Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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Week 04

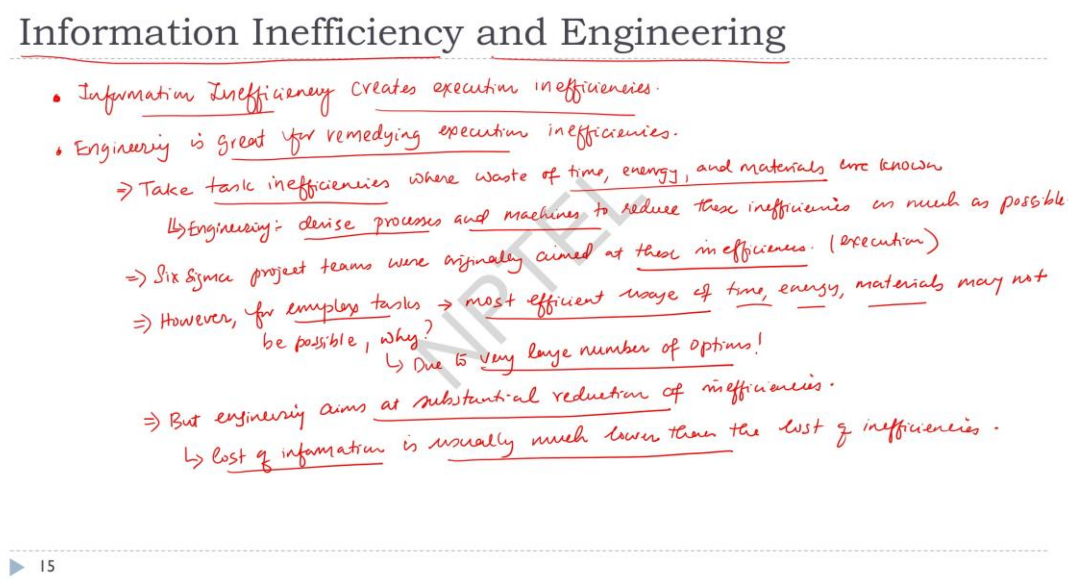
Lecture 18

Road to Product Lifecycle Management (Part-3)

Good afternoon, everyone. Welcome to yet another lecture of the course, Sustainability and Green Manufacturing for Product Lifecycle Management. And I'm Dr. Deepu Philip. I'm from IIT Kanpur. And this course is offered as part of the NPTEL MOOCs course.

Along with me, Dr. Amandeep Singh Oberoi and Dr. Prabal Pratap Singh is teaching this course. And so far in this week lecture, we have been mostly seeing how the concept of Product Lifecycle Management (PLM) and the path to PLM.

How it has actually come through, and how the PLM replaces the expensive materials, methods, time, energy, etc. With cheap information, so that the entire integration from the design all the way to the end use and disposal can be completed as part of this. So without further delay, let us get into the continuing aspects of this lecture, the final part of this lecture.



So today we will start with the topic called Information Inefficiency and Engineering. So the logic behind the information inefficiency, which means that information inefficiencies creates execution inefficiencies okay. So the first thing is if you have information inefficiency it will create execution inefficiency okay. So next thing is engineering is great for remedying remedying execution inefficiencies okay. So, engineering can be used to remedy or address execution inefficiencies okay.

So, let's take task inefficiencies. Inefficiencies where waste of time, energy and materials are knowno Okay. So, let's take a task in efficiency where the wastage of time, energy and materials, we know what is the, this one happens. Then what we do? The engineering is device, processes and machines.

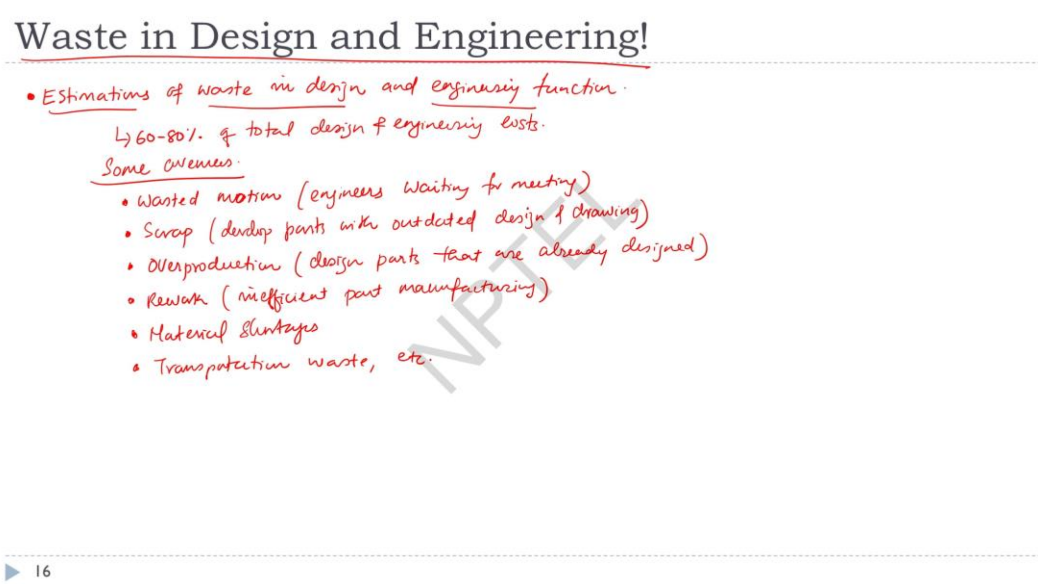
To reduce these inefficiencies as much as possible. So, what engineering does is, once you understand that there is an inefficiency, then it divides processes, machines, etc. To reduce the inefficiencies so that the execution inefficiencies can be reduced. Also, Six Sigma project teams were originally aimed at these inefficiencies. So, which are these inefficiencies?

We mean execution inefficiencies, okay. So, Six Sigma project teams were originally thought for this, but the problem is that, okay, However, for complex tasks, most efficient usage of time, energy, materials may not be possible, okay. Why?

Because if the task is complex, then the most efficient usage of time, energy and materials may not be possible. Why? Due to very large number of choices, very large number of options. Instead of choices, let's call it as options. Many of these options, large number of options actually may allow us or may not give us enough time to identify the most efficient usage pattern.

But engineering aims at substantial reduction of inefficiencies, okay. Engineering aims at substantial reduction of inefficiencies. So, the logic again is that cost of information is usually much lower than the cost of inefficiencies. So, what we are saying is that the information cost, the cost associated with the information is very much lower than the cost of the inefficiencies. Since it is very much lower than the cost of inefficiencies, if we use information and substitute it for the time, energy and materials which are expensive.

Then we can identify the execution inefficiencies and develop device processes and machines to reduce those execution inefficiencies. We will be able to engineer better products.



Now, let us talk about Waste in Design and Engineering. This is another aspect of the concept. The estimations of waste in design and engineering.

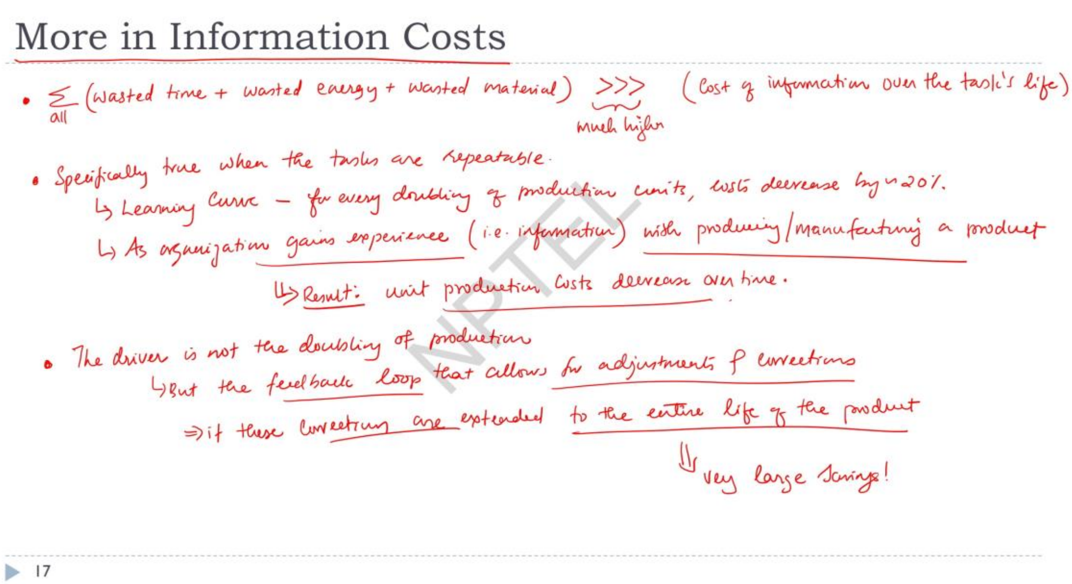
So, many estimations are available for waste in design and engineering function. It is about 60 to 80 percentage of total design and engineering costs, okay. So, waste in design and engineering estimations are about 60 to 80 percent of the total design and engineering costs, okay. So, examples, okay, some avenues. What are some of those avenues? Okay.

Number one is wasted motion or movements, okay. That is engineers waiting for meeting, okay. Then one is wasted motion. The other one is scrap, okay. An example of this is develop parts with outdated design and drawing.

Outdated design and drawing. So that's the second part scrap. So if you use outdated design and drawing, you get scrap. Third one is overproduction okay. So that is an example of this is design parts that are already designed.

Then comes something very common is rework Inefficient part manufacturing. So you did not manufacture it right at the first time itself. So now you have to remanufacture or rework. Then you have material shortages. You have material shortages then the production will stop.

You cannot proceed any further transportation waste, etc, okay. So, there is, these are some of those avenues where lot of these kind of waste in design and engineering is also part of the, can. And so if you replace all of these with cheap information, then that cost can be reduced.



Now, let us also talk about some additional aspects on the information cost, okay. Some more aspects of the information cost, okay.

So, one important information is sum of, or let us put it this way, sigma all, okay, of wasted time. Plus wasted energy plus wasted material, okay. So, the wasted time, wasted material and wasted energy, okay. This means much higher or much larger than cost of information over the task's life. When you take the entire life of the task and find the cost of getting that information, it will be much smaller than the summation of all the wasted time, wasted energy and wasted material costs, okay.

Specifically true when the tasks are repeatable. If you are repeating the task again and again, then this is true. This is very specific, okay. A couple of reasons. Number one is, the one is called as the learning curve, okay.

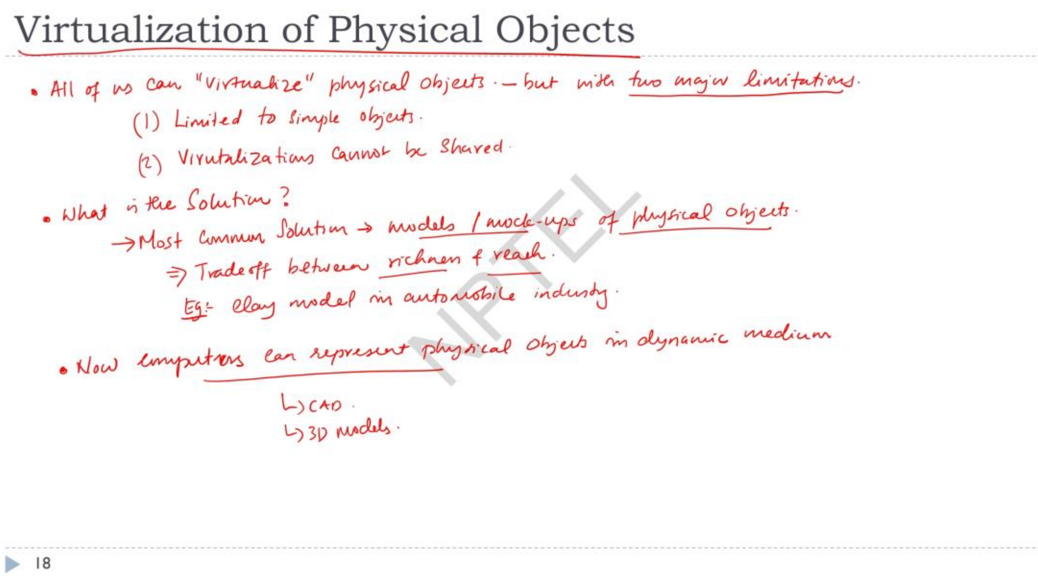
So, it means for every doubling of production units, cost decrease by 20% about 20%, okay. You double the production, cost decreases by 20%. Then, another one is as organization gains experience, okay, as an organization gains experience, So, that is, that is information, okay. More experiences, you have more and more information with producing and manufacturing a product.

Producing or manufacturing, manufacturing a product. So, what happens is as organization gains experience, that means more and more information with producing and manufacturing a product, what will happen? Result will be unit production cost. Unit production costs decrease over time. That's what happens, okay.

The logic here is the driver is not the doubling of production. Doubling is not the doubling of production, okay. But the feedback loop, the feedback loop that allows for adjustments, adjustments and corrections, okay. So, the feedback loop allows for adjustments and corrections, okay. So, if these corrections are extended to the entire life of the product.

Life of the product. If you are able to extend these corrections to the entire life of the product, very large savings. It will result in extremely large amount of savings. So, this tells you when you gain experience, that is when you collect more and more information. Then you can actually, you know, unit production cost can decrease over time.

And if you take this, it is not just doubling the production, but it is more like doing more corrections, using the information to do corrections and remove inefficiencies. So that if you extend it to the entire life of the product, you will actually have much more savings as part of this entire thing.



Now, we mentioned that later some point of time that the virtualization of physical objects or simulation or some people, the new management people call it as the digital twin is part of this. This term was not there when PLM was coined, but it was more like virtualization of physical objects is what we used to call it. We still call it that way.

So, what the main thing is, the logic is this. All of us can virtualize physical objects, okay. All of us can virtualize physical objects. That is one thing, okay. But with the two major limitations, okay.

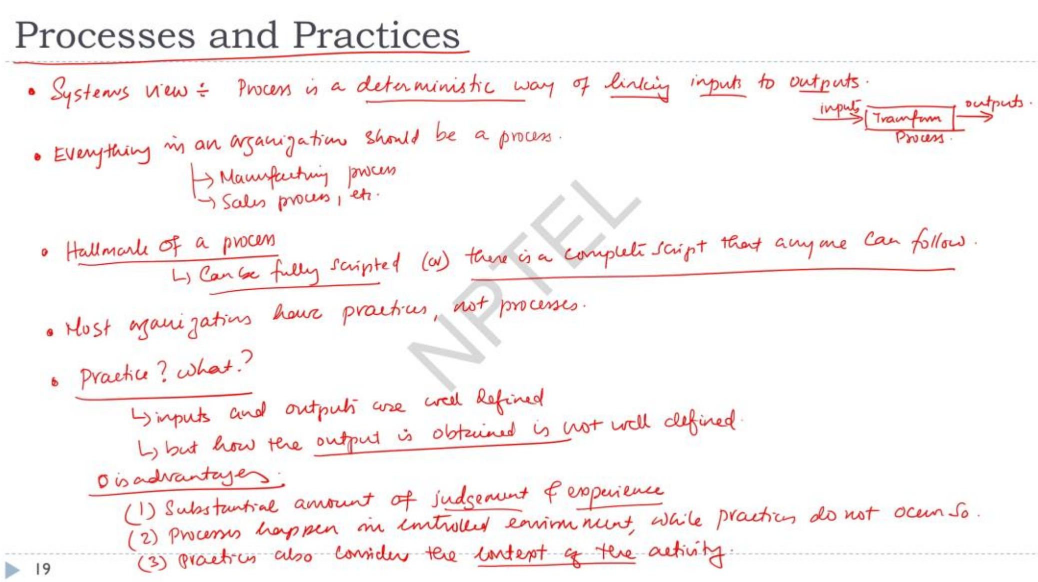
This is very critical. You can virtualize but with two major limitations, okay. What are the two major limitations? Number one, okay, it is limited to simple objects. It's very difficult to virtualize complex objects.

So, usually it's easier, people to virtualization to simple objects, right. Virtualizations cannot be shared. So, you can virtualize in your mind an object, okay. But it is very limited. Your mind is limited to very simple objects.

And those virtualizations that is within you cannot be shared, okay. So, what is the solution? What is the solution to this problem, okay. So, the most common solution is The most common solution is models and mock-ups of physical objects, okay. So, you can use, so that this is, this focuses on trade-off between richness and reach.

So, if you use models and mock-ups of physical objects that allows you to have a trade-off between richness and reach, you can use these models and mock-ups to share the virtualization with somebody, okay. So, classic example of this is clay model in automotive industry, automobile industry, okay. So, when a car is thought through and a drawing is made, they make a clay model and the clay model is used for sharing the virtualization. Now, computers can represent physical objects in dynamic medium like CAD, CAM drawings. So, the computers can now do CAD or simulations, 3D models, etc, and that can be dynamically shared among people.

So, the computers actually have allowed for the virtualization. Or maybe, or convert, or instead of making the physical model using expensive clay and time and energy, computers can actually do it. And so transporting the clay model from one factory to another will be very expensive. Whereas sending the dynamic model, the computer model in the dynamic medium can be sent across internet, okay.



So, now we come to the last aspect, the last part of the PLM, which is called Processes and Practices.

And this will conclude our lecture to the PLM system. So, the systems view of this is that the process is a deterministic system. It is a deterministic way of linking inputs to outputs, okay. We have already seen this in the earlier presentation also. The inputs, we drew this.

We have the transformation process to outputs okay. So the process here is a transformation process so the process is a deterministic way of linking inputs to outputs deterministic way of linking inputs to outputs okay. So everything in an organization ideally, everything in an organization should be a process, okay. Should be a process, okay. So, that example of it is manufacturing process, sales process, okay, etc.

So, ideally, everything should be a process, okay. So, the hallmark of a process, how do you identify a process? What is a hallmark? Can be fully scripted or there is a complete script that anyone can follow. So, what happens is there is a script available, fully scripted or there is a complete script available that anyone can follow, okay.

However, most organizations have practices, not processes, okay. So, what is a practice then? What is a practice? Okay. It is inputs and outputs are well defined, okay. That's one part.

But how the output is obtained is not well defined. The script, how you obtain the output is not well defined, okay. So, this will, so the disadvantages. What are the disadvantages of practices? Okay. Number one, substantial amount of judgment and experience, okay.

So, you are dependent on an individual. Individual's judgment and experiences, okay. Then, processes happen in controlled environment environment while practices not. Practices do not occur. So, the practices do not occur in a controlled environment, okay.

So the third one is practices also considers the context of the activity. So if you look at the context of the activity, then the outcome can be different. It may differ. So, compared to a practice, process is much desirable because irrespective of who is the person, irrespective of the judgment or the experience of the individual, if you have a process, you can get the same desired result. There is a complete script that can be followed.

Whereas in a practice, It is person dependent and it is also dependent on the context of the activity and even though the input may be clearly defined, input and output may be defined. How do you reach from the input to the output may not be well defined. So, that is why manufacturing industries specifically prefer processes whereas sometimes software industries prefers practices. So, with this we have come to the end of the PLM component of this course, the beginning. And we will have more detailed aspects in the coming lectures.

But this gives you an overview of what is PLM and how the logic of the PLM of replacing expensive time, materials and energy with inexpensive information. And how using engineering to pair out the inefficiencies in the system. And if it extended through the entire life cycle of the product from design to disposal, then the savings are in much large, which drives the productivity. So, thank you for your patient hearing and we will see in the next class with the next, the final topic for the week 4. And meanwhile, please continue to read the assignments and complete the assignments and finish the assigned readings.

Thank you very much.