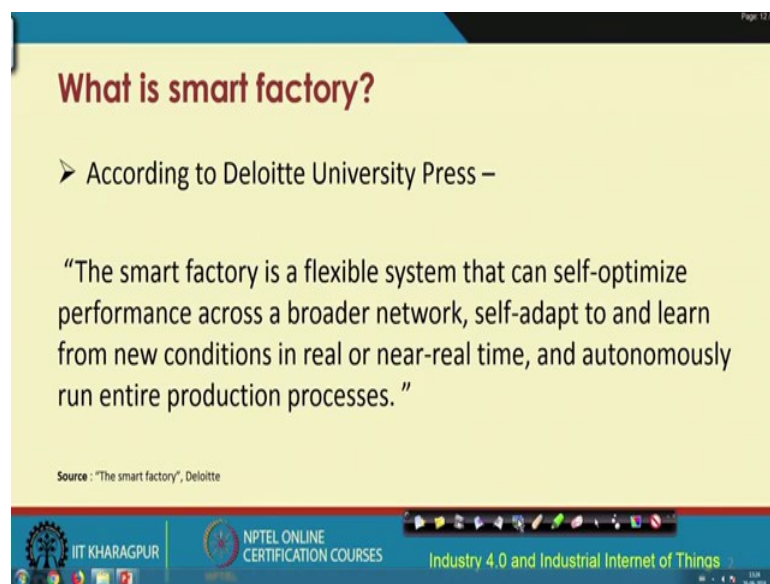**Introduction to Industry 4.0 and Industrial Internet of things**
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Lecture – 10
Industry 4.0: Smart Factories

Smart Factory is a term that is used commonly in the context of Industry 4.0 revolution. People are talking about making smart factories in the industries. So, existing factory, factory operations, processes, products everything being made smarter, but then we need to understand that what smart factory is all about.

So, there are different definitions of smart factory that is available. Let us look at one such definition of smart factory.

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So, smart factory as per this definition, "The smart factory is a flexible system. It is a flexible system, that can self optimize the performance across a broader network and self adapt and learn from the new conditions in real or near real time and autonomously run the production processes". There are different aspects that are captured over here through this very good definition of smart factory, what are these different aspects. It is a flexible system; we need to have a system, which can be changed easily. If you need to introduce certain things in an existing process, the system should be flexible enough in order to incorporate in order to help in incorporating that particular change.

Self-optimizing the performance over time when the system is performing, this smart factory or some component of it in a smart factory is able to optimize its performance over time. As you can understand, realize based on whatever we have gone through in the previous lectures, this concept can be achieved, implemented with the help of incorporation of different algorithms; algorithms that can estimate how much the performance is going to be of a particular machine or a process in the future and then optimizing its performance. This is going to self-optimize the performance across the broader network. So, a network it has to be there, which will help in the process and self-adapting to the different conditions, which are coming in real time or non-real time, and automate autonomously running the different industrial processes, the production processes.

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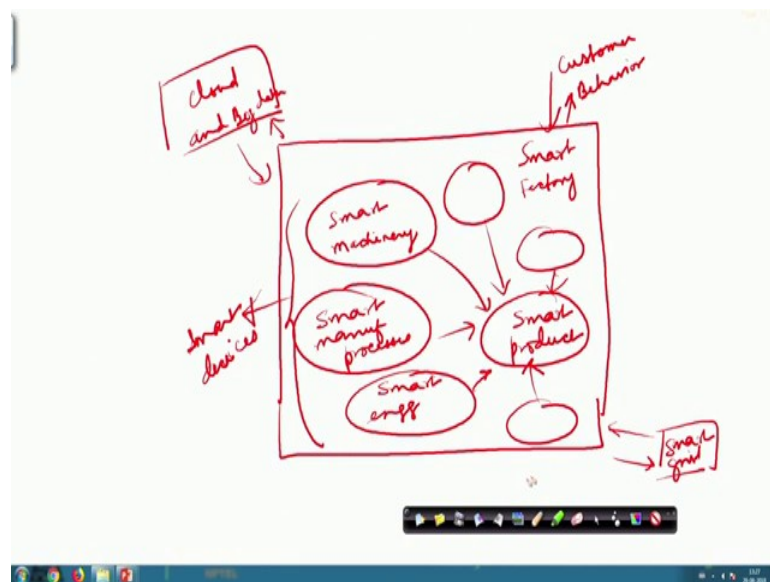
So, let us before getting into all of these things let us first try to understand this smart factory concept in little bit more detail. Let us say that we want to build a smart factory right.

So, what are the different components of it? We need to have smart machinery, smart manufacturing processes, smart engineering solutions, and these can help in arriving at the smart product. So, for all of these in order to make them smarter, we need to use smart devices. So, this is a smart factory and there are there could be few other things that you might be able to identify, which can help in making the product smarter.

Then we are talking about this interaction. This is the smart factory and the different interactions in terms of the customer behavior, interactions with the customer, the behavior of the customers on the factory, in the system. Smart grid is very important in terms of the energy management and another thing such as when we are talking about any kind of smartness, we have to deal with the analytics; cloud and big data.

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And try to understand the different other aspects. So, why at all we need to have smart factories? Why at all we need to have smart factories? In order to evolve our technologies, the market is highly competitive nowadays. If you have smarter machineries, smarter processes, smarter systems overall, it is quite likely through the use of these systems you are going to have improved productivity, efficiency, improved monitoring of this machinery, and reduce the down time. This will help in improving the competitiveness in the market. In order to deal with this competitiveness, we need to have the smart factories and high amount of production, within minimum timeline and this is quite self-understood.

The last one is very important is reducing the risk of failure, which will affect the productivity. So, reducing the risk of failure can be achieved through the use of smart factories.

So, what are the advantages of running smart factories? Reducing the overall cost, cost of production; increasing the efficiency of productivity, efficiency of the product, that is being done that is being manufactured, improving the efficiency of the surfaces, efficiency of the production processes can also be improved. So, overall efficiency in all different terms can be achieved with the help of incorporation or transitioning to smart factories.
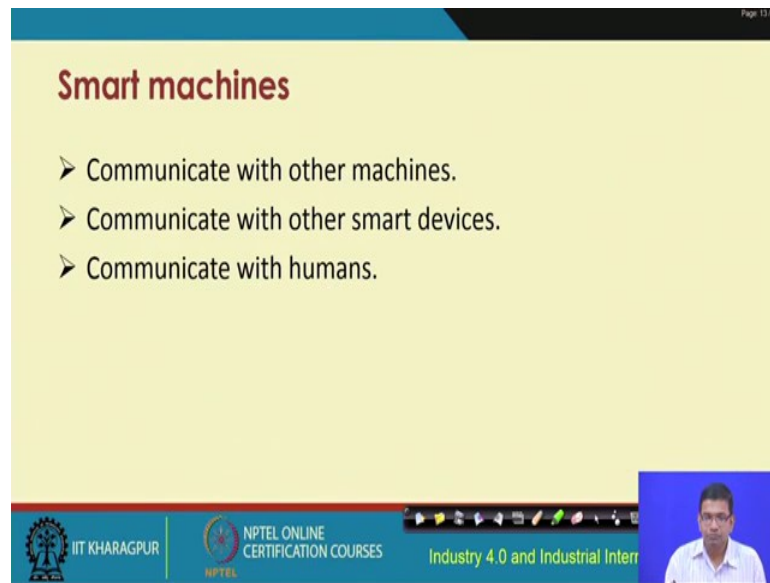
Improving the quality, improving the predictability of different things like the health of the machine; in the future predicting the health of the machine, predicting whether a fault can happen in the future, improving the safety of the machinery, and the overall safety of the workers in the factories.

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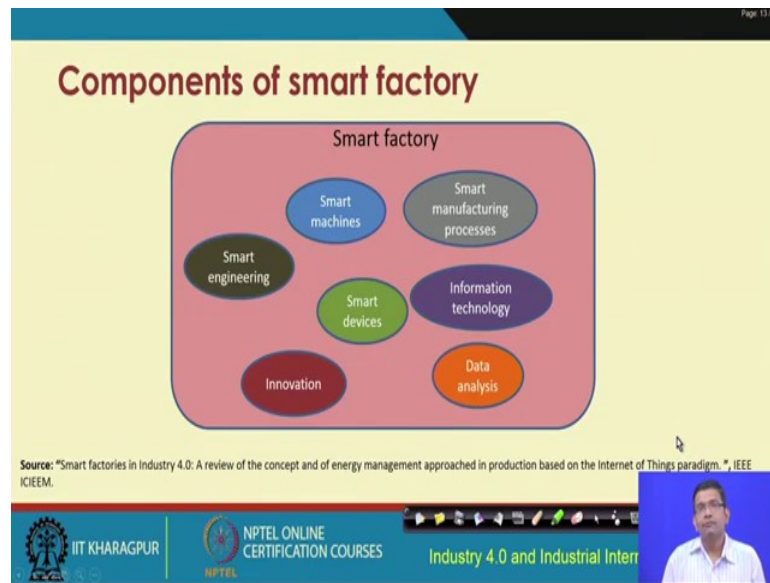
These are the different components of the smart factory, smart machines, smart engineering, smart devices, smart manufacturing process, then three things improving upon the innovation whatever was existing innovating the product, processes and all these things can be done with the help of information technology. Information technology can help in making the overall factory smart. So, this is a very important component, IT, use of IT in the factories can help in making the companies, the factory smart and the data analytics. The data of all these smart factories are the factories when you are incorporating IoT solution, sensors and actuators; they will throw in lot of data which will have to be analyzed in order to make them smarter.

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Smart machines help in communicating with other machines, communicating with other smart devices, and with humans.

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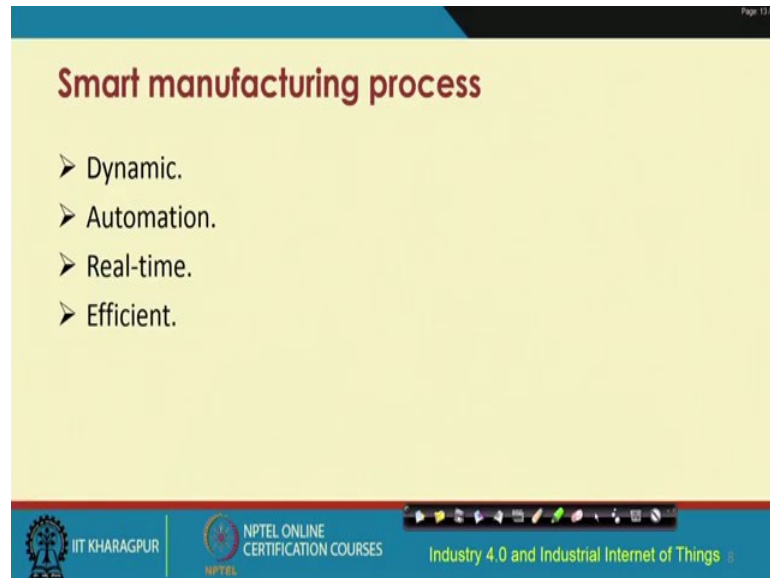
The smart devices will be connected. They will be connected between themselves and other field devices, other mobile devices, that are operating. So, this connectivity issue is very vital in the context of smart devices. Smart manufacturing process talks about the dynamism in the manufacturing. So, taking care of dynamic changes in requirements. So,

autonomic autonomously the manufacturing is going to be done, without any human intervention.

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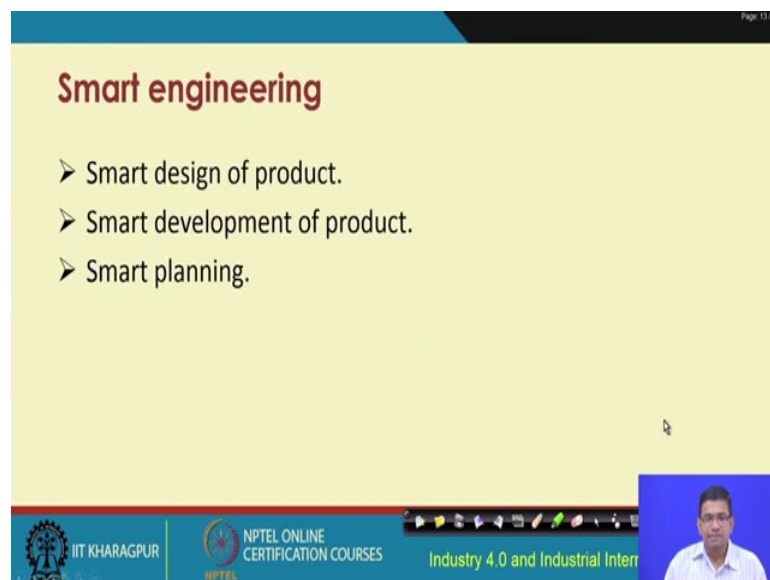
Real timeliness is very important; efficiency is very important; thus, all of these help in having smart manufacturing processes.

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Smart engineering, smart design of the product, smart development of the product, smart planning all of these are different constituents of smart engineering.

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IT is something that I was also telling you, that it is very important in this overall business of or building smart factories, we need IT solutions in terms of smart software, smart hardware, smart management, smart monitoring, and smart control.

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These are some of the characteristics of smart factories. Overall, when we are talking about smart factories there is connectivity between different machines, connectivity between machines and the different operators, connectivity between these different operators. Thus, we have machine to machine, machine to human, and then human to

human. So, all this different connectivity is very important characteristic of smart factory.

Optimization, these smart factories are such that they will optimize their solutions, their productivity, their processes, and overtime. They will have some kind of self-learning behavior incorporated, implemented in them, through different algorithms. Thus, transparency is very important proactivity and agility in terms of moving very fast. So, moving very fast in terms of changes the dynamism, changes in the requirements, changes in the environment, and changes in the environmental parameters.

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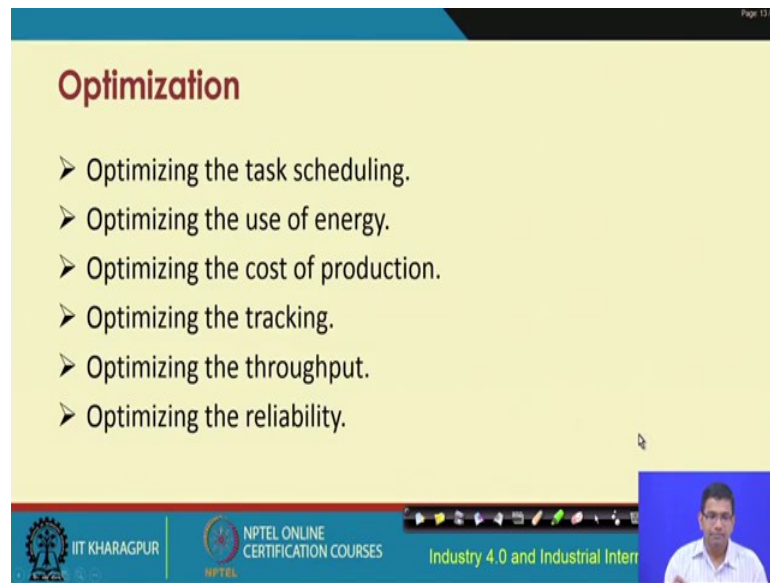
Connection-connected smart devices, connected smart machines, and all of these connected devices will bring in lot of data; so connectivity with the data center and connectivity between the different processes.

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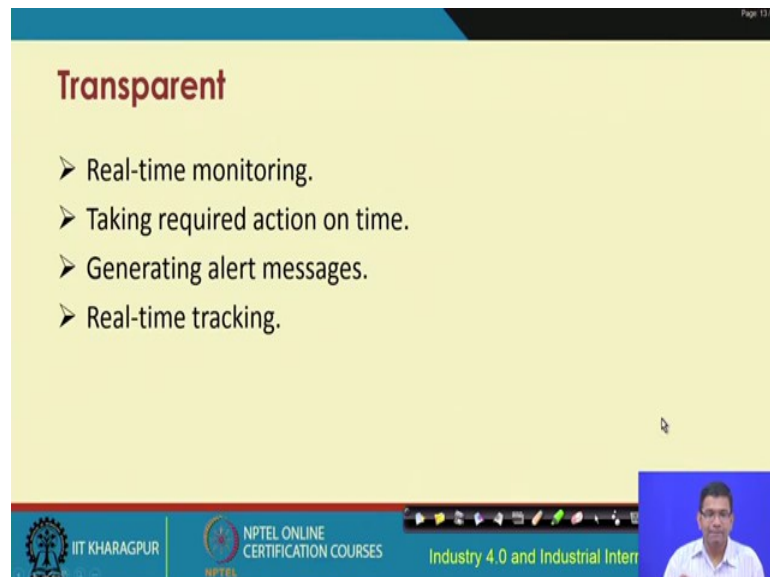
Optimization-optimizing the tasks, scheduling of the tasks, optimizing the usage of energy, optimizing the cost of production, optimizing tracking, optimizing throughput, optimizing reliability, and many different other things will have to be optimized in a smart factory.

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Transparency, because now you are able to track a particular component, a particular machinery, track some logistic item, which are done in real-time. This improves upon the transparency as well. In real-time, whenever it is required, in a smart factory that were in

a particular location. Therefore, tracking becomes very efficient, it helps in improving the transparency.

Real-time monitoring and taking required action on time. If something has gone wrong trying to know about it as quickly as possible in real-time and taking the requisite action is very important and then generating alert messages to the people, who actually need to have this information.

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Proactivity-predicting the quality issues, improving safety, forecasting the future outcomes, and predicting the future challenges.

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Agility talks about overall flexibility which I was telling you earlier, flexibility in terms of incorporating different changes, changes in requirements, maybe, changes in the different production processes, changes in the legal compliance, and there are many different things that might change over time, which are able to incorporate flexibly, what agility talks about.

Adapting with the changes in all these production processes, changes in the legal requirements, changes in the overall requirements. So, all these things are adaptation, which is a very important component of the agility attribute. Self-configuration the machines should be able to self-configure, whenever required they would be able to start up on their own, work on their own, and configure on their own.

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Supporting technologies for smart factories, big data technology is very important, cloud computing is very important. Big data is about getting lot of data, in huge volumes, in high velocity, having high variety, and many different attributes represented in terms of different Vs.

These data will have to be handled and smart factories have produced lot. They are the producers of lot of data, and these data will be useless until they are stored, processed, and analyzed in certain way. So, for this big data technologies like hadoop or different other big data technologies are used, different cloud computing platforms, public cloud, private cloud. Different companies nowadays also have their own private cloud, and public cloud services like Microsoft azure and Google cloud, all of these things are available, smart grid is a very important supporting technology, because we are talking about factories.

Factories are essentially the largest consumers, one of the largest consumers of electricity and different other energy. So, being able to efficiently use the energy is very important and having smart grids connected to the smart factories is very important.

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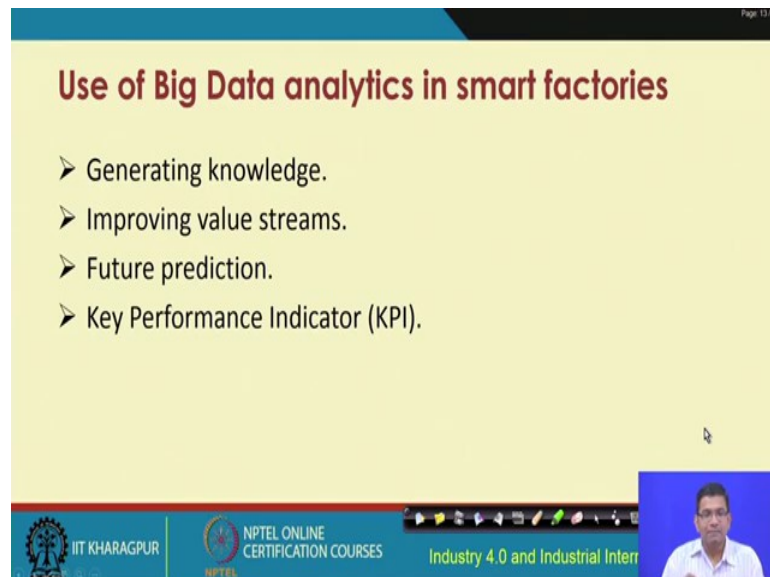The use of cloud computing in smart factory helps in the processing capabilities, providing the capability of high performance computing, giving tools for running different applications, different development platforms, storing the data. In a more scalable fashion is what cloud computing provides in the smart factories domain.

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Big data is about big data analytics, generates the knowledge from the data that is received. So, we have the data, extracting information out of the data, generating knowledge out of the information, that is processed from the data. These are very

important for improving the value streams, predicting the future, and taking care of the performance indicators, improving upon the performance indicators, the KPIs is also a very important aspect.

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Use of smart grid in smart factories, persistence in energy consumption; if you are using smart grid with smart factories, energy consumption will be taken care of in a smarter way. There will be optimized energy consumption based on the exact requirements even the energy consumption can be balanced across different processes throughout the day or throughout the different times of the year.

Load balancing is very important, certain parts of the company might require certain types of load electric load. So, certain components, certain companies', certain parts of the factory will require more load compared to the other parts of the company. This differential loading and balancing the load throughout the day, across the different parts of the company. These are the important aspects of smart grid.

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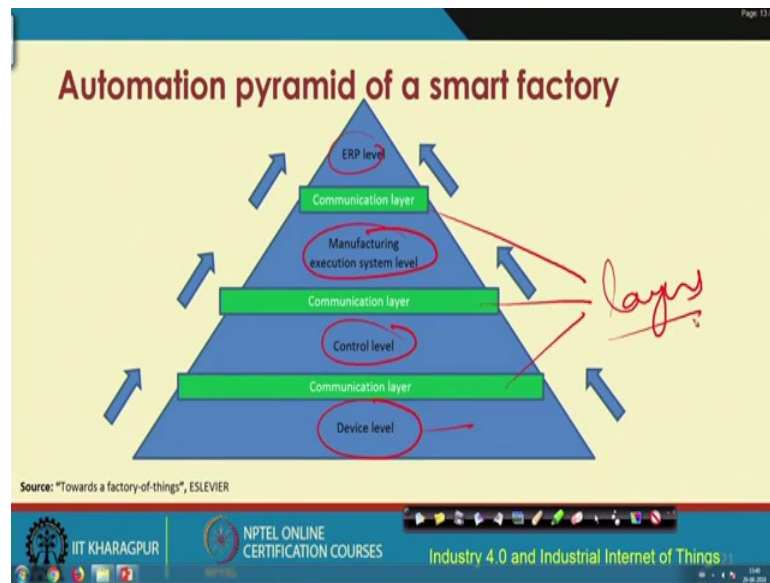
This is the automation pyramid of a smart factory at the very bottom, we have the devices in the device level, then we have the control level, then we have the manufacturing system level, and the ERP level, in between we have all these different communication layers.

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Use of augmented reality is quite rampant in smart factories. This will help in operating instruments remotely. So, remote monitoring of different machinery, different equipments in factory is possible, with the help of augmented reality.

In fact, there is another one which is the virtual reality, that we have discussed in another lecture, augmented reality and virtual reality together will help in remote monitoring, remote operations of instruments in a smart factory. These technologies can also help in improving the precision, providing precision in the processes, in the production processes, improving the safety especially for radioactive zones, and different other safety critical zones.
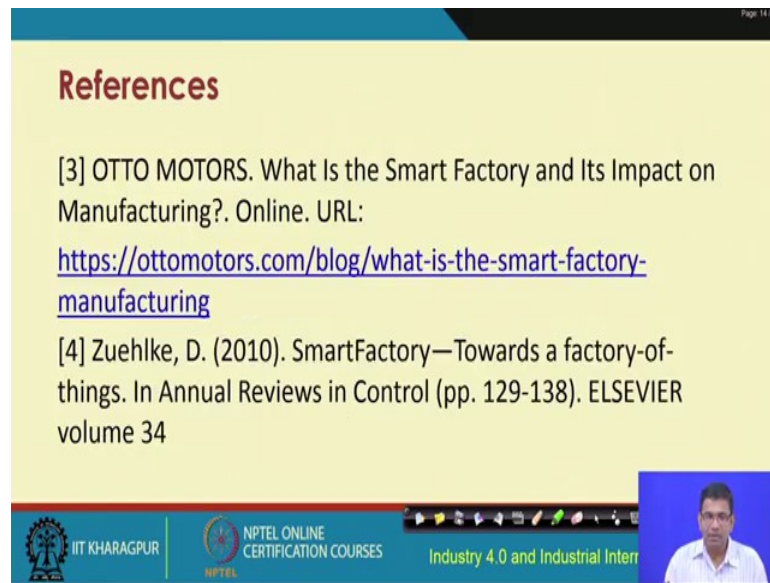
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So, with this we come to an end of the lecture on smart factory, I hope that you have some basic understanding about what smart factory is, and why smart factories are required, and what are the essential constituents of a smart factory.
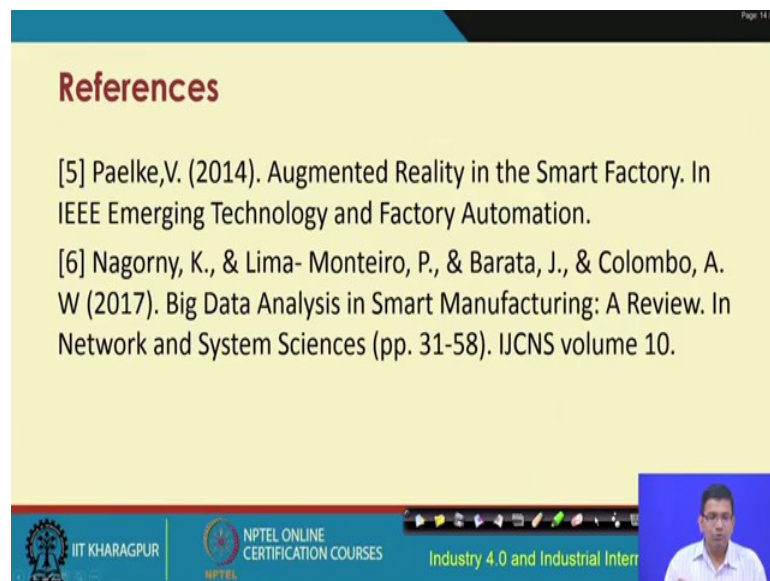
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These are some of the references that have been given for you.

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And if you are further interested you can go through, in the internet you will be able to find lot of different other lectures and different other materials on smart factories.

So, please feel free to go through them, if you are interested to know more about the smart factories. But smart factory is more of a concept there are different building technologies and different components. So, all these different technologies the enabling technologies for building smart factories, this is what we are trying to get a glimpse of

through the different lectures of this particular course. And if you really need to build a smart factory you have to start implementing these concepts that we are going through in this course.

So, with this we come to an end of it, smart factory is a very important concept, in the context of Industry 4.0. Industry 4.0 one of the most fundamental, and central theme in Industry 4.0 is building smart factories. With this we come to an end.

Thank you.