The Future of Manufacturing Business: Role of Additive Manufacturing
Mr. Murali Sundaram, Technology Consultant
Department of Management Studies
Indian Institute of Technology-Madras

Lecture – 09
Manufacturing Radar - II

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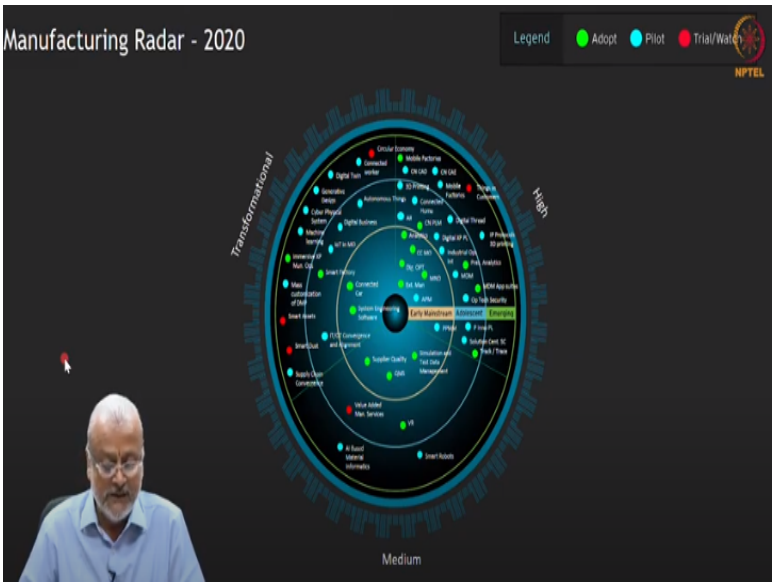

Welcome back guys. We are in the second session of the technology radar for manufacturing. Just to recap from the last session, we briefly looked at the definition of technology radar and its components. We looked at the emerging technology radar. We looked at the manufacturing radar. In the current session, we are going to go a little bit deeper into each of the technology and understand as to which journey map or how the journey map going to be.

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So, the first one that I want to look at is the wait and watch. That means you know, these are new technologies that are emerging and it has the potential to dramatically change or impact the industry and there are certain early adapters of this technology, people, process, standards need to be involved in that. So where does it stand is what we are going to be looking at. Let us go into the radar companion and see what it says.

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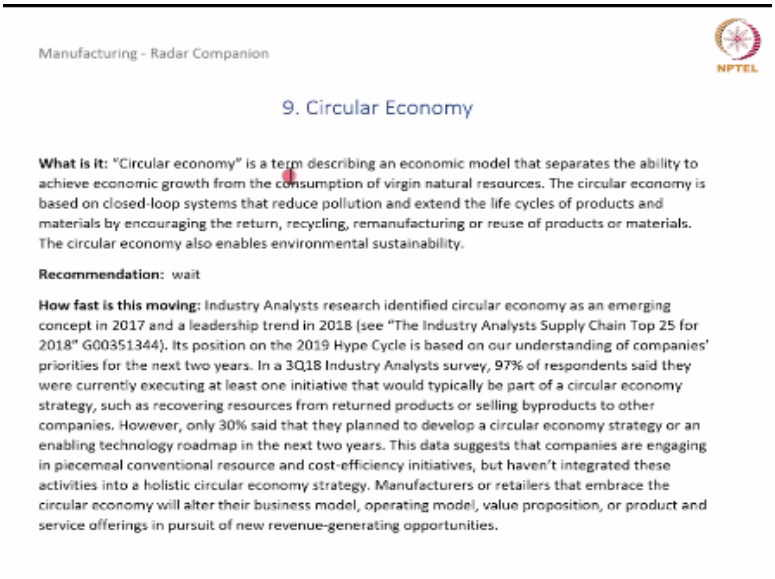

Circular economy is about is a term describing the economic model that separates the ability to achieve economic growth from consumption of virgin natural resources. This is based on closed-loop system and the idea is to reduce pollution and to the extent possible, encourage the, encouraging the returning, recycling, remanufacturing and reuse of product and materials.

It becomes very important in the manufacturing aspect of it. Let us look at some of the trends that we see in the market. You know, like you said, this is based on the closed-loop system that reduce pollution and to extend of life cycles, products and materials by encouraging return, recycling, remanufacturing and reuse of products.

Now in terms of the model the people are adapting, you can see the flowchart here. You know, normally the raw material comes in and the design is what is consuming the raw material or gets used in the manufacturing, consumption and when during the consumption lifecycle, there is some maintenance you may be doing that, and then when it comes to the reuse and refurbish is another cycle that you will do.

But before you discard what we are trying to do is to figure out from the product, which could which are the part that could be potentially reused is what we are looking at effectively Then the recycled components feeds into the raw material part of it and then it completes the cycle and the residual waste is the one that is going.

Now if you, you know if you want to look at the one that needs to look at the circular economy is probably the PCB industry or electronic industry. Electronic waste is a major problem for us and how do we make use of the raw material and then have it sustainable is something that we need to look at it.

Whereas if you look at somebody like automobile manufacturing, they have adapted the circular economy in a much more effective fashion and some manufacturing are able to say that they only have 2% residual waste in the in their cycle of operations. So, if you look at the overall picture, the data suggests that the companies are engaging in a piecemeal convention resource and cost efficiency initiative.

They have not completely integrated all the activities together. So that is the one that is giving the indication that you have to wait and watch in terms of standardizing so that everybody can look into that. But whereas you know, if you look at the manufacturer or retailer, you know they have embraced the circular economy and they will alter their business model, operating model, value proposition, product and service offering even is coming into a new model.

There is a link that I have given here, I do not know if it will, so there is a link that you will be able to check out later on that is talking about how Renault has completely achieved the circular economy in a much more effective fashion. So much for the circular economy. It should have given you an indication of the nature of wait technology.

It still gives you transformational benefit, how do we look at evaluating them and build our journey map around that. Let us look at the next technology.

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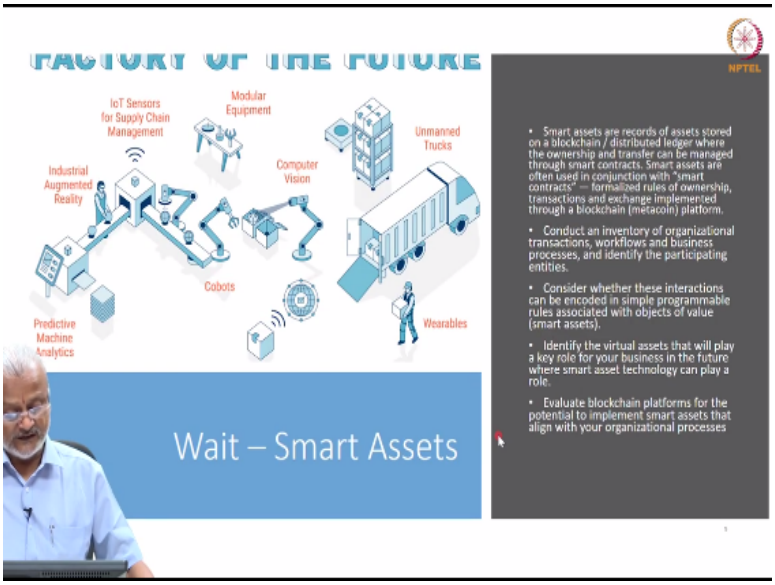

We call it smart assets. You know this you are probably familiar with that. So smart assets are records of assets stored on a blockchain and a distributed ledger where the ownership and the transfer can be managed through smart contracts and the smart contracts is improving. The programming environment is using a framework called solidity. That is also making very popular in the market.

So, the flow, the activity, the fulfillment, the SLAs, all these activities, will depend on human beings to fulfill it, whereas in smart contracts, all of them happens in an automatic fashion. Again, you know, we are saying wait and watch not because of the technology that needs to mature, but in terms of practices that need to mature with respect to each of the operation.

If you look at manufacturing as a whole, even within manufacturing automobile is very different from let us say discrete manufacturing. So, the flow that we have and

the operations that we need to do, the quality control that we need to do, everything becomes different. In order to manage that effectively, the smart contract will have to be configured differently.

That is why that variation will happen between the industry if you will. So, what are the different components that are affecting, in the smart contract, and that is given in the picture on the left-hand side here. So, what you have is the predictive machine analytics managing, managing the overall productivity of the machines here. It will be able to tell you about failures before it happens.

So that your overall workflow is effectively managed. The industrial augmented reality will help you to figure out about defect in a much more effective fashion and the IoT and supply chain management will help you to improve the flow of your manufacturing and there is this technology called cobots means that they are bots, but they will be able to work with the human beings, variations or customization if you need.

They are looking at augmenting human beings efficiencies and productivity. So, they work as well in synchronization and the modular equipment will help you to manage your workflow and the configurations of the cobots and the computer vision will help you to do the quality check on that and the IoT embedded system will track all the products that you are deploying into the customer environment.

The unmanned tracks will make sure that the end user delivers it. So, if you look at the overall flow needs to happen in a very effective fashion without much human intervention and most of them is done by the specific value that are there in the flow and that is managed by the smart contracts. All of these becomes very important and in order to adapt the smart assets how do you go about doing that?

You know, that is what is given in the right-hand side. We need to do a, we need to have a, conduct an inventory of organizational transaction, work flow, business process and figure out what are the participating entities in that and then we need to consider the interaction that can be encoded in simple programming rules. You know,

it could be that your assets, the delivery needs to happen within specific time maybe within some specific temperature.

If you look at pharma, the output will have to be maintained at specific temperature even while you know, getting shipped in the air or something like that. All of them need to be captured within the smart contract programming and then we have to identify the virtual assets that will play a key role for our business in the future, where the smart as a technology can play a role.

So that becomes an important aspect as well. If you look at the blockchain per se, there are many platforms that are available in the market. Figure out which blockchain will be more suitable for you to implement. You know, most of the blockchain is an open source, you will be able to use any of them. So, this is what is involved and it is a very impactful technology,

and you will be able to use it for your productivity and efficiency. But you need to develop skills around that to make it happen.

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Let us look at some of the adapt one. This one is a very thought provocative, imaginative, creative aspect of it. Generative design is you know, the word itself is very provocative. The design needs to be automatically generated. Can it be done? 5, 10 years back it would have been difficult. Today, it is very easy, because there is this

AI grown technology called generative application network, adversarial network, which is called as GAN.

It is able to figure out as to from the past design that you have, and the user orientation that is out there, and the feedback from the customer, all of them put together, if we are able to design it, then you probably you know, we had been doing it manually and the person who is able to do this is called some kind of a guru in design and things like that but interestingly using AI you will be able to do that effectively.

This is already being done by many of the CAD tools you know, such as Augmenta, Autodesk, ESTECO, PTC. They are looking at it. It is not only in the progressive manner, looking at all the past design, can I improve the shape? Can I improve the material strength of it? Can it have more light if it is an architectural system that you have? Can it be more resilient? Can I make the design more environmentally compliant?

You know like, we talked about the circular economy. Can I make the design in such a way that we have 100% circular economy based or recommended material? All of them becomes suddenly possible. That is why the generative design becomes such an important one for manufacturing. That is why we are saying pilot, do a pilot on that, and it is going to have an impact on your manufacturing.

You will be able to come up with the best possible design not necessarily you know, they used to have another technology glyph called cloud sourcing. You know, you look at all the global players and then they will contribute to that, using that you will do the design, not like that. This one is more like you know, the intelligence is gathered and it is put in the artificial intelligence framework.

It will be able to come up with a recommendation and then it can tell you about some of the trends, some of the constraint that you have. Within that you will be able to design your, design your solutions. So, the generative design algorithms can be multi-disciplinary. That means you know it can have design aspect of it. It can have strength of material aspect of it.

It can have environmental aspect of it, policy design aspect of it. It can be multiple things. Incorporating aesthetics, cost, sustainability, function, reliability, manufacturability, serviceability, all of them can be converged, and it can really handle the complex wicked problem as well. I have given a link that has looked at the various technologies and architectural solutions that are out there. When you have some time take a look at that. Let us look at the next technology here.

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If there is one technology that has been beaten to death, in the last two, three years, it is machine learning. Machine learning is going to have impact on every other technology that you have, every other industry that you have. But let us look at some of the aspects and vectors around that. Machine learning is a technical discipline that identify patterns and generate prediction based on analyzing large set of data.

There are major three sub disciplines that we have to be looking at it. You know supervising learning, unsupervised learning, and then reinforcement learning. These are the components that you need to be looking at it in terms of practicing it. You need to adapt machine learning from this aspect. That is, you know, do you have a competitive value built around the solution that you are doing?

That is very high. If you are saying that you know, I have put machine learning to use in order to derive a particular solution or service. And that will give you a competitive edge for you. You know and almost I would say all the vendors are looking at

machine learning as aspect. It is also based on data, it is based on audio signals, visual signals,

and is also added with the generative adversarial network. There are several components that are coming together in that. So, I think you know, piloting or machine learning becomes a very important technology that you need to pilot right now. It is more like, right now you got to adapt that. You know, that kind of a technology is what we are looking at.

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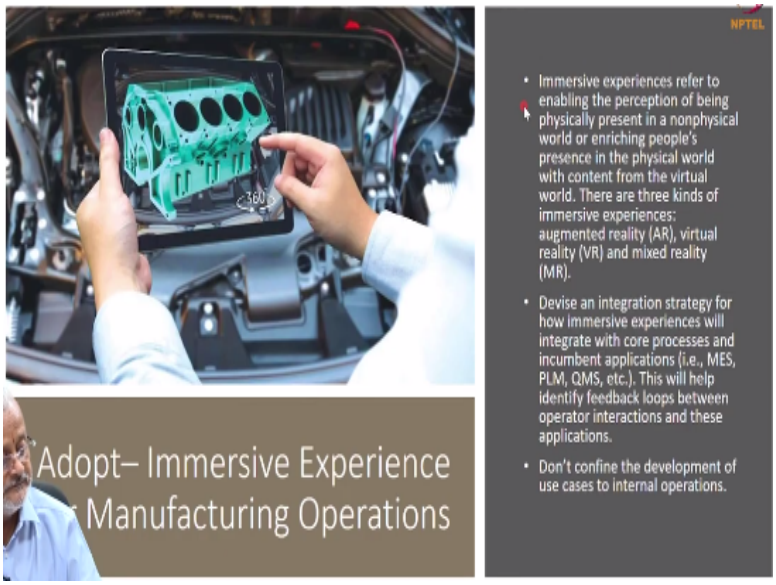

Adopt is very interesting. You know, that means that people, process, technology, standardization, everything is mature there. You just have to look, adapt tech technology, and start using it and that is what is adopt is about. Here, we looked at the immersive experience, AR, VR and MR. There are some solutions that are there in the market that are completely fascinating.

Software went through something called DevOps, development and operations combined together and they felt you know, it can be done by one person or one resource. Here, what is happening is sales and service can emerge together and the answer seems to be yeah. Now what do we need and you know, let us say you know, you want to service a part.

That means you know, you need to know what are the components of the machinery. You need to know how to open it. You need to figure out which component is going

where. You need to disassemble it, do some service on it and do it. And all of them very interestingly can be done using the AR.

You look at you know, something like a machine part, you know, what you see on the right hand side, and your tablet or your mobile, if you, you can develop app or there are some already existing app, you show that in the camera, it will show the internal parts of the engine to you. It will tell you sequence by which you can open it up, dislodge it, and you will be able to service this and put it.

So, interestingly you know, how do we used to do this 5, 10 years back or even year back or even in some places now. You go through some you know, reams of manuals and figure out which component is there, go through the standardized coding. You need to know the standards. There are lot of paper related, reference manual related complication is all taken away and your productivity is increased like anything in this.

This is about one aspect of the AR, the application in terms of the where it can be applied, how it can be used is you know, typically they use only technology, you know or technology and education where it can be effectively used. When the new technology comes, there is always this you know, digital divide that happens in terms of, you need to get experience about the technology.

But you need expensive technology environment to make it available for them. Whereas if you have the AR or VR it will be able to give you the immersive experience, hands on experience, and you will be able to internalize the knowledge around how to make it work for you. Here again, the DDD dull, dangerous and duplicate jobs are good targets for AR application.

Let us say you want to train somebody for a disaster recovery, work in a nuclear plant, make them ready for, you know operational sensibilities on what to do next, and things like that. It is not a difficult thing anymore. It used to be a complicated thing. It is not a difficult thing anymore. So, this kind of benefits is overwhelmingly helping everybody everywhere.

So, if you want to adapt this, what do I need to do is what is kind of you know indicated here. Devise an integration strategy for immersive experience, which will integrate the core experience, the incumbent application, which is you know, it could be a PLM, QMS, MES. There are several applications that are there. It is going to help identify feedback loops between the operator and the interaction between those application.

A lot more need to be gained out of the immersive experience. In all the technology that we talked so far is all transformational benefits that you will have. So, immediate gratification you will have if you are able to adapt the immersive technology, you know that is what I would say and you could like I said, you know, what I have done is only taken six technologies as example.

There are over you know, if you look at the let us look into the manufacturing part. There are several technologies that you will see here. There are over 68 technologies that are there and even if you had to go back to indication of how many technologies are in the transformational realm, there are over 15 to 16 technologies that are there.

At minimum I would say you know; you need to be evaluating this. So that could be a good journey map you could be having.

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Let us look at the last part, which is the smart factory. We looked at smart assets. We are looking at smart factory. What are the difference between them? We already know

that the smart asset is very close to distributed ledger or a blockchain technology tightly integrated with the business flow into that.

Now, if you look at the smart factory, you know, it is more like a concept that is used to describe application of different combination of modern technology to create hyper flexible self-adapting manufacturing capability. Sometimes you could call it as industry 4.0. But it is becoming more than that, you know. There is one other lecture that I am going to be giving that is on the agile manufacturing.

That again is kind of will lean on the smart factory, because sometimes your production could be disrupted. Your production capacity will have to be reconfigured and remodified for a new set of product, model and design may be needed. So those are some of the requirements around the smart factory establishment.

In order to make it happen, you know we have to do a you know, smart factory concept role as a part of agile supply system and integrated with the connected customer demand because when the customer demand varies your production will have to change as well. We will see more in the agile manufacturing in a short while. Then we have to differentiate between the Brownfield and the new Greenfield capabilities.

and we have to look at the innovation as a way to make the smart factory happen and identify the ideal technology combination that aligns smart factory with specific segments and its supports. So as a concept, the underlying fabric will be the digital the transformation integrated with the IoT, that is collecting the data and the Edge analytics that is processing the data.

It is all combined into the AI fabric to help your overall manufacturing and production capability in a much more effective and efficient fashion. These are the six important transformational technology that we looked at. We looked at each of the categories actually, you know wait and watch. We also looked at the adapt, and we also looked at the pilot ones.

So, with this, you know, I am just wrapping up this session. So, to summarize, we looked at radar as a tool. We looked at emerging technologies. We looked at manufacturing technology and each of the radar and the companions that we have. And then we went a little bit deeper and we looked at transformation and technology alone. Two samples of each of wait, pilot and adapt.

We had a very good understanding I hope and when you look at this as a whole journey, this exercise could be something like a two day workshop to figure out what are the technologies that is going to make you more productive, more efficient, and then be adaptive in the future environment or in disaster environment as well. Thank you for the opportunity. Thank you.