The Future of Manufacturing Business: Role of Additive Manufacturing

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Lecture – 07
Business Models

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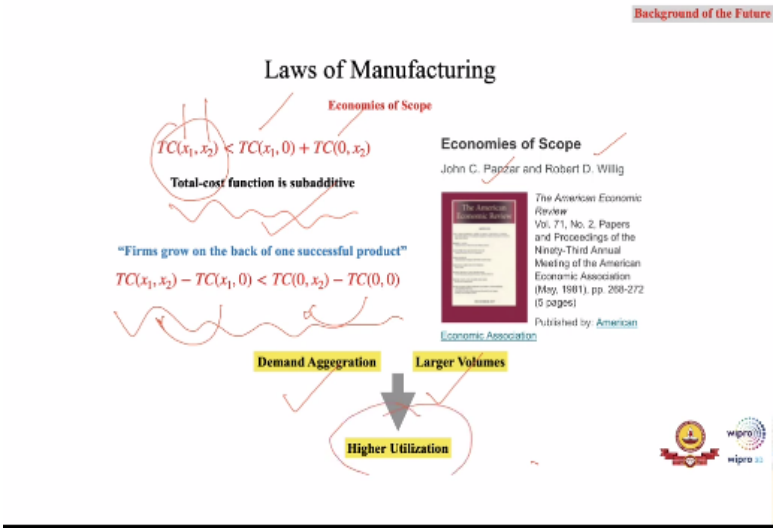

Welcome back for the next session. We were discussing laws of manufacturing in the previous one and the main concept which we concluded the session with was the economies of scale. So, I will continue my discussion and I may emphasize now economies of scope. This paper is one of the initial papers, we can say Economies of Scope by Panzer and Willig.

The main idea here is if I have two products, then

$$\mathbf{TC\ (x_1, x_2) < TC\ (x_1, 0) + TC\ (0, x_2)}$$

Where as,

TC (x_1, x_2): total cost of producing x_1, x_2

TC (x_1, 0): total cost of producing x_1

TC (0, x_2): total cost of producing x_2

we actually call this total cost function is subadditive. So, if you recall, when we talked about the economies of scale, we were saying that the average cost is decreasing.

In this case, the total cost of jointly producing x_1 and x_2 is actually lower than the individual production. The total cost function is sub additive and if you just rearrange this, it will look like this.

$$TC(x_1, x_2) - TC(x_1, 0) < TC(0, x_2) - TC(0, 0)$$

and the main idea here is that the firms grow on the back of one successful product and this concept may be not very trivial to understand.

But one reason which can lead to economies of scope could be because customers may have varied demand. They may so if you produce multiple products with different variety, in that case the customer matching may be better. You may have a higher demand. So, demand aggregation, this also leads to higher volumes, which allows you to have higher utilization of your capacity.

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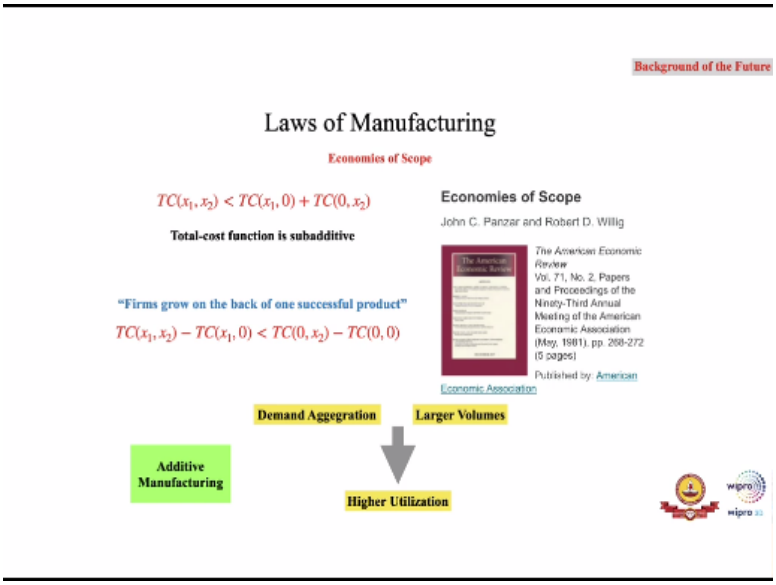

Now can the technology of additive manufacturing can come to our rescue and can actually improve the economies of scope. So, I think that is something which may be relevant in the future, how additive manufacturing can enhance the economies of scope.

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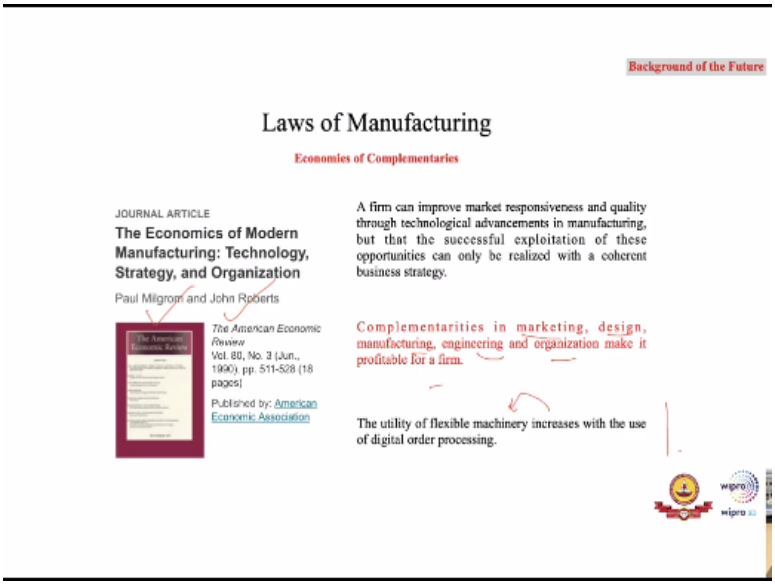

The other concept which becomes relevant is what we call as economies of complementarities. It may happen that so this paper again, is by Milgrom and Roberts so published an economic American Economic Review. It is a slightly dated paper published in 1990 and the main idea here is so when we talk about manufacturing, the manufacturing cannot be seen in isolation.

We have marketing, we have design, we are manufacturing, engineering organization, right. All these things work in sync with each other, in tandem with each other and utility of flexible machinery increases with the use. So, this example, if you see this. If I start taking the orders in the digital form, it is also important that my production system should also be flexible.

If the customers can announce or declare that this is the product they want. My production system should also match with that thing and that is where the economies of complementarities come in. So, this becomes more and more relevant as we become more platform dependent. We will discuss these things.

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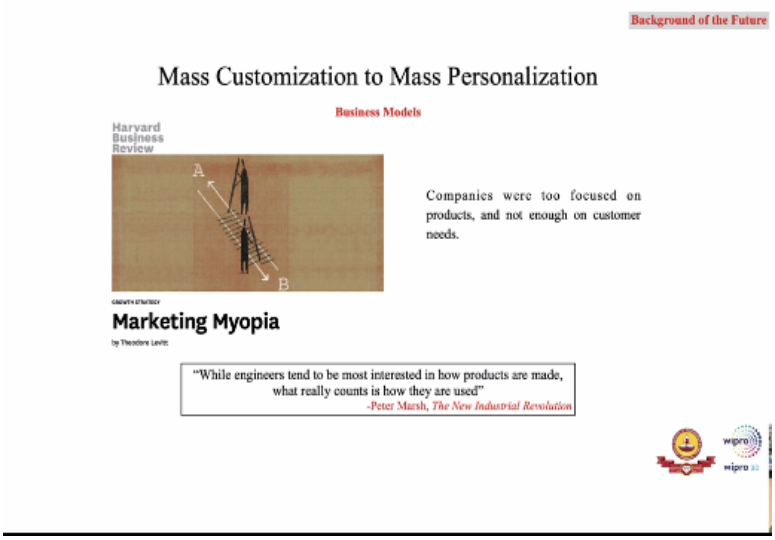

Now, so now we come to so we have seen different eras of production. We have talked about mass production, mass customization and the things which become more and more relevant in recent past is mass personalization. We need the right business models for it. So, when I say business models, it is how you deliver the value to the customers. We will formally define it in next one or two slides.

But for time being, just take it that it is about how you deliver the value to the customer. Now there is a very interesting paper produced by written by Levitt titled Marketing Myopia published in HBR and this paper I think, if you have taken any marketing course, it may be part of that course. It says the companies were too focused on products and not enough on the customer needs.

Companies focused too much on the products, they are not very specific about the customer requirements and just to extend this argument, so this is taken from a recent book by Peter Marsh, The New Industrial Revolution. While engineers tend to be more interested in how products are made, what really counts is how they are used. So, I think, I am just extending this argument by Levitt.

In fact, in one of the papers he mentioned that the companies do not buy drilling machines, they buy holes and I have seen something very similar when I visited some company in Bangalore. I think they mentioned to me that some of the aircraft manufacturers are actually converting to that kind of a business model.

They actually outsource the whole drilling operation, so they are no longer interested in buying the machines and the technology of IoT, maybe we will have a discussion on that, the technology of maybe industrial IoT allows us to track how many holes or drill has been done, what was the thrust, the rotation everything is captured.

You actually pay for how many things or how many holes had been properly drilled. So, all these business models are actually coming up.

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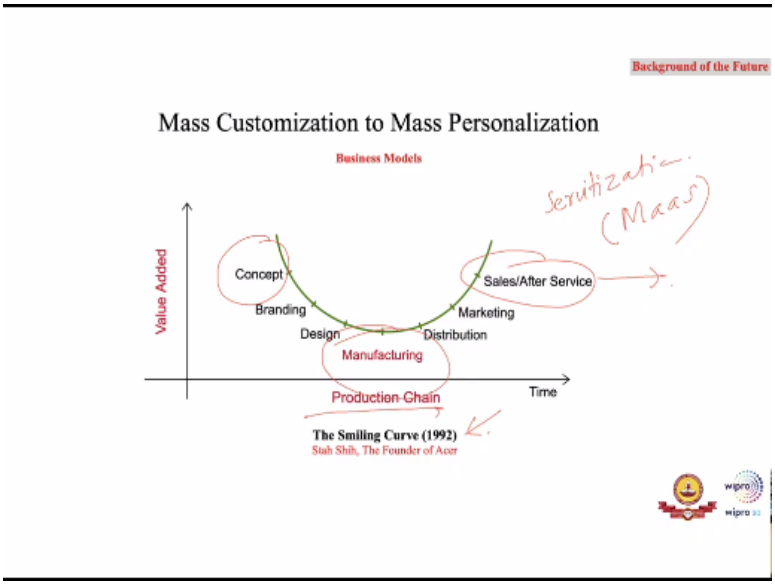

I think the next slide will give you some more insights on what I am saying. So, this is a very interesting concept given by Warren, the founder of Acer the smiling curve in 1992 may not be true for all the products, but if you see this, this is a production chain from the concept to the sales and after service and what it actually says the most value addition comes from the sales and after service.

It means that that if you actually can monetize this part by some means that actually can make a firm successful. So manufacturing, the value addition may not be much. In fact, these days we are talking about concept called as servitization. In fact, some companies are actually talking about can we make manufacturing as a service (MaaS). So, because the value addition comes mainly from the sales and the after service.

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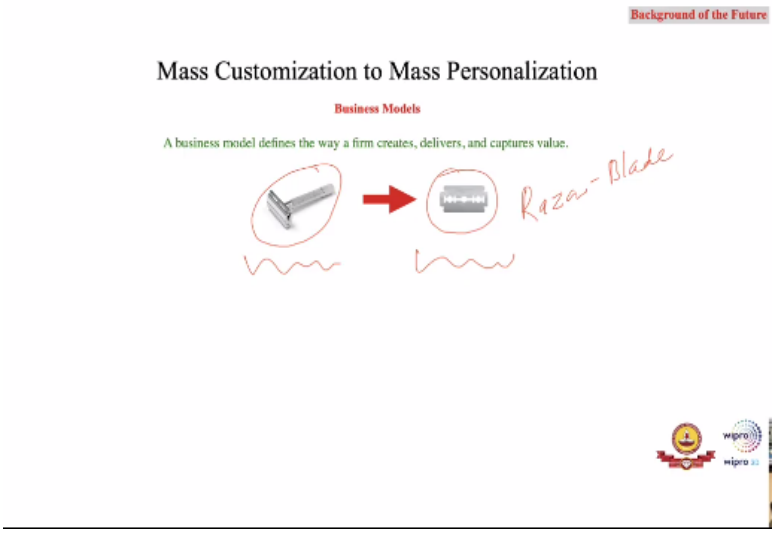

This takes us to the definition of business models. A business model defines the way a firm creates, delivers and captures the value. The classical example is always the razor blade. Some companies you may be aware that they actually sell the razor at a pretty low price, but the blades may be very expensive. What it actually means is the most value addition actually come from after sales.

The more so this may not generate much value to the company, but this suddenly would make it profitable.

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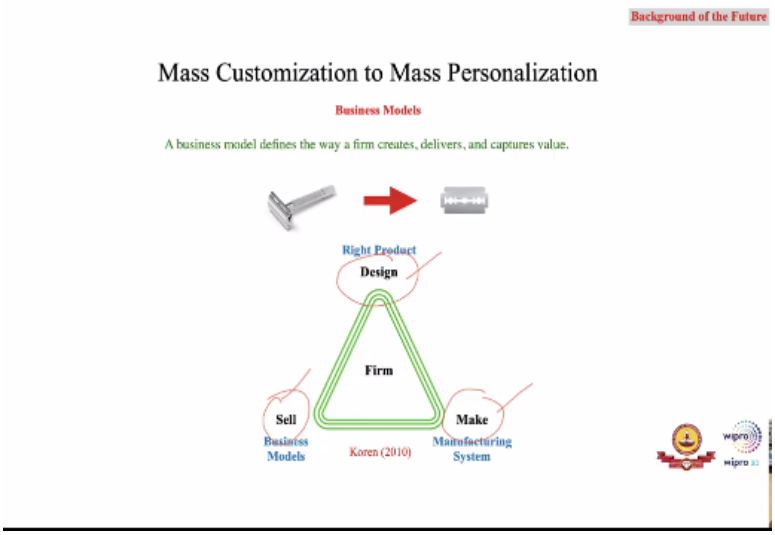

The same extent, I am extending this argument again to three parts, one is designing it, one is manufacturing and the other is selling it. I have taken it from a book on manufacturing by Koren (2010). There is a firm and the firm has a design, make and

sell operations. All these three things are important. So, you design the right product, you manufacture it with high quality, high speed, whatever.

That faster, cheaper part will still be applicable and then use the right business model to actually capture the value. Even if you have any of these two things, third thing is also important. So, even if you manufacture it well, you have the right product, but you actually do not know how to capture the value, you may not be a successful firm.

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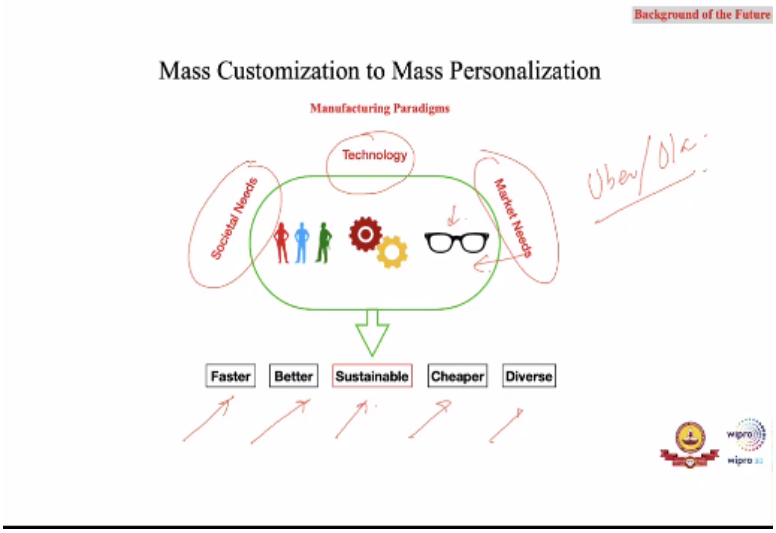

I will extend the logic. If you see this when we talk about the business models, I think one thing which becomes highly relevant is what is the nature of technology available. So, when we talk about manufacturing, we still are talking about the faster, the better, the cheaper, the diverse. I am adding sustainable from my side.

When I talk about sustainability, we are talking about sustainable manufacturing and when I say sustainable manufacturing, in fact lot of groups across the globe, research groups are already talking about it. There are groups which are titled like environmentally benign manufacturing. So, the value you deliver is actually a function of technology.

So, there would be societal needs, which could indicate sustainable part. There could be market needs, which could mean that the product should be diverse and how you deliver the value is also a function of technology. You can think of an example like, if

you have to take a taxi ride or if you have to go from A to B the technology may be 1950 may not allow you to use Ola or Uber kind of business models.

Now the technology is available, which can actually match the market needs to the manufacturing or to supply. I am giving the eyeglasses as an example, because we are going to see that as an example in our subsequent slides. So, this is the product and in fact, we need this product in high variety, because each customer may have a different requirement.

But finally, what we want is these eyeglasses should meet the customer requirement.

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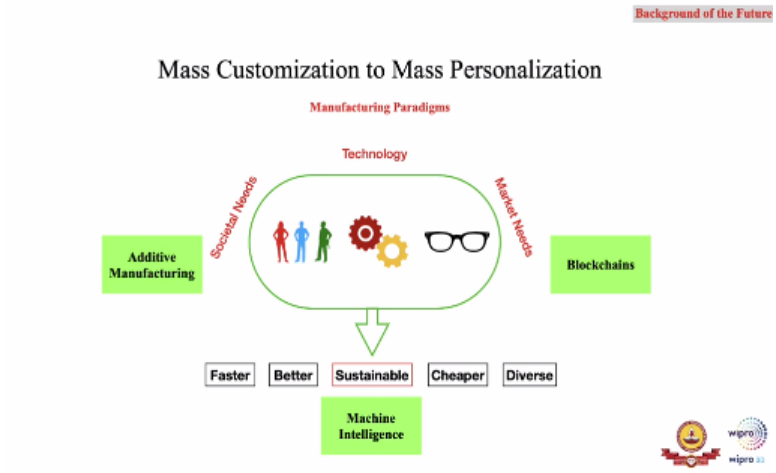

So the point here is will there be technology which will do that? Can we think of additive manufacturing as a technology? Can we think of blockchain to make the supply chain more and more transparent? Can we have machine intelligence available on the or maybe a platform which allows us to forecast what is the market need? The production system is highly flexible, which comes as part of additive manufacturing.

The supply chains are transparent, the things are well communicated to the suppliers. All these things get integrated and you would actually foresee a newer way of generating the value. I think as part of this course, we try to capture some of these ideas.

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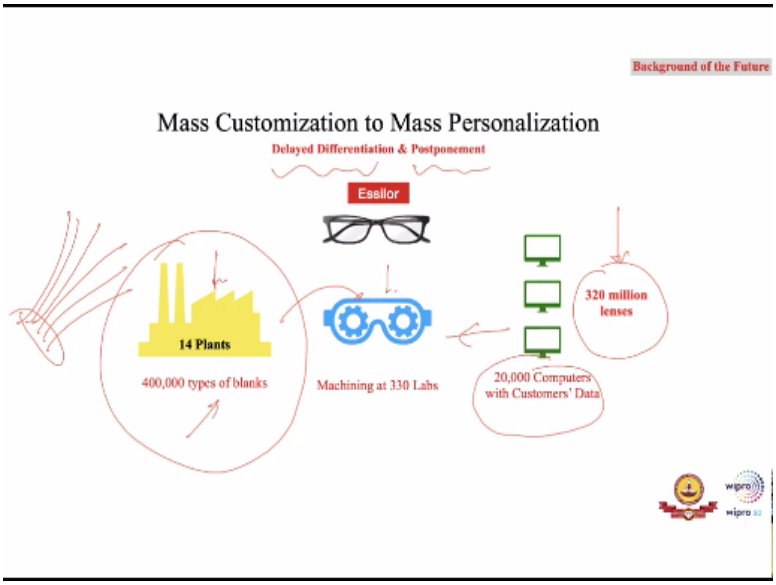

Yeah, so as I was mentioning about the example of the eyeglasses. One of the largest manufacturers of eyeglasses is a company called Essilor and so they make about so I am not sure whether this data is new, but I think the source which I have used, they mention about 320 million lenses in a year say.

You can actually say that they actually capture the customer demand, maybe in the digital firm using some computers, which is 20,000 and you can actually see that there is pretty high variety. 320 million lenses or different types of lenses they need to produce. Now what they normally do is they do not keep all these things in inventory, their inventory certainly will not have 320 million lenses.

What they have is some kind of a blank and that type would be about 400,000 types of blanks and they manufacture these in 14 different plants. Now when the customer demand comes these blanks maybe at these 330 labs. These labs are closer to the customer and these blanks will be converted to the required type of lenses at these labs.

This whole idea, so what you are actually doing is you are delaying the differentiation. 400,000 types of blanks are converted to different types of personalized products based on what the customer wants. This is called as either the delayed differentiation or postponement and what actually enables this thing? Maybe the technology.

So, you can maybe even the information technology which connects the customer to the product. Even the machining which allows you to convert those blanks into the lenses. This is called as postponement and this is not something which is only applicable in the case of lenses.

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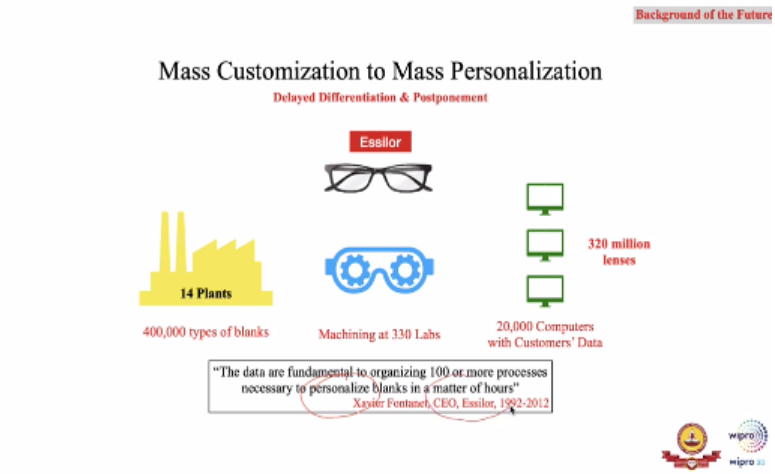

In fact, the former CEO of Essilor quotes that "the data are fundamental to organizing hundred or more processes necessary to personalize blanks in a matter of hours". In fact, you can see the concept of variety, you can see the concept of speed. Cost will always be there and you want with sustainability and you also want maybe high quality. So, all those things come as part of this example.

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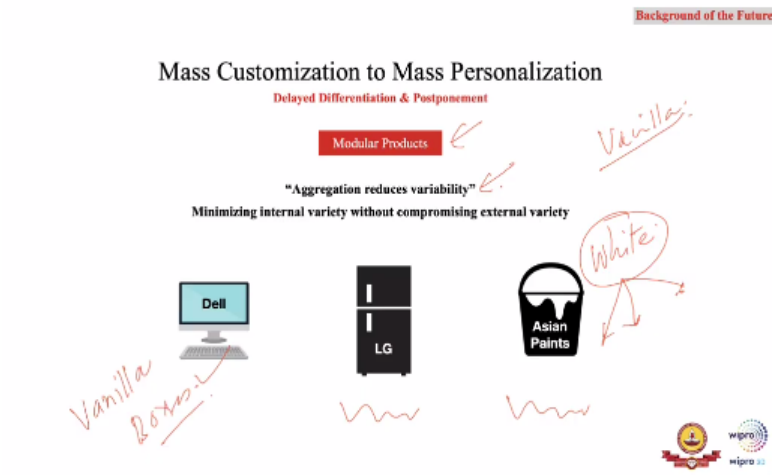

But as I mentioned that this is not the only example. There are other examples also. When we talk about say modular products, it means that you manufacture the products in modular way so the customization becomes easier and what actually encourages this, because this law of manufacturing that aggregation reduces variability. You are looking for minimizing the internal variety without compromising the external variety.

Three classical examples, so people who are aware of the Dell manufacturing. In fact, Dell keeps, so these are called as Vanilla boxes. This could be a Vanilla computer configuration. The customization happens when the demand comes. LG is doing something similar. So, what they have done is, so the refrigerator would be in a modular firm.

Based on your space requirement, they will customize it. So very interesting. Customer can actually get a very highly personalized product. Maybe very similar example is coming from the paint industry. I am putting Asian Paints, but I think it may be true for other paint manufacturers also where you keep only the white as a stock, and this converts to different colors based on the customer.

There may be, you can even go to a paint shop, and you can actually see that. What do you keep is only the white color? So even I think the vanilla ice cream could be the most common example. You keep only vanilla in stock and all the customization happens and remember that the customer demand may be highly variable also. It is important how you actually match the demand with the supply.

I think that technology plays a critical role and we are, that is why we are looking, moving from an era of mass customization to mass personalization.

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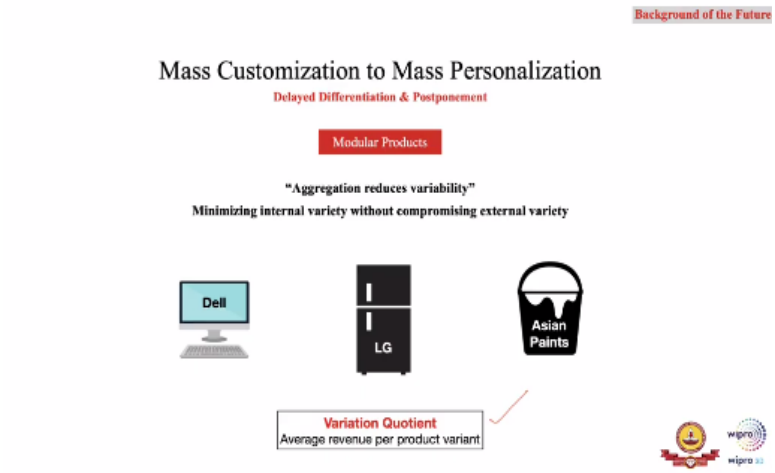

In fact, one of the metrics to capture this idea is what is the average revenue per product variant. Some of these companies actually have this number very small, because they actually customize the product based on the customer requirement. It may happen that you actually have one product variant which is specific only to one customer.

So maybe I think the point here is the companies which may be successful are those companies which actually have low variation quotient. It means that average revenue per product variant is actually very small.

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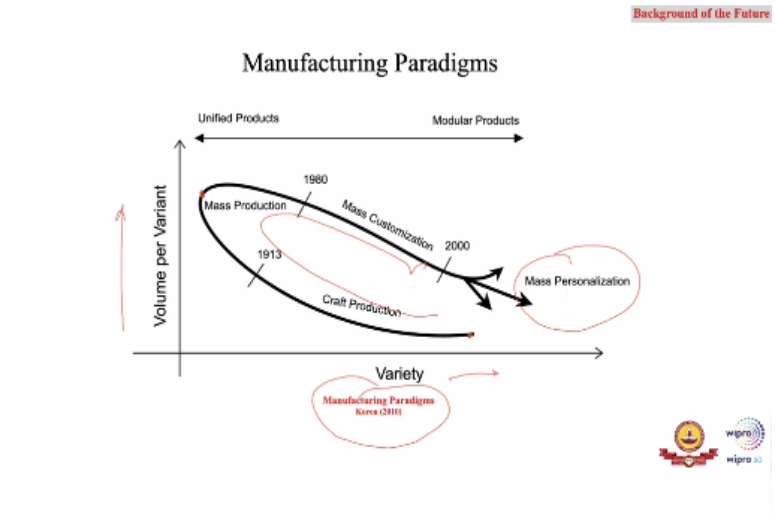

Here, so this is maybe capturing the whole story what we have discussed till now. We are talking about manufacturing paradigms coming from Koren and I think right from

the beginning of this course, we talked about craft production, we talked about mass production, mass customization, mass personalization and you can actually see the volume per variant and the variety.

When we were at craft, the volume per variant was small, but even the variety was high. When we go to mass, the volume because of economies of scale. The mass production the volume per variant was high, but the variety was low. When we go to mass customer, so we are actually moving in this direction and now we are in the area, in the era of mass personalization, where we want more and more personalized products.

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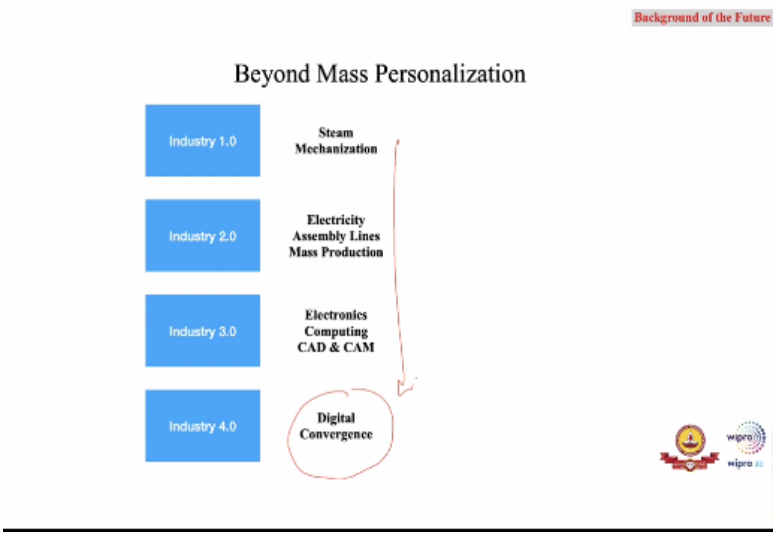

Yeah, so now the point here is, can we do better? Can we do further? Can we go further? Can we improve the manufacturing? Most of you may be aware of this definition of industry 1.0, 2.0, 3.0, 4.0 and we can actually say that, there would be some general-purpose technology which comes along with these different versions of industry.

The next is or maybe ongoing is what we say about the digital convergence. This could become the general-purpose technology and all the other technologies may merge with it.

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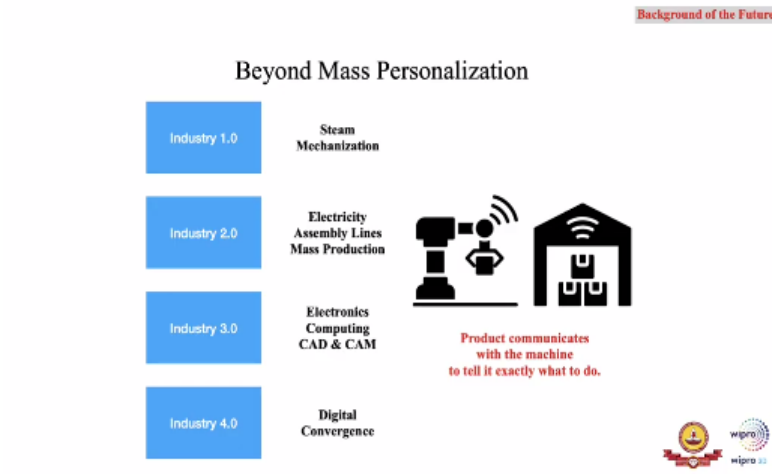

One thing which becomes more and more critical, I think it is critical not just with the context of manufacturing, it may be for the much larger domain, even when we talk about reconfiguring supply chains. It is not about automation; I think it is more about the communication. Product communicates with the machine to tell it exactly what to do. So, machine knows that this particular product is coming.

When we talk about IoT or IIoT that is something which we may be thinking off. When we talk about blockchains I think we again maybe thinking of something similar. In this case, the communication is not actually just between machine to machine, it may be also between the product to machine. So, that is something which comes as part of digital convergence and this could go beyond mass personalization.

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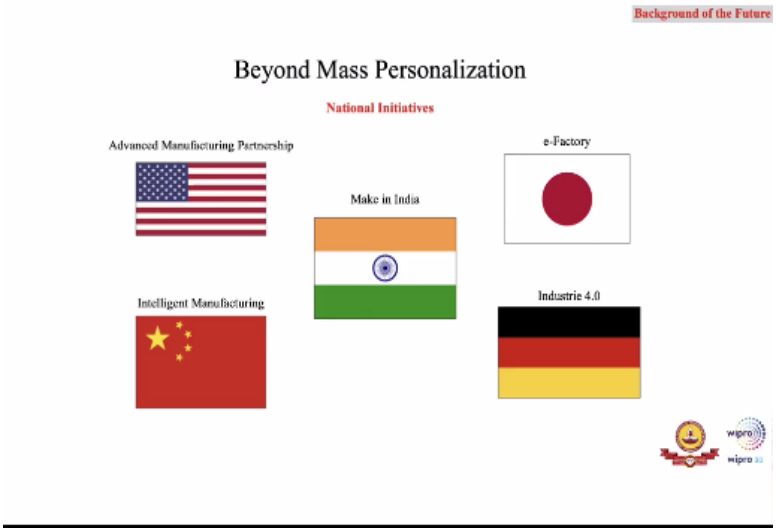

I think this gives you some idea about, in fact this may not be the complete list. Some of the countries actually have come up with their own national initiatives. You can see example of US. They have the AMP 1 and 2. Make in India in India. Intelligent manufacturing in China. E-factory in Japan. Industry, in fact the word Industry 4.0 came from Germany.

These are different national initiatives, which are trying to actually look beyond this mass personalization and how the modern digital technology can be integrated with manufacturing.

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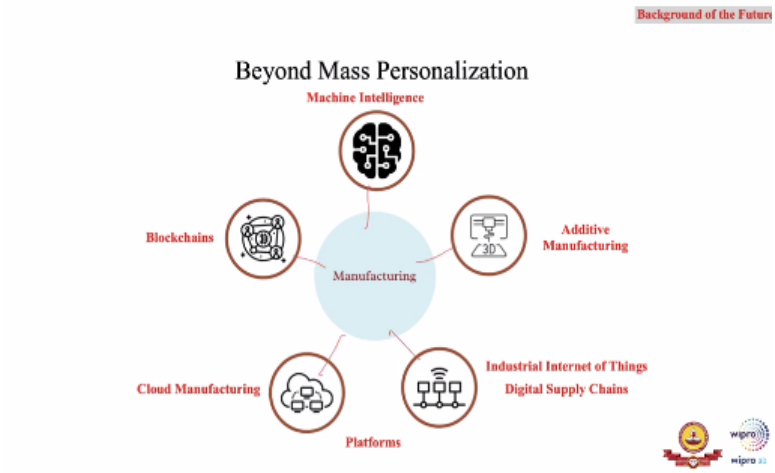

I think this gives you some flavor of the different technologies. I think so in this course, we may not be talking about all the technologies. But we may be talking about parts of machine intelligence, blockchain, additive manufacturing. I think we will have a substantial because Dr. Chandrasekhar from Wipro would be emphasizing only on additive manufacturing.

We will have some discussion on IoT, digital supply chains, platforms, cloud manufacturing. I think we will just take a small part of all these technologies and try to just explain how they are actually influencing the manufacturing. So, this may be the important part of this course.

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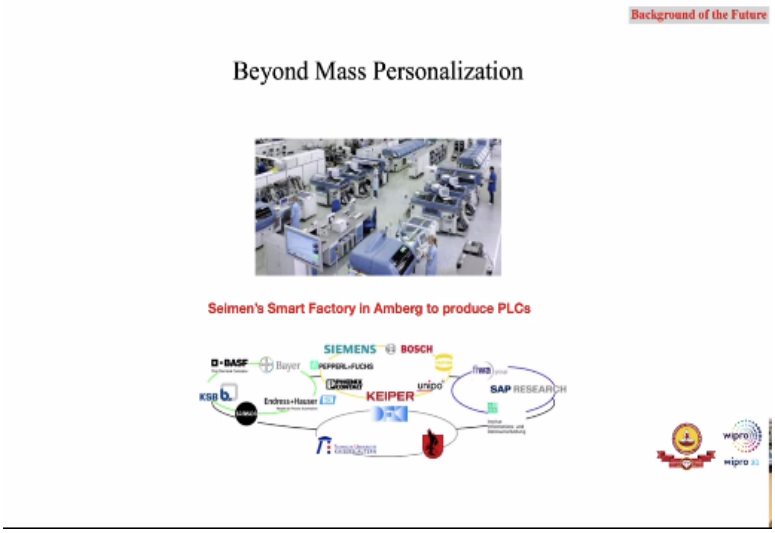

I just give you one example of Siemens smart factory in Hamburg in Germany, where they produce this PLCs, the programmable logical controllers and this may be the larger ecosystem.

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I give you some numbers to give you the insights. Let me skip this part.

This actually talks about efficiency, agility, risk capturing and innovation.

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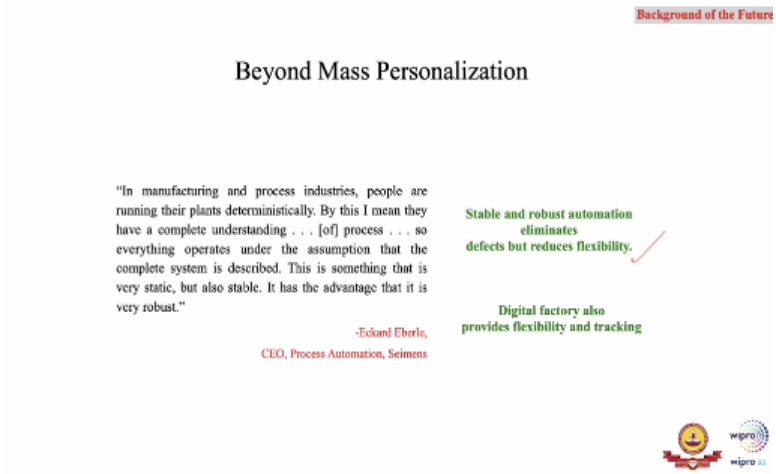

Let me not spend time on this. Let me directly come to what the Siemens is doing? See you can actually see this in manufacturing and process people are running their plants deterministically. The process is well understood. This is something very stable, static and the it has advantage that it is very robust. But what it actually does is it actually removes the flexibility.

You remove defects because of robustness, because of stability. But the flexibility is not there. When we talk about digital factory, it also provides the tracking as well as the flexibility.

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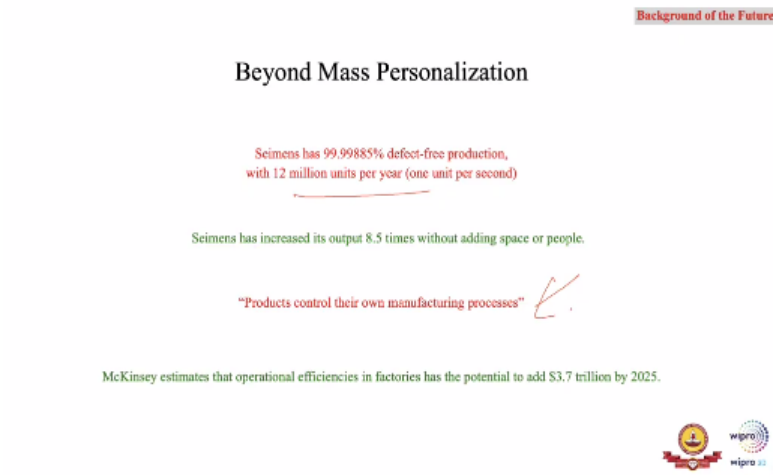

I give you some numbers about so you can actually see 12 million units per year (one unit per second). This is the number coming from the digital factory. So very high defect free production. The output has gone up and you can see the statement about the digital convergence what I made earlier that the products control their own manufacturing processes.

McKinsey estimates that the operational efficiencies in factories has the potential of adding about $3.7 trillion by 2025. This gives you the context. This gives you the number, what numbers we are actually talking about. So, with this, I will stop my part for time being. The next session we have an invited speaker, Mr. Murali, who would actually talk about the manufacturing radar.

He will give you how these technologies are impacting the manufacturing. After the manufacturing radar, he will continue his sessions on agility, on manufacturing agility. After that, I will actually come back and talk about these technologies. So, for next, maybe four sessions, you will be listening to Mr. Murali. Thank you.