centers that give you a complete carbon accounting, those parts we will discuss.

Now, when we are talking about the components of a system, we need to understand the different factors in addition to requirements that have been identified. That is, we establish PLM to be a dynamic system. And the gap between different individuals, different components and PMM professionals will be bridged. So these components are

to be first jotted down. Then a prompt provision of the training of different business stakeholders is important.

So let me first try to put different components. So first part is the data product, data management. Following my part of the course, Dr. Prabal Pratap Singh will come up with different databases and how do we develop the databases? How do we connect them, the UI he will discuss? But product data management is important part, when we talk about components of a PLN system.

In which, when we talk about any PLN system, any product, I am talking about a tangible product here. So, we have a CAD (Computed Aided Design). That is the feel of the component that we design. This is a stylus. I need to design this stylus.

I need to understand the complete carbon accounting and whatever. First and the foremost part or the step would be to design this. Design means I will have a software design, computer edit design, where specific sizes, all the specifications will be put, colors could be put. I could have a feel or the look of the product when we have developed there. And using different other parts, I will come to that.

We can also have a rapid prototyping system that we 3D print and try to have a feel of the weight, size of the components as well. So CAD is one data or one data set that you develop for any component. Then definitely we need to have a bill of material. I'm putting eBOM. e is engineering bill of material.

When I say engineering bill of material, this is a complete list of the components which are required from the engineering viewpoint. So, this E bill of materials is an entity here in the product data management. Then we have release orders. When I say release orders, these are the release orders to the manufacturing concern. After product data management.

Another component is manufacturing process management. Manufacturing process management implies when we have already the e-bill of materials that is engineering bill of materials, now I need to have the process layout. Process layout that how would be my machines placed now? How would be my different transfer of materials or material handling system would be there? This would be a process layout.

Then we have longer process layout because we have developed the engineering bill of materials that is the product bill of material already there in the part 1. Now also we will have MBOM. This MBOM is my Manufacturing Bill Of Materials. When we have

manufacturing bill of materials, I will definitely have a process plan. Then when the process plan is ready, this process plan has to be further disseminated or to be given to the people who are going to work upon, the operators, the workers.

That is my work instruction. And definitely, when one construction are given, there would be small changes, we have a control plan. This MBOM is also known as POP, that is Manufacturing Bill Of Materials. For instance, if I have to manufacture this stylus, I would first have to put what are the different processes. If it is a metal component, I would first say I have a complete cylinder.

For example, maybe a mild steel rod is purchased. That is one process. Then there has to be machining. Second part is a machine that is a circular cutting machine called a rake machine. Then there has to be certain cuts may be available.

Certain holes might have to be made here. Then a drill machine is required that is bill of processes that would be following. So, that is a manufacturing bill of material. I will put it here. An EBM or Engineering Bill Of Material.

Now when I say control plan at the end here, definitely there would be difference between the plan or the schedule and the actual processes. The schedule and actual processes difference is there, therefore we always have a chain management system. In a chain management system, there are different stakeholders further here. We have production requirements, we have the Product Requirements known as PR because if any change is there, that has to be reported in this. Then we have ECR, ECN.

And eco what are these ECR is my Engineering Change Request, so this is a request and ECN is my Engineering Change Notice; Engineering Change Request is for instance. There is something that is to be changed some machine when it is available they put or the specifications are put lathe machine cannot do a small generation like this. For example, there is a step here that specific lathe machine could not do. That has to be taken or that has to be maybe outsourced. So, special components have to be ordered for it.

That is the engineering change request, a small request. If ordering of components would be a big request, but if a small change in the setup of the machine is there, that is a small request. Engineering change request is a document that is circulated to all the people who are involved in it. So, engineering change request could also be sometimes maybe unaccepted or unapproved by the seniors. So, this is a very minor thing.

So, this is a request in the change of the process. On the other hand, engineering change notice, those are issued by little senior people. That is, something, a change that cannot be ignored, that cannot be disapproved. This is a notice given to the people. Then, once engineering change notice is ready, then we come for Engineering Change Order.

Now in this process, in this overall change order, when we're talking about. I'm talking about general manufacturing processes or general product design and development process here. When we are talking in the context of product lifecycle management, when we also involve carbon accounting at any point. When a machining is happening, for a specific machining, specific set of operations, energy that is being used could be heavy. For a specific set of operations, the scrap that is being produced could be very high in amount.

So, those changes could also be requested, could also be notified using a notice or could also be ordered further. So, these are parts of change management. Other than this, in change management, we have the quality management. When it is a quality management, there are documents such as corrective and preventive action. If there is a non-conformance, non-conformance could be minor, could be major.

Minor non-conformance is a component specific condition that is given, it is given little 0.001 out of the specified limits. That is a minor non-conformance. It could be non-conformance, the product or the component that is being reported as within the sustainable limits is completely black in color. Black in color means it is completely going out of the reports which have been given. So that is a corrective and preventive action has to be taken.

What is the corrective action immediately? That is to be taken to correct this mistake or this error that has happened. If preventive action is in the future, this would not come so that it reflects upon a corrected part in the future components which are being manufactured. So, it is a corrective and preventive action document is being presented.

Other than that, we have PPAP. PPAP is Production Part Approval Process. Production part approval process, once the components and corrective actions, everything is taken, then part approval is again given by the further people.

Now, along with change management, definitely we cannot leave here the supplier management. So, as I mentioned in the previous slide as well, the vendor development is

very important. So, when we talk about the change management, because the components or the raw materials, some of them are also supplied by the vendors.

So, we always have a vendor management or supplier management. In supplier management, we have majorly the approved vendor list, approved manufacturer part list. I will put it here. AML that is Approved Manufacturer Part list then I also have AVL (Approved Vendors Part List). So, this is my manufacturer and this is vendor.

We are talking about part lists here. So all the part lists are here developed. Supply management is very important. What are the requirements of the manufacturer, the parts which are required, and sometimes exact components are not gotten. Sometimes the equivalent components are there.

Equivalent means the components which are compatible to it. For instance, maybe some of the mobile sets that you purchase, some of the cars that you purchase. Those are stopped by the company in manufacturing and spare parts are also not available. You try to get the components or the parts. Which are compatible with your car or with your mobile and try to make a system work.

So, the manufacturer's part list, vendor's part list are always gotten here. Then overall, when we are talking about all these systems here, let me try to put it in a box. So, I will put it like this, different components. This is to be completely managed by a team that is managing your product. The team that is called as project management team.

That is also, we call it one of the components. We call it the umbrella under which all of these systems work. Here, we have a team that is working on the new product introduction. NPI and it is talking about as well the new product development. So, these are the major components of the PLM.

I will talk about the components in detail in the forthcoming slides. I will draw down certain pointers here. That is, number one, PLM starts during the concept phase and during which components of high quality and reliability are selected for their anticipated and extended lifespans.

Call it concept phase or you call it the design phase. Second important point is all the important, all the vital components definitely and critical components are securely regulated through an enterprise business process.

That is what is the responsibility that lies with different components, say a product data management. The manufacturing process management, change management, supplier management, overall taken by the project management.

The system, if it is to be regularized, the components, critical components are definitely also taken into control with the specifications, the validation. Because the product has to be commenced. The validation of the component till the point the product is manufactured and till the point the product goes beyond during use and to the after use phase also it goes.

So, that is it is regulated in this way. Also, another characteristic or important point, I will put is the critical area such as product design and data development and supplier and change management are all taken care by project management team.

So, this enables the manufacturing concern or the product development concern to come up with a resilient product development. Resilience means a quick response to the change, a quickly having corrective and preventive I think this is well enough for this lecture.

I will continue the components of PLM in the coming lecture. Where I will try to explain all the different components in somewhat more detail, product data management, manufacturing process management, change management, supplier management. And overall taken care by the project management team. And also, I will give an introduction to the model, how carbon accounting is taken throughout the PLM process in the next lecture.

Thank you.