The Future of Manufacturing Business: Role of Additive Manufacturing

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Lecture – 18
Digital Supply Network - II

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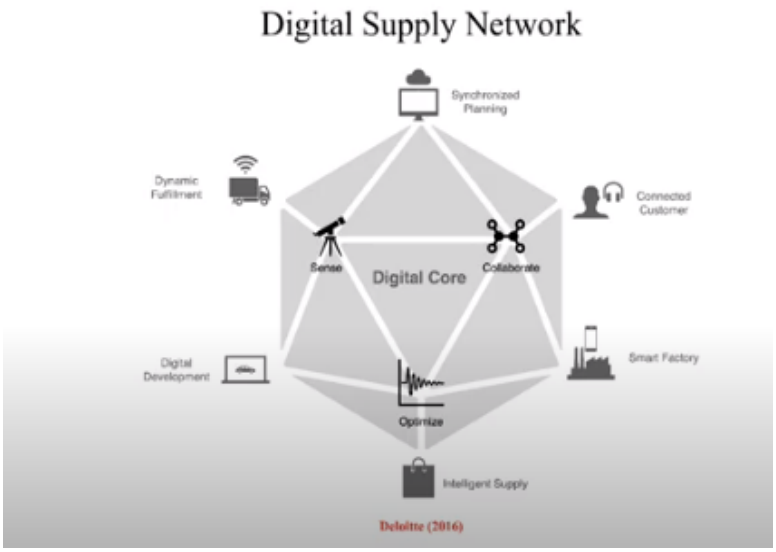

Welcome back for the next session. In the previous session, we were discussing about the digital supply network. We mentioned like how the six dimensions of this network, how they integrate and what is the digital core. We discussed about sensing, calibration and optimization.

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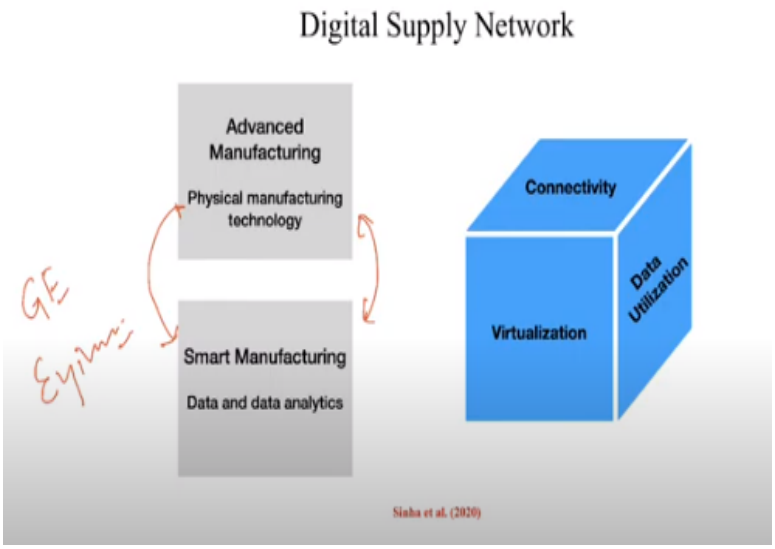

I will continue with this discussion and this give you an idea about the digital twin. Normally, we use advanced manufacturing and smart manufacturing interchangeably. But when we talk about advanced manufacturing, we are looking for physical manufacturing technology. When we talk about smart manufacturing, we are looking at data and data analytics. So, this is the difference.

You are converting maybe something which is in the physical space to something in the digital space and then you do all the analysis on the digital space and how it actually becomes relevant. So how it becomes relevant? Because when we talk about say sensing, when we talk about the calibration, when we talk about optimization, all these things can integrate at the digital level.

Three dimensions of this smart manufacturing, one is connectivity and there is virtualization, and the third one is data utilization. So, when we talk about connectivity, it means that you put, so if you recall, when we talked about industry 4.0 at that point, we mentioned it is not like just machine to machine communication. It is also product to machine communication.

That is where connecting and synchronizing data gathering systems, sensors, manufacturing equipment, products, through IT for analytical purpose is a necessary requirement to enable development of reliable insights through advanced analytics. So, connectivity becomes very important. The second part is the virtualization. So, a physical environment, you want to replicate in the virtual space.

It enables advanced analytics and it is the backbone of most applications of IIoT, One example which comes is for the GE engines. So, which if you recall, the GE Predix example, where you put everything as a digital twin, and all the analysis is actually done on the digital twin. You are not doing much on the physical. Any experimentation on the physical side is very expensive.

So, what we are doing is maybe in the digital space, and what it actually does is it also allows things become more visible. I can relate to a typical manufacturing system like the say, the Lean manufacturing system. So, when we talk about Lean, we have

looked at the concepts like the Kaizen and what it actually does, it actually says that you get the information about what is actually happening in a manufacturing process.

Now the same thing can be done in the digital space. Because now you have sensors, you can even monitor the defects. You can integrate all the information which is happening in a process and that is the advantage which comes along with the virtualization and it just does not confine to within the organization. It also goes outside the organization.

So. when we talk about the digital supply network, when we talk about synchronized planning, that is the idea. It means that you collect the information not just at the organization level, but also at the supply chain level. This can come along with the technology like blockchains. Now, you do the connectivity part, you do the virtualization part.

The third part, which is important is the data utilization. It means that even if you collect the data, you actually have to run some kind of algorithms to make inference out of it. So, data utilization means that you look contextualization of data into actionable insights through advanced analytics. New manufacturing processes like additive manufacturing, which are predominantly digital.

You can integrate the insights which you are getting because of virtualization along with additive manufacturing and that is where I think when we talk about intelligent supply or connected customer, dynamic fulfillment, all these things become the part of it. It means that I can integrate a manufacturing process with what are the other things in the ecosystem.

I think I will explain this more through examples, maybe when we look at the used cases, these things will become more transparent for you.

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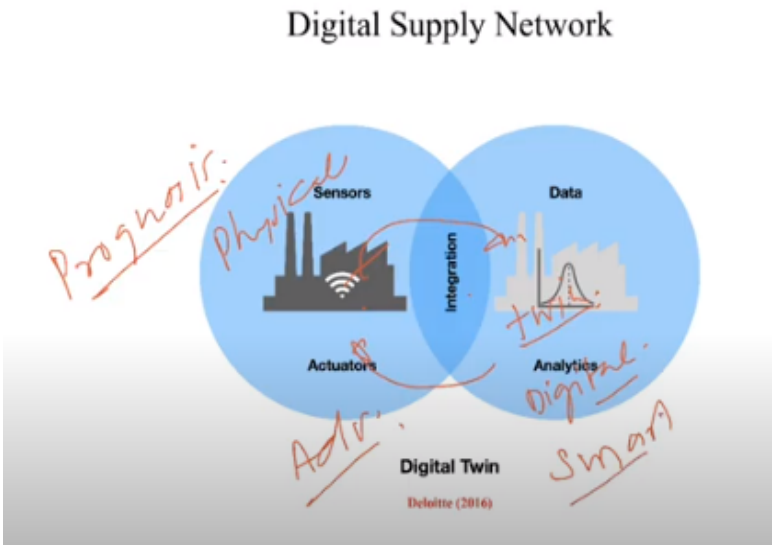

So, this converts to a digital twin. You can actually see; I have taken it from the Deloitte report. You can see a physical version and then you have a digital version. You can see a factory with a sensor. It integrates, so this is the factory and this is the digital twin. So, whatever you do from this, this goes into this thing as a twin and all the analysis is actually done on the twin part.

So, in fact lot of prognosis is part of it. You actually get the real time information from a physical system and you run all the algorithms, safer prognosis for fault detection, and then you actually change it. It becomes more like a connected thing. So, this is one example of digital twin. I think, they may not be emphasizing too much on it. But this gives you an idea.

So, this could be the advanced part, where you put the sensors and this could be the smart part where you do the data analytics. This is an example of it and this forms the integral part of the digital supply network. So, digitization, I think is the core of it. You cannot ignore that part. We will continue with this.

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I give you two examples, which may be the industry examples, which are related to what I am saying. One is an initiative of the European Commission, which is called as ManuCloud and if you read this, you can actually make a sense of the things which we already have discussed as part of this course. ManuCloud is a next generation manufacturing as a service environment.

The transition from mass production to personalized, customer oriented, and eco efficient manufacturing. Just relate to what we already have talked about in the as the goal of manufacturing, from flexible, diverse, cheap, better and sustainable eco efficient manufacturing is considered to be the promising approach to improve and secure the competitiveness of European manufacturing industries in the future.

So, it is not just like you make something. You actually have to achieve these goals along with it, which constitute an important pillar of the European prosperity. So, I think this relates to the macro view, which we talked in the initial lectures. One precondition for this transition is the availability of agile IT supporting this level of flexibility on the production network layer on one hand and the factory and process levels on the other hand.

You can actually see the integration of the smart and the advanced part as part of, so most of the analysis will actually be done on the cloud. So, if you see even the digital supply network, we are actually talking about that thing. ManuCloud is one example.

Other example, which I mentioned in the previous session also is Ariba. Ariba is a platform, which connects the customers and the suppliers.

You can think, in fact Ariba could be just one example. There are other examples also. In fact, in the Indian context, there is one initiative called as AutoDX. Maybe look at some other examples like Covisint. So, Ariba if you look at the numbers, I think this gives you some insights. 2.5 million companies are registered at Ariba and total transaction is $1.25 trillion. 76% of Fortune 2000 companies are registered on it.

So, this becomes this gives you an insight, because if you look at the Indian GDP, our GDP is about 2.8 to 2.9 trillion dollars. So. about half of it is actually part coming or you can say not coming, we can just look at the numbers that about half of it is actually transact at Ariba itself. So. this gives you the context of how these platforms are becoming more and more relevant.

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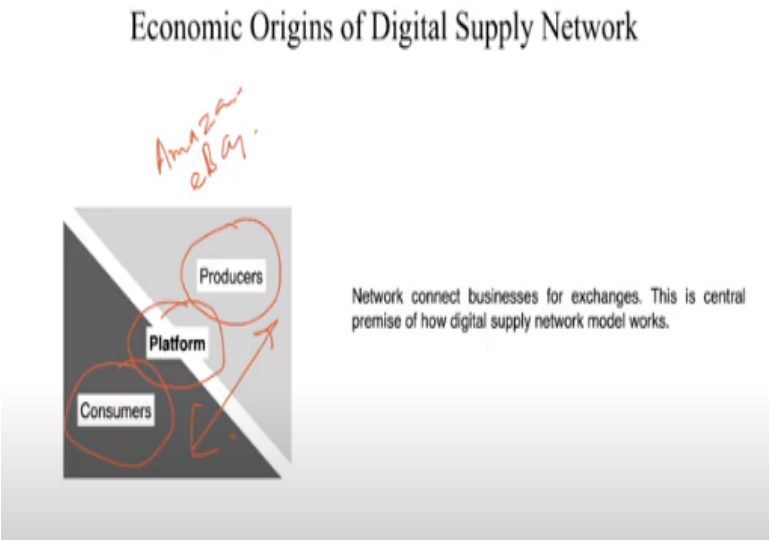

But I give you the background behind it. We look at the economic origins of some of these digital supply networks. So, you can look a platform, you have a producer on one side and you have consumer on other sides and these things get connected at the platform level. Network connect businesses for exchanges and this is central premise of how digital supply network model works.

I can typically think of an example like Amazon or even eBay. These are the platforms, which connect the customer side and the producer side and the point here is lot of these things are getting integrated because of better computing and digitization.

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So, this is important to understand the context of the digital supply network, but at the center of the thinking or rather the economic thinking, I take three names. One is Leonid Kantorovich, the other is Friedrich Hayek, and third is Ronald Coase. We relate Kantorovich for centralized planning, Friedrich Hayek for perfect markets and Ronald Coase for firms.

Now, in fact all three actually got the Nobel Prize. Kantorovich got in 1975, Friedrich got in 1974, and Coase got in 1991. So, three Nobel laureates in economics and three great ideas. So perfect market is not something which is given by Hayek, but he was bit proponent of it and has done lot of work on understanding the perfect markets. This actually goes back to the father of economics, Adam Smith, which talks about invisible hand.

When we talk about invisible hand, we talk about the role of prizes, which integrate the economy, which integrate or which you can say bring the customers and the producers to the market. Adam Smith has also a very famous statement, that competitive markets or the free markets are the best. So, this is something which came right from the Adam Smith's time.

Ronald Coase actually posed the question that why firms exist and if you recall, we discussed the Ronald Coase argument that the firms exists to minimize the transaction cost. That is where you actually see vertical integrated firm like Ford and as the technology improves, as the transaction cost gets lowered, because of maybe better sensing or digitalization, you can actually see that the organization has started getting becoming more and more vertically integrated.

So, you move from Ford to Toyota and we are actually going to the next level when we talk about the digital supply networks. So, even the firms may not be needed, because the transaction cost will go to that level where you can actually transact like you may be transacting in a free market. At the same time, the other extreme is coming as part of so free market maybe the most disintegrated firm.

Then you have firms and then you have the centralized planning where there is a central planner who take the economy wide. So, you capture the demand, you capture the supply, and then you decide what should be the prices and that is something which we have seen in the USSR kind of a setting. Kantorovich being a Russian, in fact Kantorovich is also called as the father of linear programming.

In fact, he got the Nobel Prize for his work on linear programming. Kantorovich went to the other extreme. So, this debate between the centralized planning and perfect market, in fact was during the height of the Cold War. Centralized planning means that you follow more like the Russian kind of a or USSR kind of a setting and when we talk about perfect markets, you are looking mainly the capitalist economies.

Now this debate, started a very interesting discussion, which is better? So, there were supporters from both sides. Hayek always argued that the information which is you can set distributed across the economy; it is very difficult to capture in a centralized economy. In fact, if you actually see, Hayek maybe winning the race, because or winning the argument, because the USSR actually collapsed in 1990.

You see, they are also taking the path more towards the capitalist economy. Even China, if you talk about that way, even a single party government, but their emphasis would also be on becoming more and more open economy. So, that way I think

Hayek is winning the argument, but then you can actually say that that time was different and this time is different.

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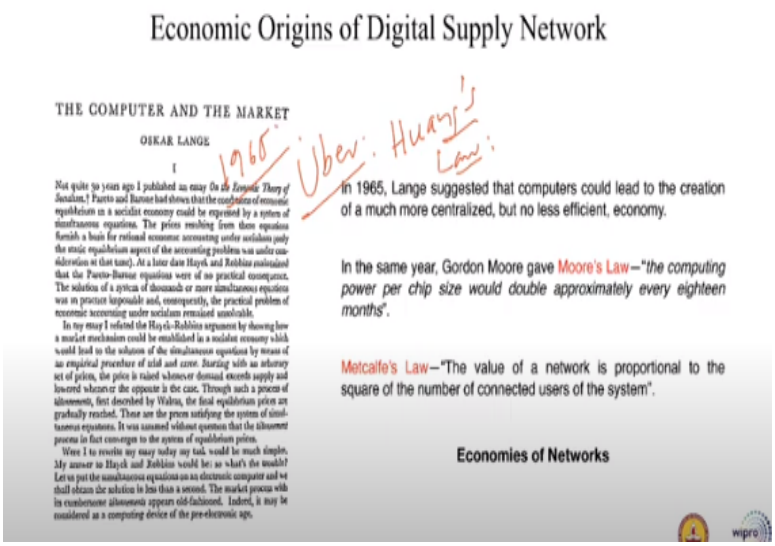

And why I am saying this, because Oskar Lange, which is in fact, belongs more to the, you can say, closer to the centralized planning, actually wrote a paper way back in 1965, which talks about the computer and the market. In fact, if you read the paper, it is hardly three, four-page paper. It actually gives you insights about how a platform like Uber may be replicating what Oskar Lange actually said way back in 1965.

It means that whatever be the information, which is available, if you sense that information by technology, you can actually decide through a computer, what should be the prices and what should be the allocation. This actually can give you some initial, what you call insights about how a platform or a digital supply network works.

So, you can actually see that the Lange in fact suggested that computers could lead to the creation of a more centralized, but no less efficient economy. This is a very powerful thought, coming way back in 1965. But then, there are other things which happened around the same time. So, you can actually see lot of advances in the computing hardware.

Moore's the Gordon Moore in the same year in 1965, he gave the Moore's Law. If I recall correctly, he was associated with Intel and till this point, I think we are actually more or less following the Moore's Law. The computing power per chip size would

double approximately every 18 months. So, you can actually see the exponential part of it.

Now the point here is that even I think as recent as yesterday, I read something called as the Huang's Law. Now the point here is people say that the Moore's Law is no longer applicable and we will start following this Huang's Law. I still not fully understood what is this Huang's Law, so I am not talking about it. So, you can actually say the Moore's Law will be replaced by Huang's Law.

But this is just a if you have time just have a look at it. But the other law which becomes relevant, so you can actually see Moore's Law talk about the exponential increase in the computing power. Then there is another law, which is called as the Metcalfe's Law, which says that the value of a network is proportional to the square of the number of connected users of the systema and we actually call it economies of network.

The main idea here is that the larger the network, the more is the value. So, you can easily correlate with a thing like a WhatsApp. So, if you have only few agents who are using the WhatsApp, the value of the WhatsApp is not very high. But if everyone is available on WhatsApp, the value of the network is very high and that is the something we call as the economies of network.

So, these platforms, these digital supply network, use this concept of economies of network. So, you recall, we have talked multiple economies. We have talked economies of scale, we have talked economies of scope, we have talked economies of complementarities, we have talked economies of unscale.

Now we are talking of economies of network. So, it means that it gives you the whole wisdom, which comes along with how you actually can make, or how you can actually make manufacturing scalable by using these wisdoms of economies of different types. So, I assume that this would have given you some clarity on how this whole digital supply network, what are the economic origins of it.

With this, I will close this session. The next session, I would be continuing my discussion on some part of AI and the blockchains. Thank you.