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

Lecture – 08
Manufacturing Radar - I

Hi, welcome to the session on technology radar manufacturing. Let me introduce myself. My name is Murali. I am technology consultant for NPEDIA Technologies. Today, we are going to be having a detail, depth level access into the technology radar manufacturing. It has two parts to it. One is technology radar as a tool. What component does it have? What speed at which technology is moving?

and what are the recommendation that you could adapt into it? That is the first part. Second part, we are going to go into the details of what are the technologies that are currently impacting manufacturing as a broad brush. So, we have to be looking into this. Let us quickly go into understanding what is a technology radar. The term radar, you perhaps are very familiar with that.

You know they are glyphs that are moving around, target objects are moving at a specific speed. You can get a sense of what speed it is moving. What are the shape it is having, and things like that. So, we use the similar idea behind understanding how to identify the technologies and make executive or strategic or tactical decisions on that. So let us look into some of the components of the radar.

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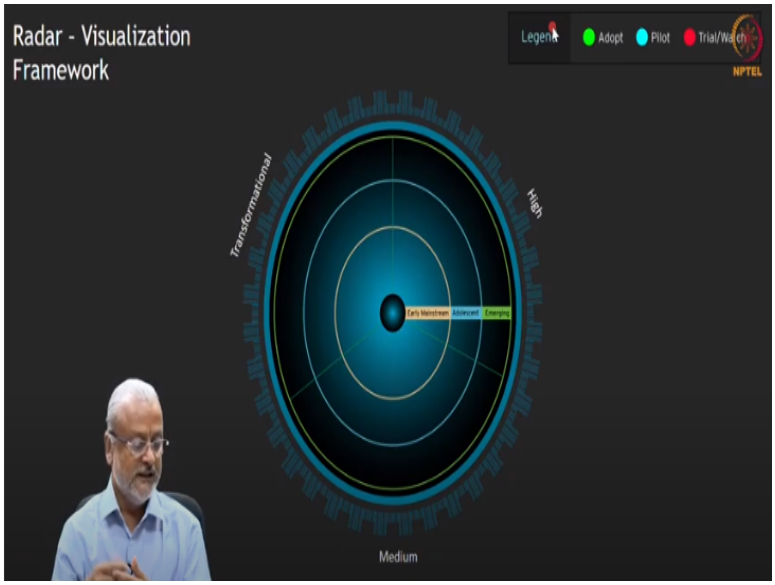

So, in this radar, you will see three sectors, three rings, and legends going around in that. Let me explain some of the piece. The one that says transformational is talking about the benefits you could have in adapting in that sector of the technology. It means that you could have anywhere between 5 times to 10 times the benefit, if you are adapting those technologies.

And the one on the right that you see is noted high, that means anywhere between 2 to 5 times the benefits you could be having. The one at the bottom is indicating medium. That means anywhere between 1 and 2 types of benefit you can have and what is interesting is you will notice additional ring level legend that says emerging technology, adolescent and early mainstream.

These are indicators of where technology is currently. Emerging means that there are disruptive technologies that are available in the market. Disruptive means it is changing the business model, it is changing the service model, several things could be happening there. But when the new technology is emerging, there is a little bit of adoption reluctances from individual vendors.

So you see some generic adaption that are there in the market, but yet it is not up to the mark. So that is what is indicated by emerging. Adolescent means that it is improved a little bit and the early mainstream means that you know it is widely adapted. In each of that, you have to bear in mind that each of the technology have

people, process and technology. So emerging means in terms of practitioners, it may not be fully developed.

Training material may not be there. Manufacturing practices may not be up to the mark. Whereas in adolescent it is slowly developing. If it is early mainstream, it indicates that it is fully developed and you will be able to look into that and then at the top you will see some colored legend. You know these are the colors that you will be seeing. The colors that will indicate as to what you should do with the technology.

So, emerging in if you have an emerging ring and a transformational sector and you have a green dot on that it means you have to adapt the technology. That means people are, people process technology is very matured. You have the maximum benefit, and you have to quickly adapt to this technology. That is what is indicated by a green dot. A cyan dot in case you have to do a pilot.

The cyan indicates that there are differences in practices. Every technology when you look at it, between shop floor between different software houses, they have their best practices and you have to evaluate for your needs. That means that you have to run a pilot to figure out what are the best methodologies that could potentially be adapted for this particular technology.

So that is indicated by the pilot. The last one that you see, which is in the red, that is interesting. It says, trial and watch. Sometimes you can try it, but there is no guarantee that it will be adapted by the end user. That means that it becomes economically not viable at certain level but you may have interest in exploring that because you want to develop skills around that technology.

That means you may want to trial on a trial basis, you want to try those technologies or if you do not have enough budgets, you just wait and watch for the analytical reports on that. That is what is indicated by that. Now why do we need radar? Let us think and talk about it for a while. The technology is coming at the business speed you can say.

So as and when new technology comes up, that is productivity, efficiency improvement in overall delivery capability, serviceability capability. You have better economies to be leveraged out of that. It is not just one technology. 5, 10 years back, if you look at it, it is either cloud you have to go, either mobile you have to go or IoT that you have to go and things like that.

Now if you look at it is just not one technology, there are multiple technologies, and you may have to prioritize and you may need larger team that is working on it. So, it becomes very important for corporation, both from strategic and tactical perspective as to which technologies that I want to select, and which how do I prioritize them?

And how do I make it in the best practices? That is why we are going through these exercises of looking at technologies. Now can we look at the technologies in terms of a horizontal which is impacting across all the businesses, or should we look at the verticals, that means the technologies that are impacting for manufacturing is different from the technologies that are impacting for let us say space technologies or insurance, or financial.

Obviously, what is important for business will drive the technology adaption. So you have both aspect of it. One on the one that says horizontally, I will look at all the technologies together and another slice that will look at the vertical and say, I am going to look at all the critical vertical technologies, okay.

So, with that as the introduction on the radar as a tool, which is going to help you rapidly go through your journey map on what is your strategic approach for adapting technologies. Let us go into exploring that.

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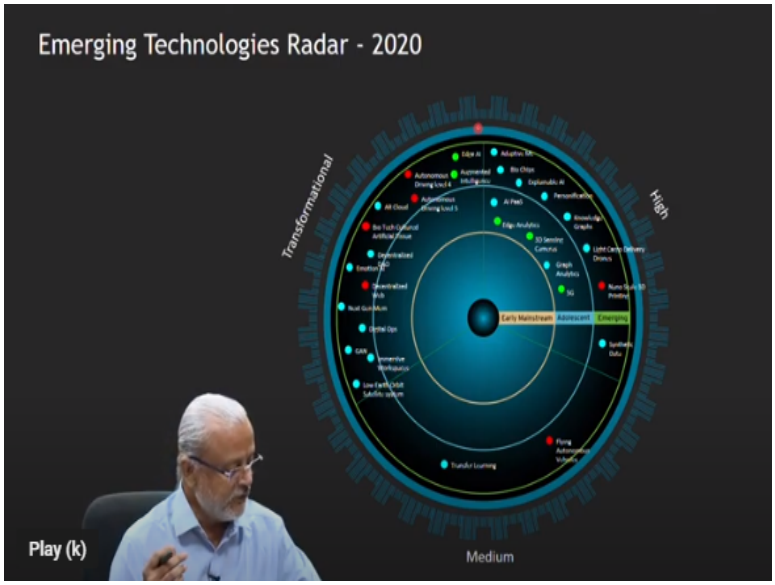

I am having what is known as the emerging technologies radar here for the 2020. This we are looking at various industrial analyst report like Gartner, IDC, Forrester, even IEEE, ACM Professionals, every one of them is looking at the technology landscape and say you know here are the technologies that are going to impact this year and here are the best thing that are happening.

So based on that we plot this technology radar. So here you will see and let us look at the transformational one. I am going to use a marker here. In the transformational one, what are the ones that are important. You know Edge AI that we see, augmented intelligence, autonomous level driving four and five, biotech and cultured tissue, AR in cloud. AR stands for augmented reality.

So all of them is becoming important in terms of adopting at the horizontal level, because irrespective whether you are in manufacturing or insurance or financial, or wherever it is, these are the technologies that are going to have a deeper impact, you know look at the decentralized DAO that is more like a the distributed ledger technologies.

Blockchain is very deeply impactful in terms of adapting it and ensuring the next level of governance, you could be implementing it. Generative adversarial network, which is known as the GAN is going to be big in the artificial intelligence space, immersive workspace, which is mixing AR, VR and MR together is becoming a more important one.

So, all the transformational one, you will notice that they are quite a few in the current one and the high benefits you will see is relatively not clustered together but you know it is distributed. You will notice a pattern many of them are in the pilot mode. You know the cyan color that you are seeing and the red one are the one that is talking about wait and watch,

and the green one is saying that it is ready to be adapted. For example, you look at the Edge AI that is saying that it is green, you can directly adapt because there are lot of AIML programs are there and you will be able to extract information, mine information, build intelligence around that, apply deep learning into that. All these technology advantage you may be able to effectively use on that.

Now, these are just technology names. Now if you look at something like AIML or AR, even the definition would vary from one group to the other. What are some standard definitions? What are the best practices that we do? So for that, we have something what is known as a radar companion. Let me show you that in a while.

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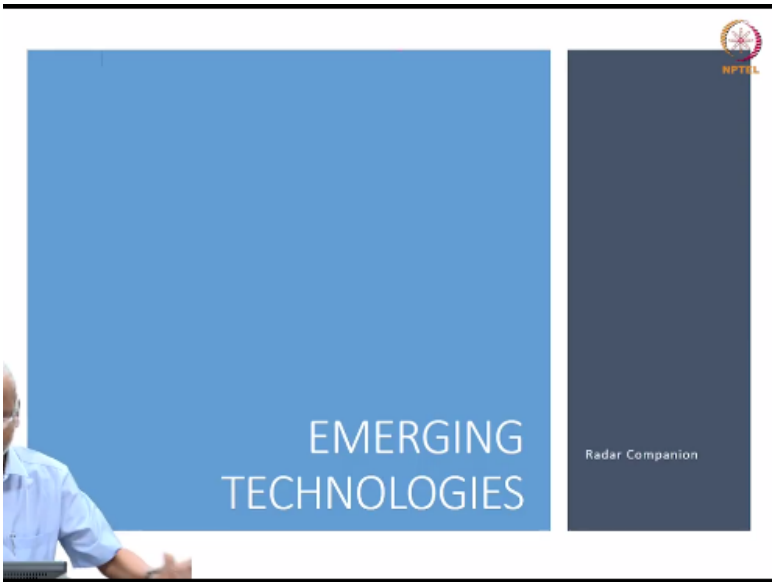

Emerging Technologies, that is what we see here. So, what we see here is a radar companion. Let us look into this. All the technologies that we saw there is going to be listed here. You know we saw the, we see the AR Cloud here.

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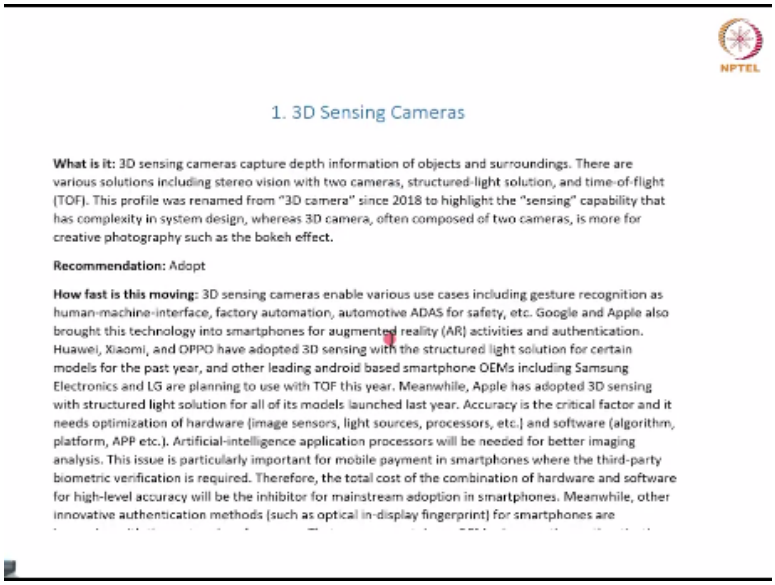

1. 3D Sensing Cameras

What is it: 3D sensing cameras capture depth information of objects and surroundings. There are various solutions including stereo vision with two cameras, structured-light solution, and time-of-flight (TOF). This profile was renamed from "3D camera" since 2018 to highlight the "sensing" capability that has complexity in system design, whereas 3D camera, often composed of two cameras, is more for creative photography such as the bokeh effect.

Recommendation: Adopt

How fast is this moving: 3D sensing cameras enable various use cases including gesture recognition as human-machine-interface, factory automation, automotive ADAS for safety, etc. Google and Apple also brought this technology into smartphones for augmented reality (AR) activities and authentication. Huawei, Xiaomi, and OPPO have adopted 3D sensing with the structured light solution for certain models for the past year, and other leading android based smartphone OEMs including Samsung Electronics and LG are planning to use with TOF this year. Meanwhile, Apple has adopted 3D sensing with structured light solution for all of its models launched last year. Accuracy is the critical factor and it needs optimization of hardware (image sensors, light sources, processors, etc.) and software (algorithm, platform, APP etc.). Artificial-intelligence application processors will be needed for better imaging analysis. This issue is particularly important for mobile payment in smartphones where the third-party biometric verification is required. Therefore, the total cost of the combination of hardware and software for high-level accuracy will be the inhibitor for mainstream adoption in smartphones. Meanwhile, other innovative authentication methods (such as optical in-display fingerprint) for smartphones are

If we go into that, so each of the technologies, the way we are trying to help the corporation making addition is you need to define what it is. Let us look into the AR Cloud adaptive ML, AI PaaS and AR Cloud.

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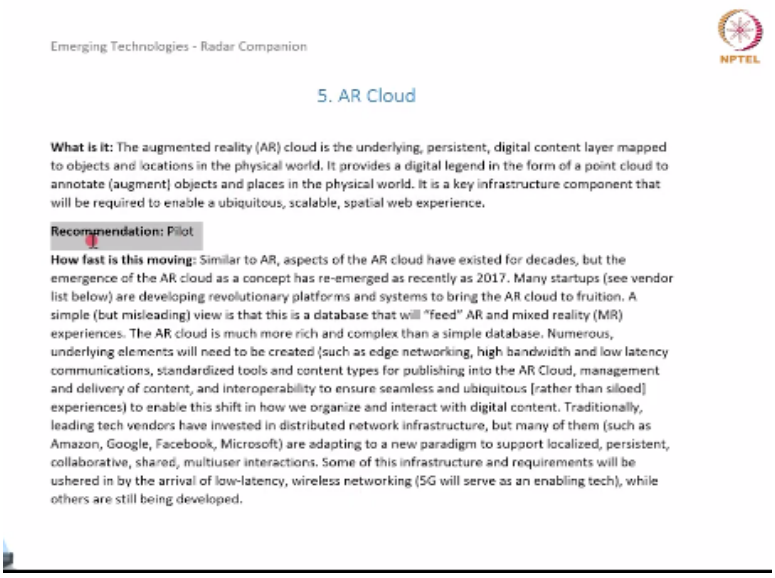

Emerging Technologies - Radar Companion

5. AR Cloud

What is it: The augmented reality (AR) cloud is the underlying, persistent, digital content layer mapped to objects and locations in the physical world. It provides a digital legend in the form of a point cloud to annotate (augment) objects and places in the physical world. It is a key infrastructure component that will be required to enable a ubiquitous, scalable, spatial web experience.

Recommendation: Pilot

How fast is this moving: Similar to AR, aspects of the AR cloud have existed for decades, but the emergence of the AR cloud as a concept has re-emerged as recently as 2017. Many startups (see vendor list below) are developing revolutionary platforms and systems to bring the AR cloud to fruition. A simple (but misleading) view is that this is a database that will "feed" AR and mixed reality (MR) experiences. The AR cloud is much more rich and complex than a simple database. Numerous, underlying elements will need to be created (such as edge networking, high bandwidth and low latency communications, standardized tools and content types for publishing into the AR Cloud, management and delivery of content, and interoperability to ensure seamless and ubiquitous (rather than siloed) experiences) to enable this shift in how we organize and interact with digital content. Traditionally, leading tech vendors have invested in distributed network infrastructure, but many of them (such as Amazon, Google, Facebook, Microsoft) are adapting to a new paradigm to support localized, persistent, collaborative, shared, multiuser interactions. Some of this infrastructure and requirements will be ushered in by the arrival of low-latency, wireless networking (5G will serve as an enabling tech), while others are still being developed.

So what is you know you need to have a definition of what is AR Cloud. So you know it is going to be looking at the underlying persistent digital content layer mapped onto objects and location in the physical world. It is going to be a very useful productive tool in terms of understanding from the digital transformational perspective. what do we do the recommendation is also captured here.

What is happening in the industry is briefly captured here, in terms of how fast is it moving in the market and then how does it affect our business is captured in the next

session here; and what do the corporation need to do? How do they do the or build the best practices around that? How do they protect the assets is all captured here. and the type of benefit that you will get out of that is also indicated here.

So, these are like a page or page and half companion that will help you to understand a little bit more into detail about each of the technologies that are represented in the radar. So, it is going to give you a lot more powerful tool that helps you to say, here is the technology that I want to put it on priority. Let us go back to the radar now. We looked at the transformation, we looked at the high benefit radar glyph,

and we are also looking at the medium level, you know transfer learning and flying autonomous cycle which is in the red. At some level, you are seeing lot of news in the Middle East or in California in technology adapting ecosystem. The flying autonomous vehicle is there are quite a few pilots that are already there. So now if you look at the radar, somebody may ask you a question that well, transformational is there.

So obviously everybody needs to do only transformational, you do not have to necessarily look at high and medium. That could be a question. Now why would anybody look at high and medium and prioritize that. Sometimes what happens is something like a compliance, you know when you come to cloud, a data related to a geography will have to physically stay within the geography.

That is a compliance. It may not have transformational benefit for you. It may have medium benefit for you but still, you may have to adapt into that. Sometimes it may be a standardized programming language that you want to look. It may not have transformational benefit; it may only have high benefit for you. You may still have to do it.

In terms of radar sectoring and classifying into emerging adolescent and early mainstream technology helps you to group and helps you to prioritize, and then let our larger working group adapt each of the technologies. That is the idea behind that. So, with emerging technologies, giving you this overall picture, I want to take you into

the manufacturing type of technologies that are having a impact on that. Let us look into that.

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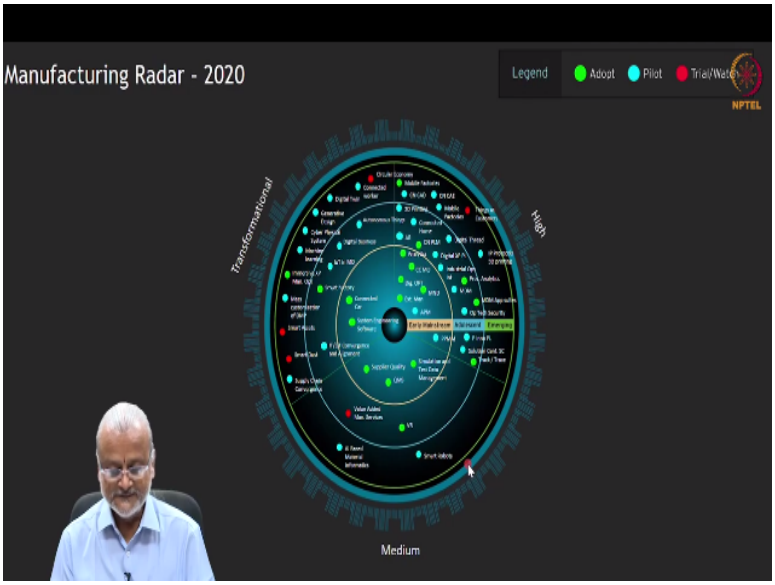

Wow, this is cluttered. A lot of technologies are there both in transformational and high and even in medium the relative density of the technologies that are listed is very high. We will look at some of, let us look at some of the things that we have heard in the news. It is very popular right you know something like a digital twin.

Something like a immersive experience for manufacturing operation, machine learning, generative design, supply chain convergence, digital business, from IoT it is kind of moving to autonomous things, smart factory, connected car and system engineering software. These are the things that we have heard quite a bit in the manufacturing space.

So similar to the emerging technologies that I have given, I have a similar companion radar document as well. We will go to that in a short while. I want to spend little bit more time looking at the radar because these are these many technologies will have to be adapted into the manufacturing within a short while to make you more productive, more scalable, and more efficient.

You know all these technologies will have to help in one of those things to happen. Maybe alternative business model to say you know from product, I want to go to as a service mode or sometimes it may be hybrid, I want to go in between them. If you

look at something like Tesla car, Tesla is not selling you the car anymore. You know they are constantly monitoring your car, to give you the service capability on that.

It is always connected car and because of that it is more like car as a service is what they are selling rather than the car. Lots of people are noticing it and they are trying to shift to that as well. Now, let us look at another one. You know I have given red indication here. I am going to cover in detail in the second session is the circular economy.

Circular economy is you use bunch of raw material for making your product. Instead of putting it all into the dump yard you try to figure out what part of it can be introduced into the new product design. What percentage? You know people like Toyota is talking about 98% of the old car component I want to put it back in the new car.

That means you know there is awareness about environmental health in that. So, this becomes important in terms of what are the technology that I am going to leverage in order to make it happen. You cannot I cannot use plastic material. I want to use recyclable material into that. So, this kind of awareness as well is looking at new way of doing business.

Sustainable business rather than constantly increasing profit, increasing financial number kind of business as well. That is on the economy and the environment side. Let us look into the high-end technology, look at the digital twin something like that. Now it is a kind of an extension from AR, VR AR and VR is trying to replicate the environment that you already have and try to do some additional give some additional information on that.

They are also coupled with real time analytics on that, coupled with predictive analytics on that and things like that but what we want to do in digital twin is an exact replica of the physical system into the virtual world. Where does it find application? The applications are in the extreme what they call it DDD; dull, dangerous, and duplicate. So this becomes very important as well.

Now let us say imagine that you are trying to do a gas turbine on that and you want to do a study on that. If you want to use the real gas turbine to go through the stress studies on that, it could become very expensive proposition for you and when you want to change the material aspect on that, then it becomes doubly expensive as well. So, in all these area, say digital twin steps up, especially I think Boeing is using this example.

Many of the manufacturing industry are looking into that is to figure out in terms of can I look at an alternative material? Can I decide how long would it sustain in the real environment? So, all these aspects can be studied into that. The next generation of the product or services; how does it you know how does it impact? what is it going to be? All those aspects can be looked into that.

Now we will go into this a little bit more in detail in the following presentation. But I want to give you a glimpse of you know the type of impact that the transformation and technology could have for a manufacturing industry and similarly, even if you look at on the right-hand side, you have the high benefits one. You know whether you have the connected home or 3D printing or something like operational tech security.

It looks exhaustive. Let us spend the brief minute or minute and a half on that. 3D printing probably these are familiar, it is known as the additive manufacturing. Normally, in the traditional manufacturing, you take a stock or a block of material, remove the unwanted part and then you get the actual material. Whether you do shaping or lathing or you know the other manufacturing activity or fabrication activity that you do.

That there is always certain wastage from the block material on that. Whereas in 3D printing that you start with a nucleus, you keep building upon it, and then you stop when the boundary hits. So it is supposed to be extremely efficient and no wastage in the additive manufacturing. That is changing lot of things and it used to have some challenge in terms of you know metals and some really complicated material, but things are improving.

Nowadays, you can even print metal in the 3D printing. What about strength and heat, you know heat treatment and things like that. Those are things that are catching up. Now let us look into the other one that we looked at, operational tech security. Now these are you have CNC machines; they are all computerized. They are all digital.

That means that you know it can be driven from a network, it can be remotely operated. You have always on network, that means that could be a man in the middle attack and your system could be compromised. So, some of the traditional security for IT may not hold here. It may be a lot more complicated. That is why you know the operational tech security becomes an important one in this particular space.

You know we can go into details about it, and the you know and the tech radar companion that I have, will help you to look at technology in a brief one. So, if you look at each of these technologies, it has a depth as well on that. With so much it is almost like a ocean. With so much variation, how do I handle it? We want to make the job easier.

That is why we have the tech radar tool, and we have the companion tool. So let us switch to the companion tool and look at what we have over here.

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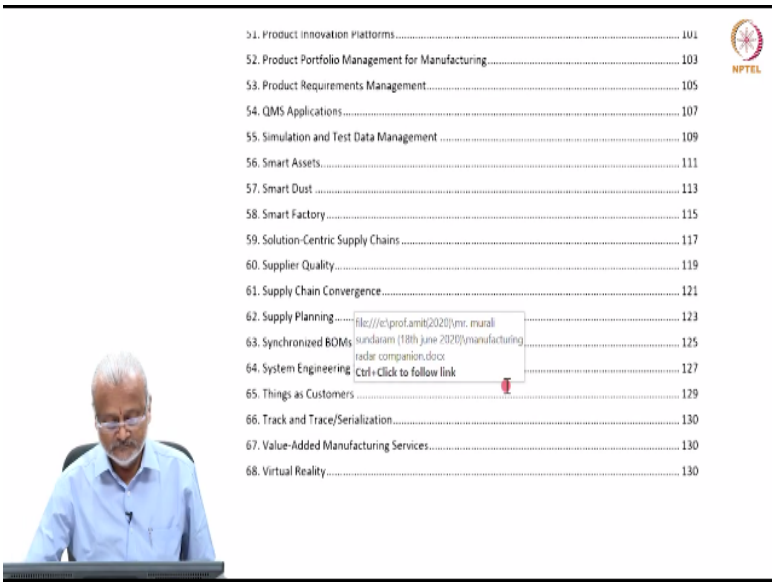

So interesting you know, you have about 68 technologies that are there in the manufacturing that you want to do. Even if you prioritize top 10 it may not be sufficient. You may have to do more like a top 30 in order to make it happen.

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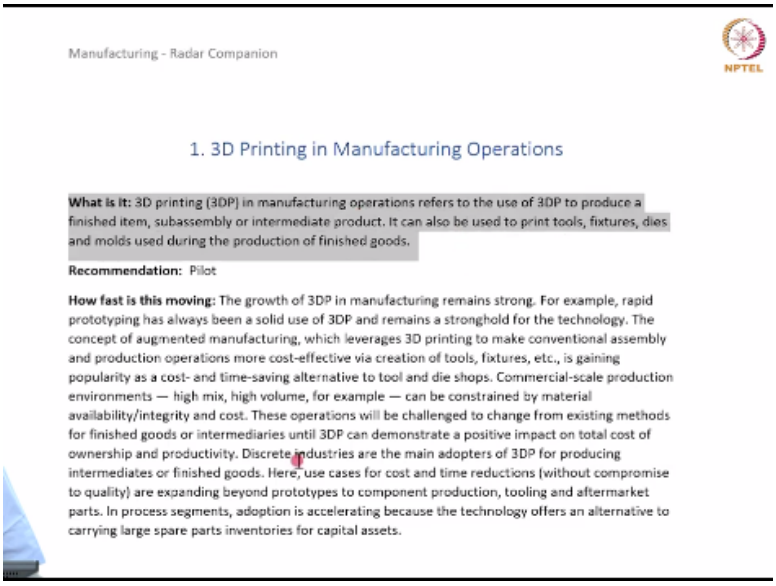

So you have a you know like I explained in the earlier one you have the definition, recommendation, the speed at which it moving, how does it affect the business? What do we need? Let us look into something like a circular economy we wanted to look at.

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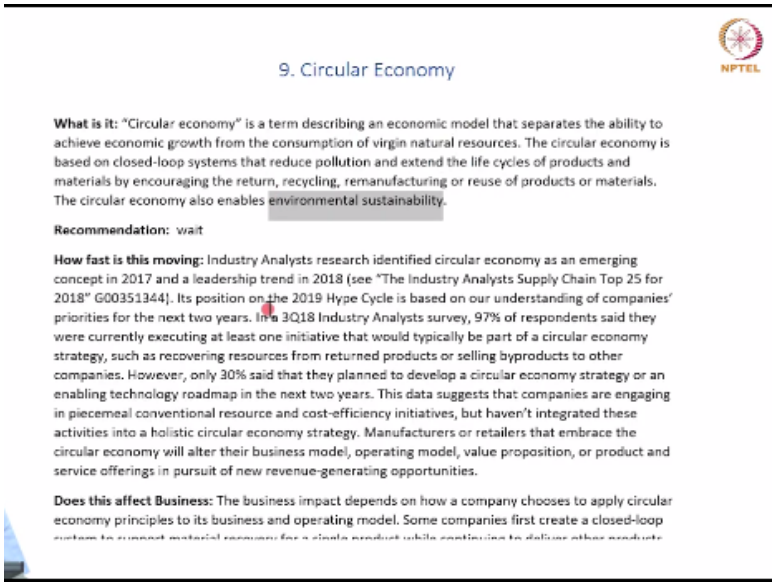

You know we wanted to, you know every other industry is want to look at the environmental sustainability. It becomes a very important one to look at it. It says wait, but you can give it a trial and do a watch on that. Let us look at I wanted to show the digital twin on that. Digital business, digital business technology platform, digital optimization, digital thread, digital twin.

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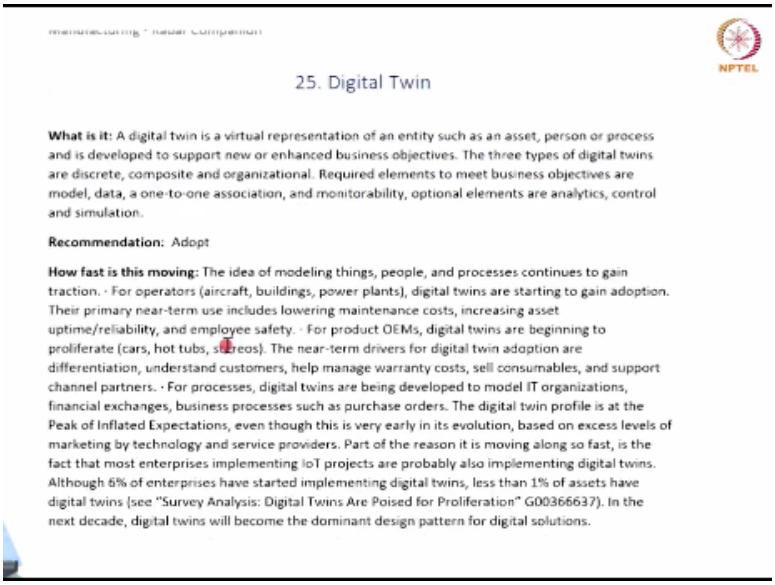

So digital twin is a virtual representation of an entity such as an asset, person, process and is developed to support or enhance business objective. So, you will see the area in which it is affecting your business here and what we need to do and it has a tremendous benefit as well on that. So, all the key technologies that are important to us is well managed within this.

This is briefly the one that I wanted to cover. So, in this session, we had understood about what is a raider and its legends. What does each of the legend signifies? We looked at emerging technology radar to understand technology as a horizontal. We looked at the manufacturing radar to understand about what are the technologies that are impacting this thing.

So, the next half hour session, I want to look into a representative sample of each of the technologies, sectors, you know transformational high and medium. Go a little bit deeper and understand you know if you need to adapt to one or more technology. What is going to be our journey map? That we will see in the next half hour session.