Computer Integrated Manufacturing
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Lecture 49
Computers in Manufacturing Industry, current scenario (part 2 of 3)

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Smart Manufacturing, the word smart is very attractive and today smart is commonly used for a smart personality, smart cell phone, smart laptop, so smart is commonly used and in manufacturing is also no way behind. So, we have also started using smart manufacturing and Dr. Amandeep Singh has covered this in a big way, so let me quickly jump through it and then go away.

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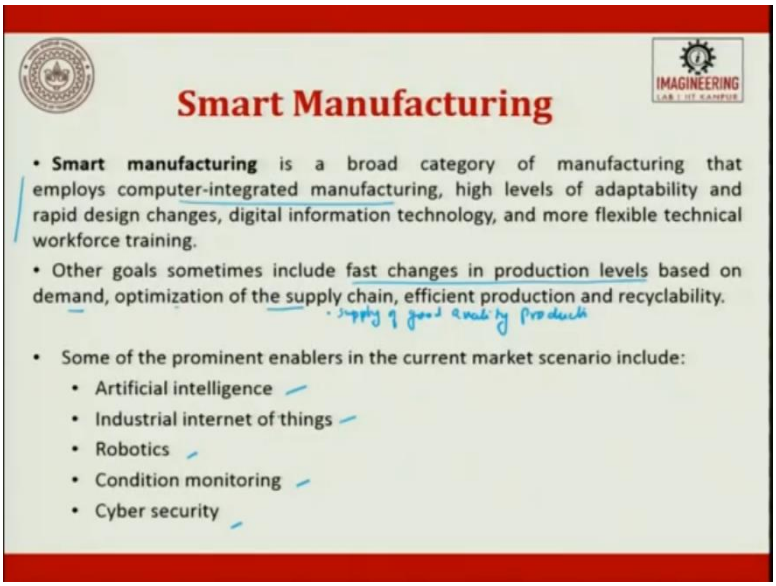

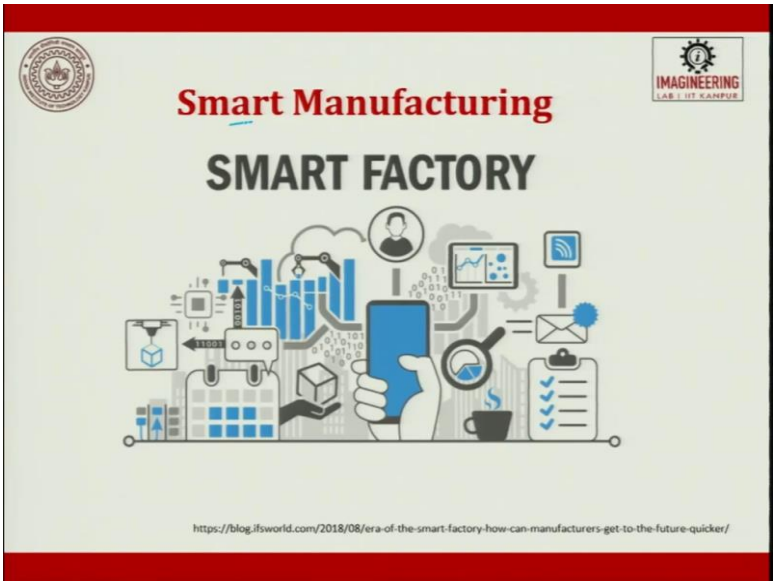

Smart Manufacturing is a broad category of manufacturing that employs computer-integrated manufacturing, high-level adaptability and rapid design changes, digital information technology, and more flexible technical workforce training. Smart is this, it is not only talking about the machine, but it is also the man-power which is involved, so that means to say how quickly and dynamically, how agile they are in developing products to meet out the customer need.

Today, what has happened is everything is online purchase, including cars, are today online purchased, if that is the case at the time of purchase they have to give a slip saying when will be the time of delivery and what all has to be used for a checklist to take care of the quality of the output.

So, in that case, computer-integrated manufacturing high level of adaptability rapid design changes, digital information technology, and flexible workforce training. All these things are part of smart manufacturing. Other goals sometimes include fast changes in the production level based on demand, optimization of the supply chain, efficient production, and recyclability.

See, today when we talk about supply chain, we are also talking about suppose, if the vendor has a larger stock quantity of a particular item you as company do not need it at this point of time. But still, try to make use of the inventory which is there in the supply chain and convert it into a product such that you meet out to customer demand.

So, if that has to happen, think of a product what should be the level of modularity, for example, if you take a desktop or a laptop computer, it has a base system, and then it has lot of

components which are plug and play. You keep attaching and detaching such that you meet out various customer requirements. The customer requirements can be one exhaustively using for entertainment, exhaustively using for graphics, exhaustively computation.

So, all the requirements are different, so you can keep changing the components by doing plug and play and meeting out the requirements, so this is what optimisation of supply chain is also there, when I talk about supply chain it is not only supply, it is also supply of good quality products. So, it also depends upon the rating of the supplier.

Now, some of the prominent enablers in the current market scenario include Artificial intelligence, an Industrial IOT internet of things, Robotics, Condition monitoring, and Cybersecurity. All these things are part of smart manufacturing, so this what it is, and since doctor Amandeep has covered I will keep moving to the next topic.

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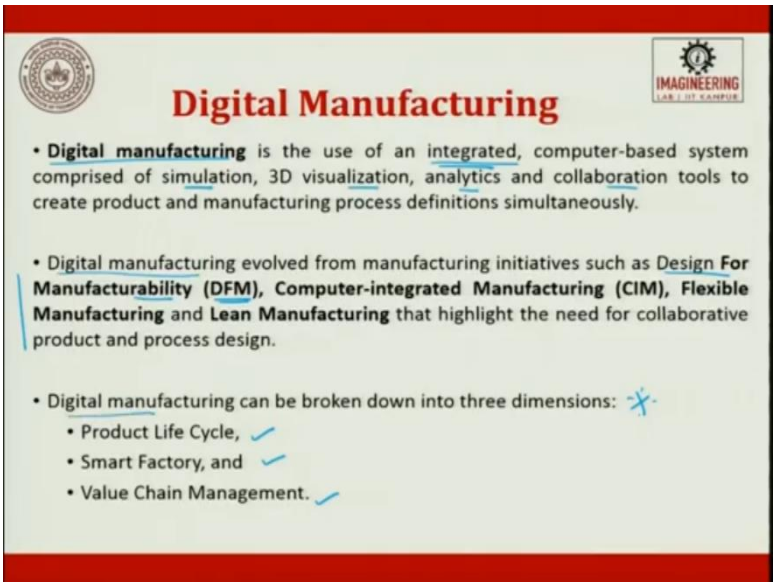

Next is digital manufacturing. Digital manufacturing is the use of an integrated, computer-based system comprised of simulation, 3D visualization, analytics, collaboration tools to create product and manufacturing process definitions simultaneously. Very important digital manufacturing is the talk of the town, so digital manufacturing is used of an integrated approach of what computer-based system comprising of simulation, visualization, analytics, and collaboration tools, to create products and manufacturing processes, definitions simultaneously.

Digital manufacturing evolved from the manufacturing initiatives such as Design for Manufacturability, please do not think the improvement which happened in manufacturing,

smart, digital they were all there, now today what has happened they have been given new packets and when we have been in new packets for it they have been added more benefits in it and they have been moved to the next era.

Agile manufacturing was there for a long time when agile manufacturing was there it was talked in terms of philosophy it was not implemented that much but when we talk about smart manufacturing, that is implemented in the same way when digital manufacturing has to happen today, it is not that it is just erupted right now it was there for a long time it got evolved to digital manufacturing.

The manufacturing initiative such as Design for Manufacturability (DFM), Computer-integrated Manufacturing, Flexible Manufacturing, and Lean Manufacturing that highlights the need for collaborative product and process design. So, this is all part of design manufacturing, DFM, Design for Manufacturability inside this it comes casting, machining, assembly all the things.

Computer integrated manufacturing where and which customer voice is heard it is converted and then that inturn is used by a design engineer, we reiterate the design, customize the design, data is given to manufacturing, and then the assembly person also gets to see the same data and then finally they make it and then deliver it.

Digital manufacturing can be broken down into three dimensions very important three dimensions, Product Life Cycle, Smart Factory, Value Chain Management. These three are very very important, these are the three verticals of digital manufacturing.

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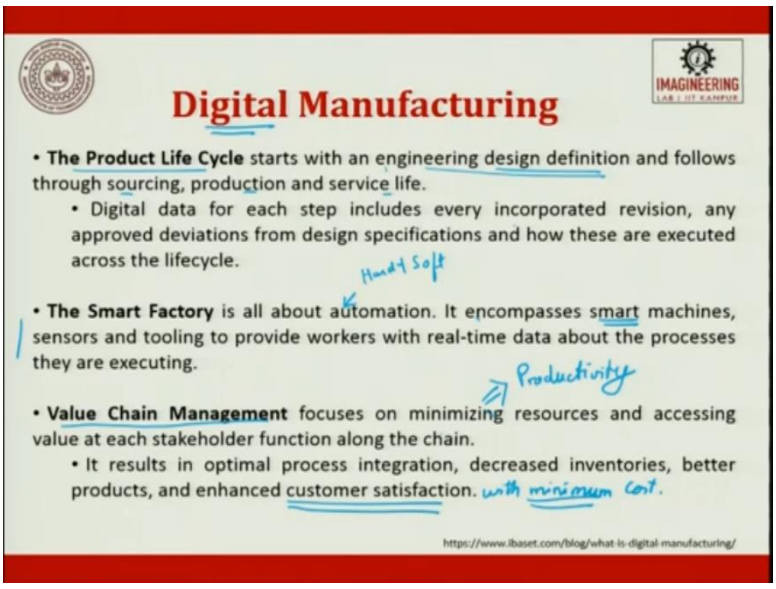

What is product life cycle? Starts with an engineering design definition and follows through sourcing, production, and service life. Digital data for each step includes every incorporated revision, any appropriate deviations from the design specifications, and how these are executed across the lifecycle. So, product life cycle starts with the engineering design specification.

So, we use lot of QFD tools, we do design thinking approach, we try to understand what a customer wants. Customer wants converting into an engineering specification we use house of quality. So, many tools are used behind, so finally all these tools gives to designer what is an engineering spec a customer wants. So, that is what engineering design definition.

And then followed by this, we try to divide it what is the outsource item, what is manufactured item, and then when it has to be delivered, and all those things. So, through sourcing, production, and service life. The Smart Factory is a next vertical, Smart Factory is all about automation.

It encompasses smart machines, which can change depending upon customer requirements, smart machines, sensors, and tooling to provide workers with real-time data about the processes they are executing. Very important, today many times what happens is in a factory the worker does not even understand where his part gets through, and what is the assembly behind, and who is his customer?

So, now in smart factory what happens he sees who is his customer he knows what is a product he wants he knows what is the variation in the products from the existing master design what they have when they have to deliver and if one machine is producing a defect what all is the repercussion of it, so what amount of involvement he has to be there in the shop floor.

So, smart factory is all about automation. It is not hard automation it is hard plus soft automation, so here we use sensors, we use algorithms in understanding and developing patterns, it encompasses smart machine when we talk about smart machine, we are also talking about modular machine which can be collapsed and redesigned to make a new setup for machining.

It is not a fixture, it is a complete machine development. In Japan, in the year 2000, they demonstrated desktop factory. A complete factory which has come to a small desktop, they make plug and play assembly on a table where it has holes. So, they assemble machines and disassemble machines, depending upon the product requirement, and the concept was very much appreciated then and now it has come into implementation.

Wherever you want a product, then or a part immediately the factory moves to the spot, makes it to the customer requirement, and then it starts selling it. So, smart machining sensors tools provide workers with real-time data about processes they have executed.

The last vertical is a Value Chain Management which focuses on minimizing resources and assessing value to each stakeholder function along the chain. Many a times when we do an operation converting a product or a raw material into next stage of a finishing or moving towards finishing one process we do, we have to be very clear what is the value which is getting added to the product in terms of customer satisfaction and what is the money you get.

So, we have to be very focused, so value chain management focuses on minimizing resources when I do this operations what is the value getting added to the part and what is the customer going to give value to that part at that stage. If the customer is not going to add value in terms of money at that point of time, we have to relook into the process. So, that is value chain management all the three are very important.

Product life cycle, all these days as engineers we are focusing on this, but on top of these we need smart factory, we need value-added chain focuses on minimizing resources, it is if you see crudely it is taking more towards productivity. And assesses value to each stakeholders function along the chain, it results in optimal process integration, decreased inventory, better products, and enhanced customer satisfaction.

So, ultimately the entire manufacturing today is focused towards customer satisfaction with minimum cost. This is what is the focus of today's era in manufacturing, let it be service, let it be goods, everything goes around this. If you go to your chain, foods stop, like café coffee day or you go to pizza corner or you go to Starbucks or you go to some same shops which are available in India. So, you will see that finally what is the customer satisfaction and what is the money he gives.

So, this is what matters, so the brand is all focused towards value chain management, so all these things put together falls under one gamut which is called as digital manufacturing where is artificial intelligence coming here it is a part of digital manufacturing.

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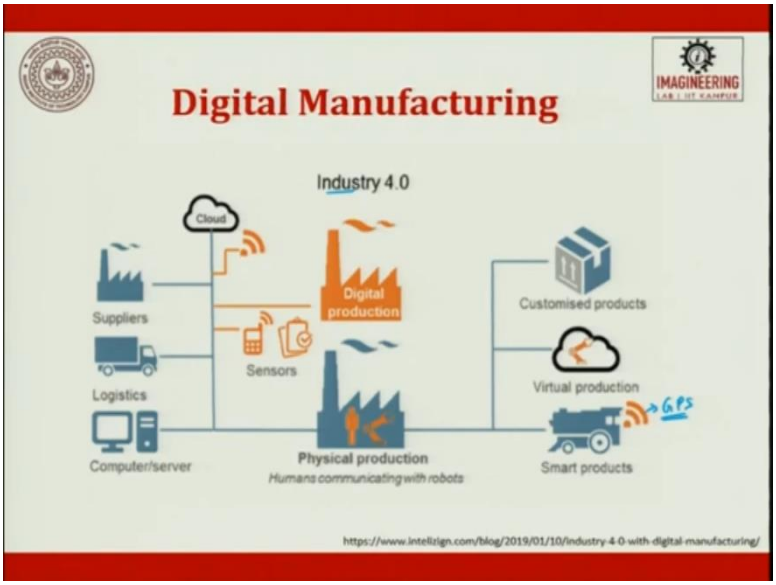

So, if you look at digital manufacturing again when you go to industry 4.0, you have supplier, you have logistics, you have computer and server and all these data which is there got into cloud now, so you can have when this moment happen every information is in cloud and from the cloud you get a Wi-Fi which can keep communicating to the factory, so you have sensors for moving and also sensors for quality recording.

So, this is that digital production, and here we use virtual simulation and understand whether company can make it. Then finally what happens is they make it here and there is the physical production happening on the product, and here this are what is the output of this? Customized product, virtual production can be shown, and smart products can be developed and today if you look at it, even the truck which takes the product and keeps moving towards the customers that is also tracked through GPS and they are able to update the customer how things move along the way.

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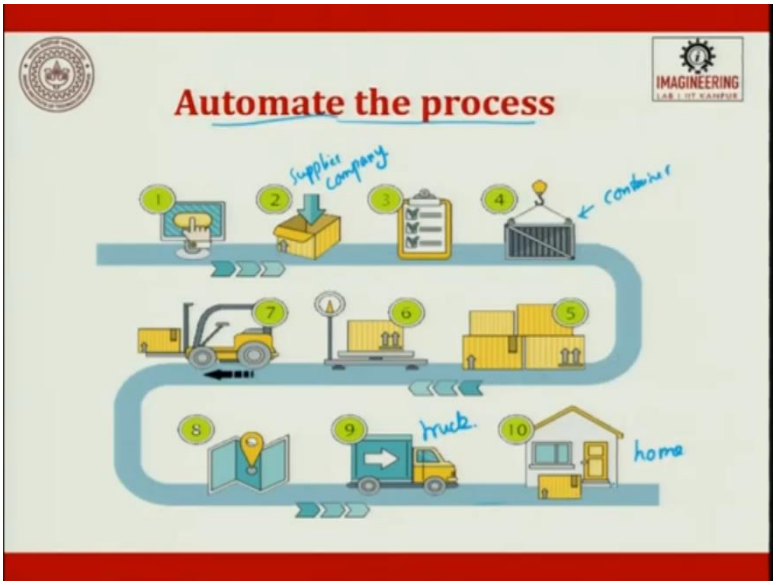

When we start thinking of automating a process, this is how automate the process first is we try to plug in what we want and then this is put inside this is this is at the supplier end, so he puts everything there then he checklist and then he says everything inside his is okay then it is getting shipped, then after it is put in the ship and then all the shipped material which is put under container, so now several of these containers are started and these containers are moved.

These has a sensor which communicates with a main server and then the information goes to individual trolley moving and then that in turn is located where is the company and other locations are identified then the truck moves and then finally it gets delivered to home, so home this is truck this is from the company I will say, company these are containers moving, this is brought into the factory and then it goes. So, this is how the entire process is getting automated today.

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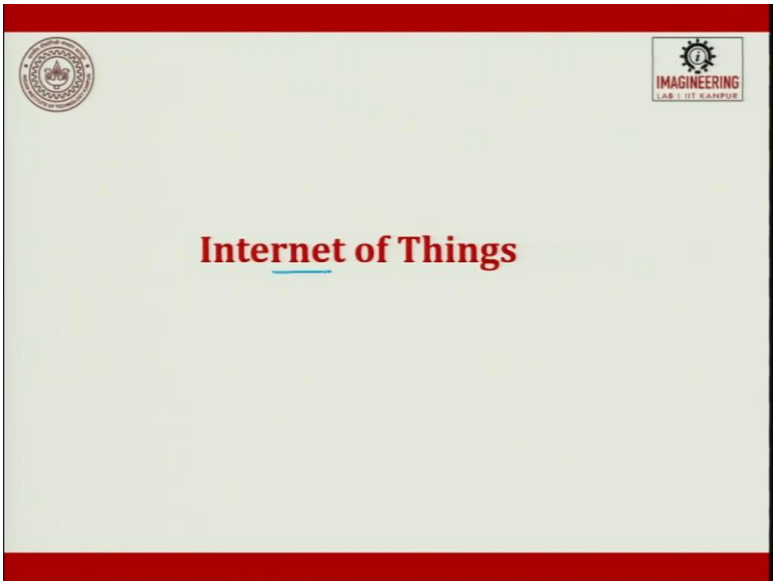

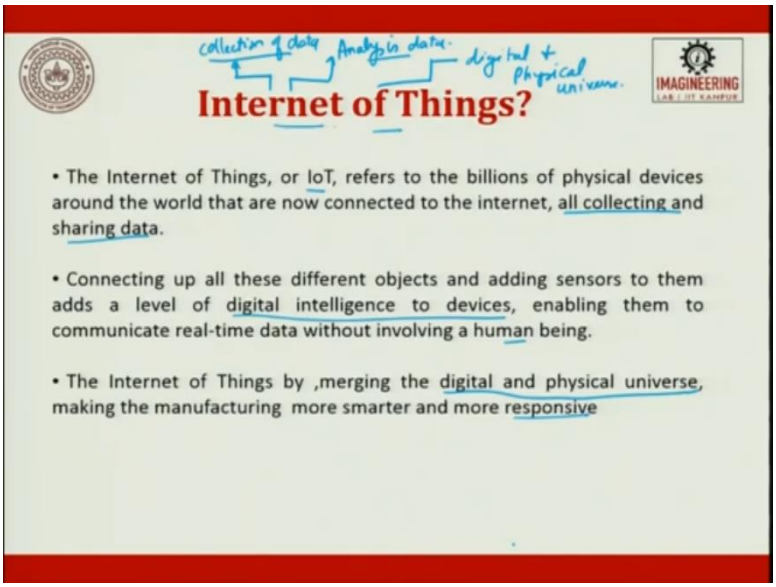

Now, let us see the next topic which is Internet of things I am quickly going through all the jargon words, so you will understand what are these jargon words used and how are they helping in, how is computer playing a role in in in improving the manufacturing processes or customer satisfaction.

Internet of things is otherwise called as IoT, refers to the billions of physical devices around the world that are now connected to the internet, all collecting and sharing data. Most important thing is only this today's digital era goes around IoT because it has to collect data it has to share data. Once it starts sharing the data multiple resources can use the same data, so the data is reliable and that data can be used by multiple resources, so any modification, each resource makes it will be reflected and everybody gets an access to see.

Connecting up all these different objects and adding sensors to them, adds a level of digital intelligence to the device, once I have all the data, I run a small program on top of it and then I try to analyse the data, so the moment I analyse comes the next level a digital intelligence to devices enabling them to communicate real-time data without involving a human being.

For example, if there is a bugler or robber, so a person enters inside there is a sensor which raises an alarm, and now these alarm is communicated through Bluetooth or through your mobile phone to the customer. So, now the entire operation happens without the involvement of a human being.

I recently enjoyed this IoT when I visited my village, so now in villages what has happened is the motor which is used to pump water irrigation, so they use to pump water and these motors 10HP motors, very high power-consuming motors earlier it use to keep on pumping and person has to go all the way to the field to switch on and switch off. Now, it is connected through IoT from the mobile phone itself, a farmer can switch off and switch on his motors which is far of close to 20-25 kilometres from his house.

So, you see now it has become a now the next level of intelligence is there moment there is a flooding which is happening from a tank then there is a sensor which auto-switches off or auto-switches on, so that is also there now. So, now what is happening the data is generated real-time monitoring is done intelligence is happening and then without the involvement of the human being, so that is what the best part of IoT is.

The Internet of Things by merging the digital and physical universe, this is very important word merging digital and physical universe making the manufacturing more smarter and more responsive. So, this is what is the major thing, if you ask the keyword 1 is collection of data, 2 is analyse the data, 3 is connecting digital, and a physical universe. So, the last thing I collect data, I analyze data, all these things happen without human being that is what is the beauty of Internet of Things.

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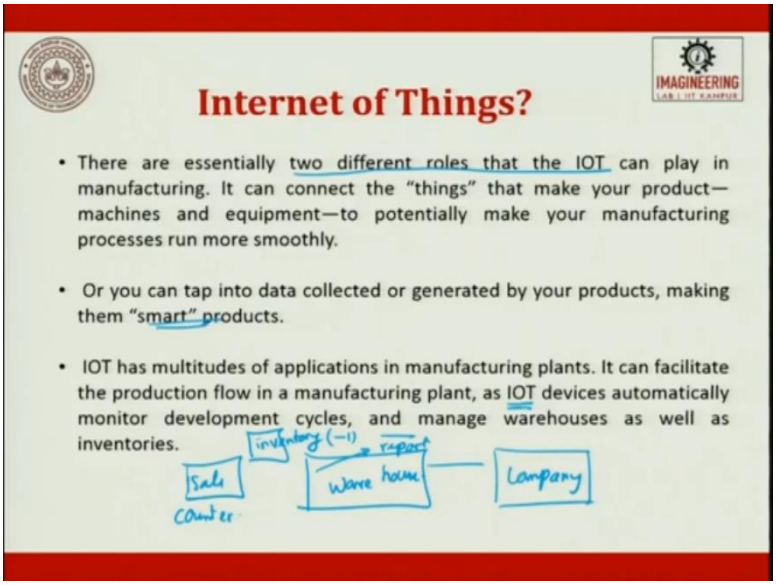

There are essentially two different roles that the IoT can play in manufacturing. It can connect the things that make your product machines and equipment-to potentially make your manufacturing processes run more smoothly. Or you can tap into data collected or generated by your products, making them smart products.

So, two different roles are played by IoT one making the product smart and then connecting inside the factory, IoT has multitudes of application in manufacturing plant, it can facilitate the production flow in manufacturing plant as IoT devices automatically monitors development cycle and manage warehouse as well as inventory.

So, what they are trying to say is you have a warehouse, let us assume there is a sales counter, so sales counter, and here is an inventory which have which is there in a mall. Mall or a supermarket. So, there is inventory where customer comes and pulls it out and whenever the customer pulls out a product, he goes to the sales counter, and he tries to pay cash and the moment there is in the sales counter a cash is paid, there is a black flushing happening at this point, so inventory is reduced by minus 1.

So, when it keeps on going below the economic order quantity or below a level then immediately the warehouse raises a report and that please try to go and stop it here and the moment in the warehouse there is drain happening again here there is a breakeven which intern communicates to a company and says. Please try to deliver to warehouse such that the flow for the customer can be smooth.

Now, all these things happen without women intervention they have loading into the bin happens by a man, but apart from that everything happens automatic. So, without human intervention using the sensor data using RFID tag or QR code reading we are able to completely monitor the inventory as well as the warehouse. So, that is what is the need or use of IoT.

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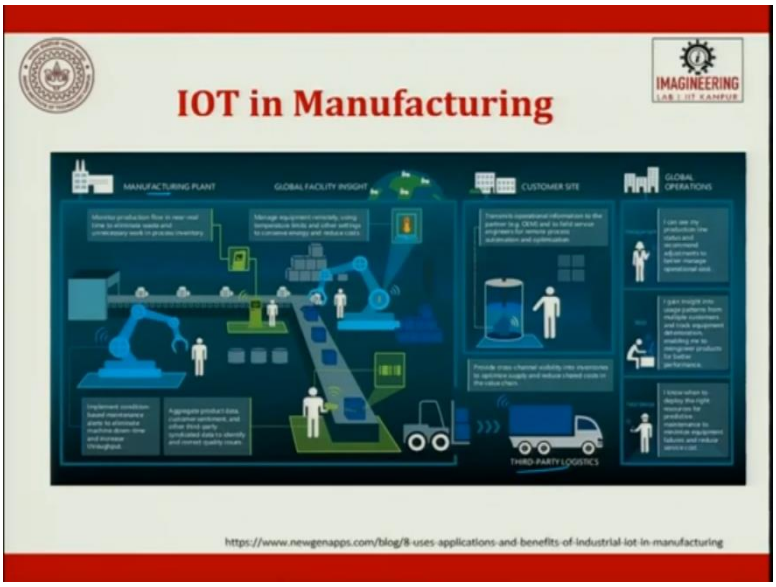

So, IoT in manufacturing if you see this is manufacturing plant, global facility inside then you can see customer side, and then you can see global operations. So, monitor production flow in near real-time to eliminate waste and unnecessary work in the process inventory, so that is the first important thing which happens. Suppose there is only need for 100 cars saying that my batch size is 120 you cannot produce 120, so that is what it is.

So, you are doing 20 car or 20 more products which is not to be sold right away but still, you do work, and then keep it somewhere, so that is what it is. So, now this is what is a manufacturing plant doing then let us look at the global facility inside, so here manage equipment's remotely using temperature limits and other settings to conserve energy and reduce cost.

So, this is the other thing, so today you can see in the air conditions they have inverter air condition where and which it does not switch on and switch off after your certain limit. So, early it use to have a thermos start moment the temperature falls below it starts from 0 and starts running. So, till that time once it is switched off the complete system goes for switch off but now what they say is it will not be complete switch off a fan will be circulating and once below it then slowly the motor or the refrigerator will switch on, so here they say it is energy

efficient, so here the temperature control limits are set then if you say implementing condition-based maintenance alert to element machine breakdown and an increase throughput.

So, they are now talking about predictive maintenance rather than preventive maintenance. Predictive maintenance are you put some sensor find out what is going on do an optimization multi-objective optimization find out and then you quickly go and start working on the machine based upon 4-5 sensors predicting rather than preventive maintenance

Preventive maintenance, many a times they use to replace oil and sometimes oil condition is very good they replace tools sometimes the tool's status is very good but still they throw because they have set the hardbound limit, so then aggregate production customer sentiment and other third party.

So, from nowhere if you move to the customer side you can see there are several operations which are done one is transmitting operation is done, then same way you also have provide channel visibility for the movement of the third-party logistics happen, and here are global operations which monitor the entire factory sitting in some other place but monitoring all the data.

So, IoT in manufacturing is becoming very common today the design for a printer is done in Japan, or in Thailand the part manufacturing happens at Malaysia, the assembly happens in India and the delivery is done in United States or vice versa. So, you see now everything happens globally.

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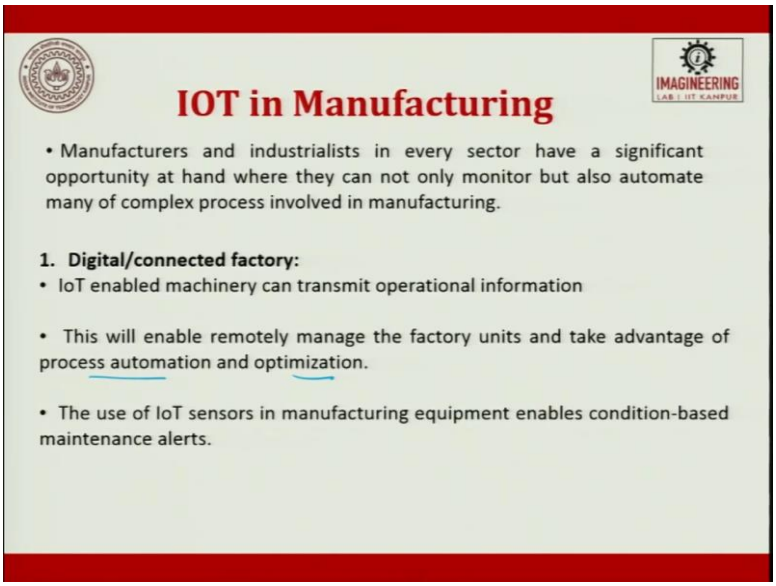

Manufacturers and industrialists in every sector have a significant opportunity at hand where they can not only monitor but also automate many of the complex processes involved in manufacturing. Digital slash connect factory, IoT enabled machinery can transmit operational information. This will enable remotely manage the factory units and take advantage of process automation and optimization. Very important, Automation, and Optimization. The use of IoT sensors in manufacturing equipment enables condition-based maintenance alerts.

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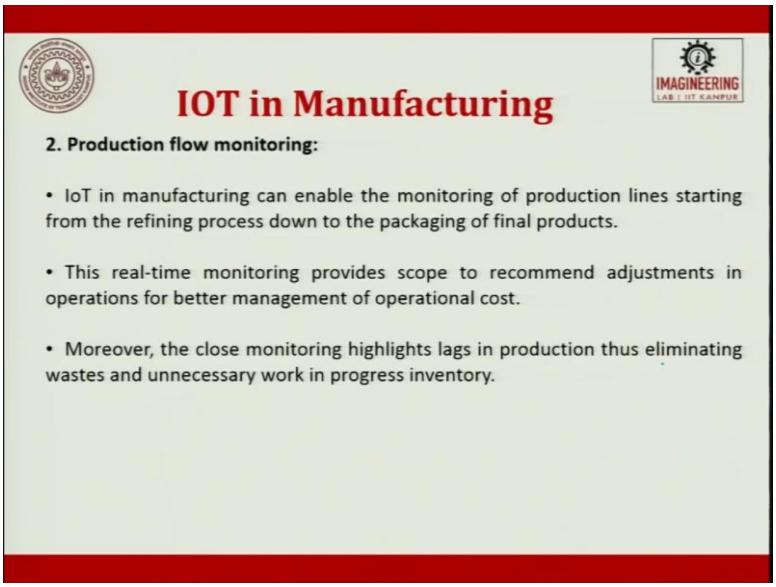

The Production flow monitoring, IoT in manufacturing can enable the monitoring of production lines starting from the refining process down to the packaging of final products. This real-time monitoring provides scope to recommend adjustments in operations for better management of operational cost. Moreover, close monitoring highlights lags in production thus eliminating wastes and unnecessary work in progress inventory.

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So, the Inventory Management system which is implemented in manufacturing is tracked locally as well as globally on a line-item level and the users are notified of any significant deviations from the plans. I was giving you an example of a supermarket, so in the same way, you can also do inventory while taking a photo or taking images, you can noting it and understanding it.

This provides cross-channel visibility into inventories and managers are provided with realistic estimates of the available material, work in progress, and estimate the arrival time of new materials. Ultimately this optimizes supply and reduces shared costs in the value chain.

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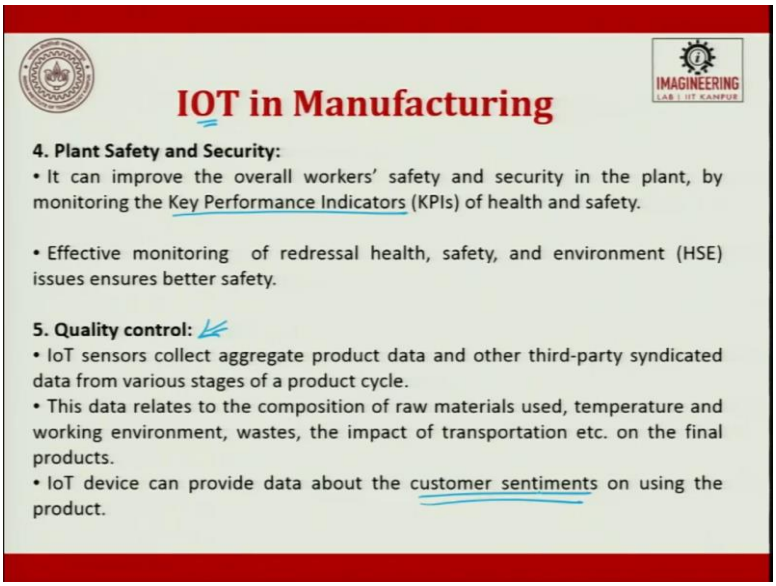

Plant Safety and Security is also a part of IoT in manufacturing, it can improve the overall workers safety and security in the plant, by monitoring the Key Performance, it is a ratio of health and safety inside the factory. Effective monitoring of redressal health, safety, and environment issues ensures better safety inside the factory.

The Quality control is also done by using the IoT in manufacturing, so IoT devices can provide data about the customer sentiments on using the product sentiments. This is also part of quality rest all you know but know you understand what we are talking about. Customer sentiments also got by using IoT.

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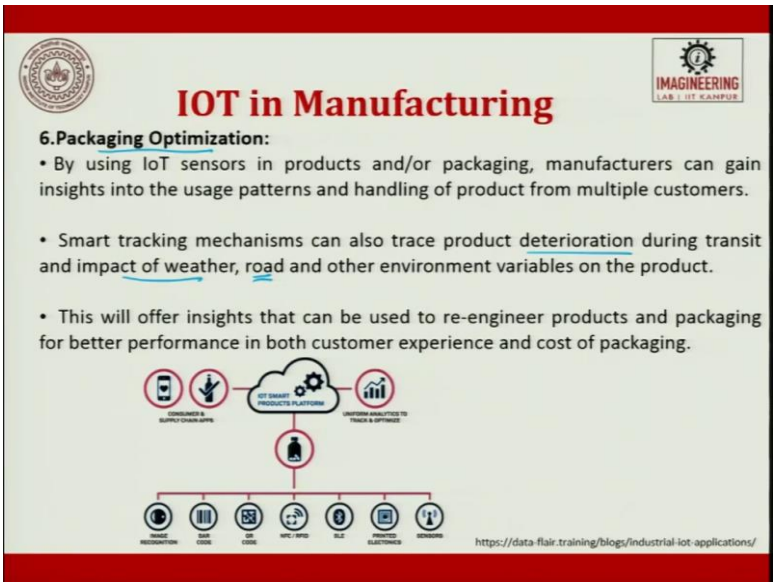

Packaging Optimization, by using IoT sensors in products and or packaging, manufacturers can gain insights into the usable patterns and handling of product from multiple of customers. So, packaging optimization is also there. Smart tracking mechanisms can also trace product deterioration, perishable goods, vegetables, fruits during transit, and impact of weather for example I do not know how many of you realize in summer the apple loses almost close to 5-6 grams per apple because of heat.

So, that is impact of weather, road if the road condition are poor if the perishable goods get spoiled other environment variables, how is it going to impact the product quality at the customer end? This will offer insights that can be used to re-engineer products and packaging for better performance in both customer experience and cost of packaging.

So, look at it how interesting it is, today you look at if a product is sold to a place where it is more of humidity, so then accordingly you will plan and design the products for that particular area with some modifications. It can paint modifications, or it can be package modifications.

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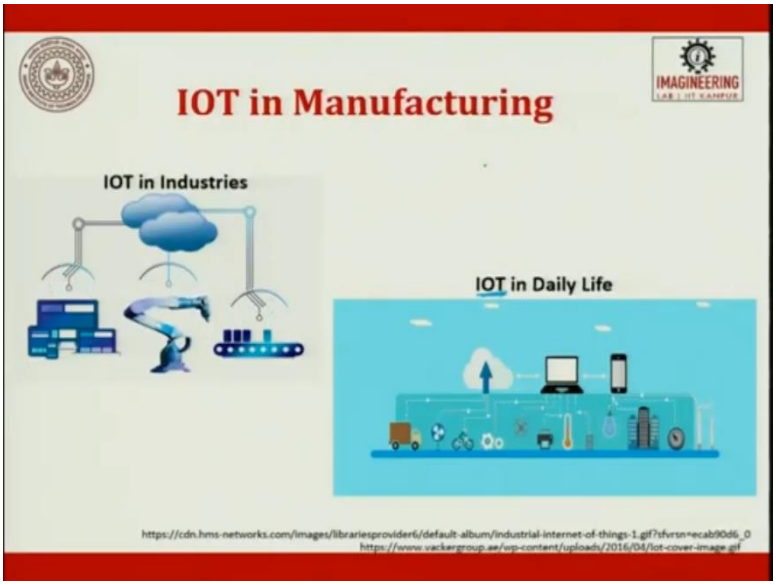

So, this is how it is, so you have cloud computing is attached, company is attached, so packaging is attached and the assembly is also attached, so IoT in daily life you can see that everything is cloud computing your electricity consumption, your car movement, your energy what you have spent on that day, your what all machines you have used and a drone used then a temperature around you, electricity and then the humidity along with energy generation all these things are today integrated into IoT and then this has been moved into manufacturing.

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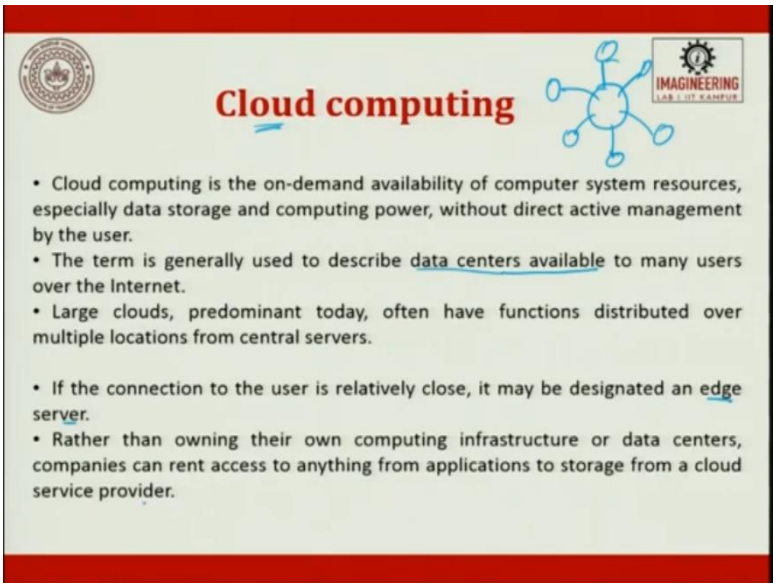

So, the last part is Cloud Computing, Cloud computing is the on-demand availability of computer system resources, you do not buy and keep a resource which you do not use suppose many of us buy a computer, and we keep it on our desktop and we hardly use in a day for one hour for which you have paid 40,000 rupees or 50,000 rupees.

People buy a car which is a luxurious car 24 lakhs or 50 lakhs and then they travel once in a year-long trip maybe for 5 days, 6 days and you see the amount of investment made on the car and the utility on that particular product for them. So, when you look into it is very clear that the resources we have underutilized.

So, now cloud computing is also something like that. Cloud Computing, Cloud computing is the on-demand availability of computer system resources, it is only computer system resources especially data storage and computing power without direct active management by the user.

Today they talk about cloud computing safety also cybersecurity is also working more stringently on cloud computing. The term is usually used to describe data centres available to many users over the internet. Today what is happening, there is lot of data which is commonly stored at one point and many people can have access to it.

For example, number of students between the age group of 18 to 21 available in India. How many students have registered for education? This data government generates, the other data government generates. Now, if there are so many number of students trying to take higher education, so then how many schools, and colleges required? So, accordingly, the government can plan whether to improve or reduce the amount of investment done on those infrastructure.

So, all these things can happen today because of data sharing, so the term is generally used to describe data centres available to many users over the internet. Large clouds, predominant today, often have functions distributed over multiple locations from central servers. So, its not that one place it is there, so this can be stored at several servers, local servers are there if the correction to the user is relatively close, it may be designated and edge server.

So, now you have several servers, now you have to look which server to use for this customer, so whichever is closer then they allot it, so that is called as edge server. Rather than owning their own computing infrastructure or data centres companies can rent access to anything from application to storage from a cloud service provider.

So, for example, you have a computer which you are underutilizing it you can now say I am giving my memory space for somebody else to use so that my computer is effectively utilized for which you get money and somebody uses your space. It can be used for computing, it can be used for storing.

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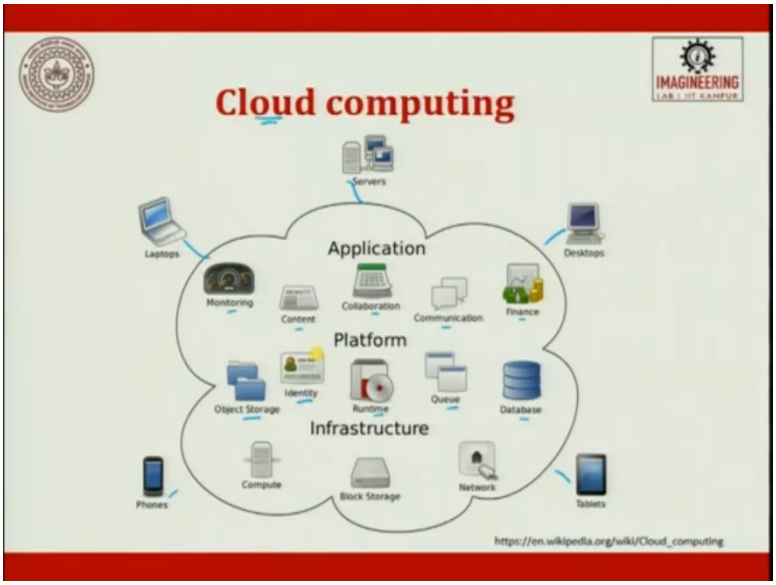

So, today this is what is cloud computing we are all talking about server, laptop, phones, can be connected, tablets can be connected, desktops can be connected, all these things can be connected in cloud computing. So, what is there in the platform inside, so you will have monitoring data, content, collaboration, communication finance, applications can be there, the platforms can be objects stored, so basically DBMS Database Management Systems are done object storage identity, runtime, queening, and database.

So, all these things are platforms which will try to run the data based upon the query whatever and all you have to do is once the query is run you have used it for 24 minutes, pay money only for the 24 minutes. So, this is what they are talking about then infrastructure is compute, block storage and then network, so all these things are infrastructure which are part of cloud computing.

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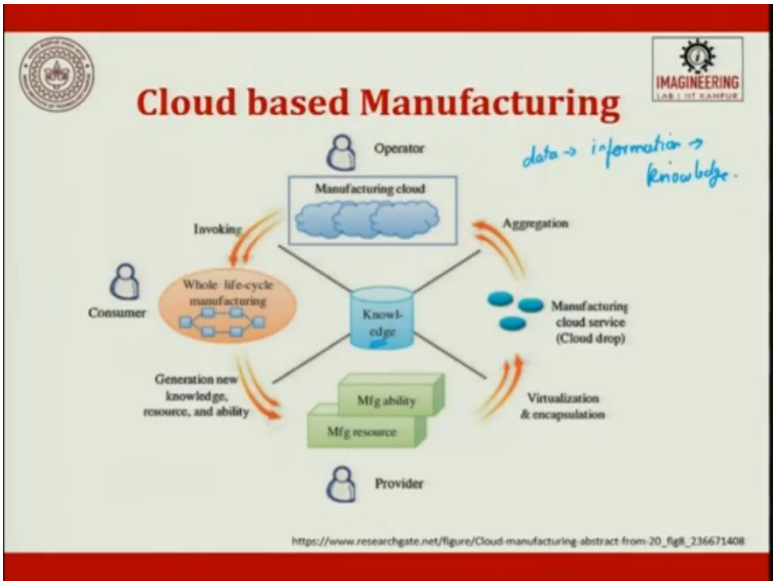

So, the cloud-based manufacturing that was for cloud computing, now let us move to our scenario of manufacturing so, you will have operator, you will have Manufacturing cloud server, then you will have provider, you will also have customer. So, operator he gets data from the customer, so customer is the consumer here, so the whole life cycle manufacturing is taken care, so then from here, how does he get the data he gets generation of knowledge, resource, and ability from this.

So, manufacturing ability and resources so it is here then virtualisation, encapsulation happens in the cloud and the aggregate is given, and this is the cloud manufacturing cloud data which is available which can be used, so this is where is a knowledge, so data to information, it converts information, it gets converted into knowledge. So, these is what is knowledge so data will be more from the extracted data you get information, from several of these information you get knowledge. So, knowledge is a compact way of storing a large amount of data points.

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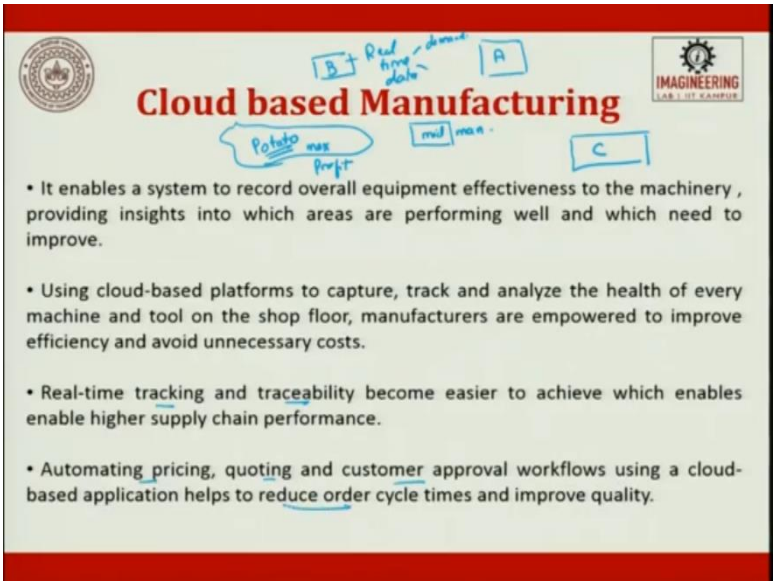

Cloud-based manufacturing it enables a system to record overall equipment effectiveness to the machinery, providing insights into which areas are performing well and which needs to be improved. See if you know where all your pitfalls in manufacturing then it becomes easy for you to go and strengthen those areas.

Using cloud-based platforms to capture, track, and analyze the health of every machine and tool on the shop floor, manufacturers are empowered to improve efficiency and avoid unnecessary costs. Real-time tracking and traceability is very much used in cloud-based manufacturing, automating price, quotation, and customer approval workflows using a cloud-based application helps to produce the order cycle time and improve quality.

Let me tell you a practical example, let us take a place called A, a place called B and then there is lot of farm here, so in all these farms they are producing potatoes. Now, the farmer has to decide where to send his potato such that he gets the maximum price. So, earlier what they use to do is these potatoes the farmer they use to give it to a person a middle man they use they use sell it to the middle man, then the middle man sends a person to location B finds out what is the cost sends to location A, finds out the cost and then goes to C, and finds out what is the cost.

When he tries to find out the cost he also tries to find out what is the demand, so now middle man once he has got everything from him, so then what he decides he decides at what time he has to move it to B, at what time he has to move it to A, and at what time he has to move it to C. It can so happen he ditches A and B and send only to C. Now, you see what he is trying to do? He is trying to maximize the price when he has to maximize the price he has to get the real-

time data. Real-time data, so what are the real-time data? One is demand and second is the cost, current price.

So, if you know the demand, so the costing is inbuilt so we can remove that it is only he has to know the demand, depending upon the demand he tries to decide to go to A, B, and C. Today what has happened? After this cloud computing, and cloud actions coming up, now a farmer is himself able to access whether to select B, A, or C so that he gets the maximum profit.

In the same way, the same analogy can be pitched in for manufacturing, so now instead of A, B, and C this are cities or towns which I said, now you replace it with countries and now you look at the real-time data, so then you decide where to send? How to send? Now, when you sent to different countries you have to send it through air or by ship.

You have to send it by air or by ship then you have to decide which is economical? When it will reach? And how will be the customer demand? So, this is what is automating pricing, quoting and customer approval workflow using cloud-based application which helps to reduce the order cycle time and improve the quality.

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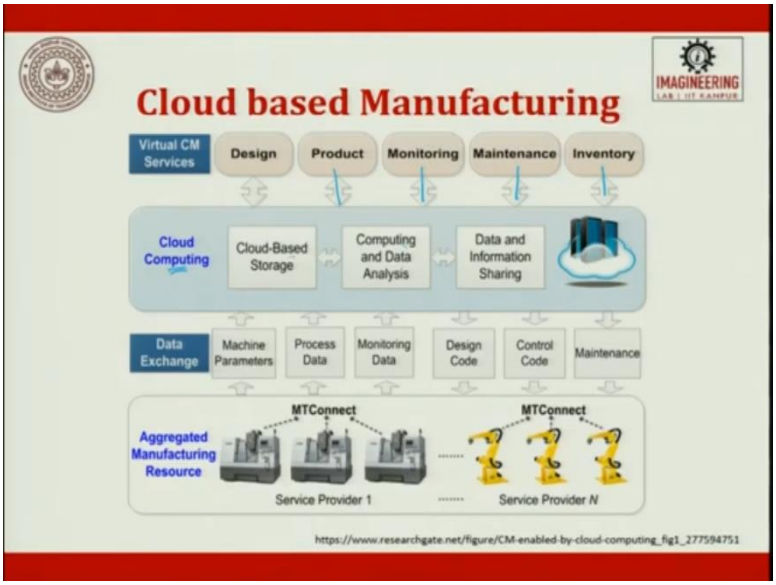

When you look at the virtual cloud manufacturing service providing, today design is given product monitoring, maintenance and inventory all data can be stored the computing happens the cloud-based storage, cloud-based data analysis, and information sharing, all these things happen across in cloud computing, these are all the service, service is which is given to the customer, so design product, monitoring, maintenance and inventory you can do that.

So, then there is a platform where they have written a library function, so you have to give it in your data and run the library function there and get the analysis whatever you want you do not have to write a software for it, so that is what is cloud computing today and then data exchange happens, vision parameters, process data, monitoring data, design, control, and maintenance these are all aggregate manufacturing resources which is given by service provider one and service provider N.

So, this is what is the data this data is exchanged, get on this data which is getting collected the analysis is done and finally what service which is provided by cloud in today's manufacturing scenario it can help you in design product monitoring maintenance and inventory. So, it is very very efficient today.

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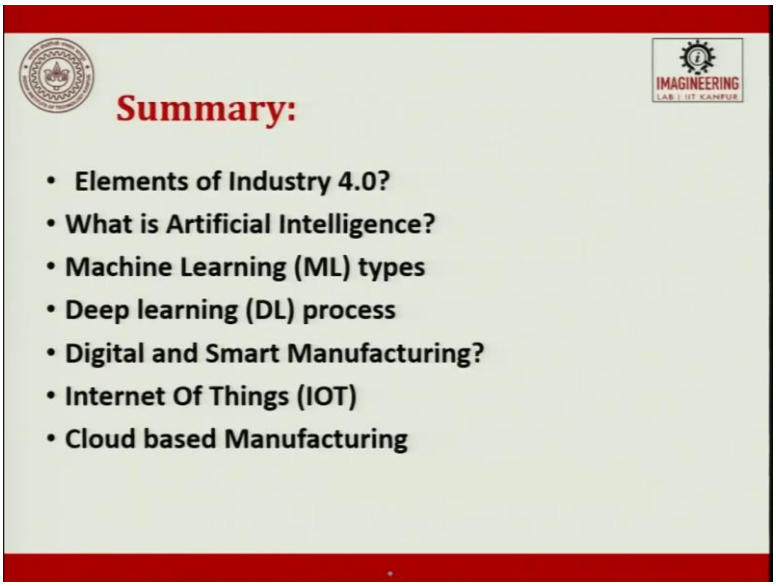

Finally to summarize what all we have discussed till now we have discussed what are all the Elements of Industry 4.0? We have discussed what is Artificial Intelligence? And what are the verticals of Artificial Intelligence? What are Machine Learning and Machine Learning types? Deep learning process? Then Digital and Smart Manufacturing? IoT and finally we studied Cloud-based Manufacturing.

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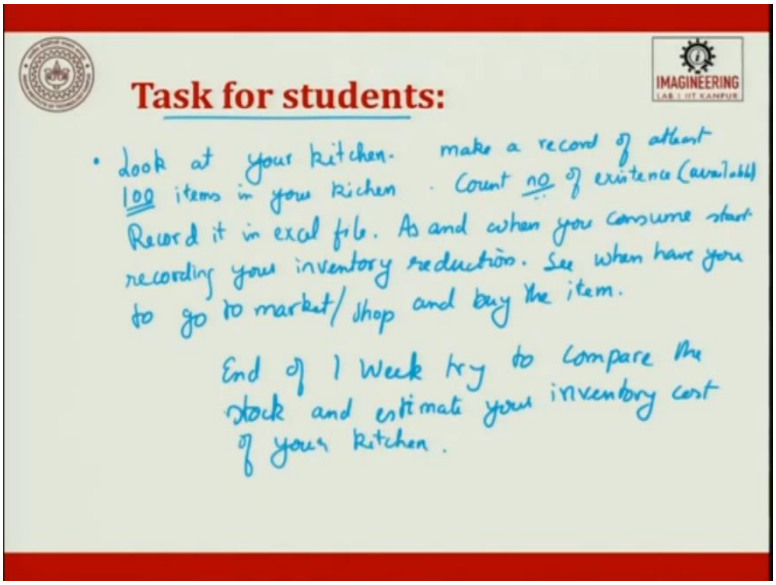

So, the task for students, look at your room or your house. Make a record of at least 100 items in your room or house. Count their numbers existence. Than all these 100 items should be it should not be a car or scooter and all it should be items like pen, pencil, rubber which you will buy multiples.

Count number of existence of their that means to say your available in your house, record it in excel file okay? Now, as in when you consume, start recording your inventory reduction. See when have you to go to market/shop and buy the item. If the entire exercise if you can do it for your kitchen, look at your, I will say, kitchen. Look at your kitchen look at 100 items in your kitchen.

So, then what you do is then you try to make a note of it 100 items do not take 1 or 2 take 100 items, so then you will see as in when you consume start recording your inventory reduction, so see when you have to go to a market/shop and buy the item and, end of one week try to compare the stock, and estimate your inventory cost of your kitchen.

This will be a very good exercise if you do, you will realize what amount of inventory we hold in our kitchen, or in our shirts what we buy and how should we optimize such that we can enjoy the space, we can enjoy buying new things and discarding old things. So, this is a good exercise you try for yourself, and then you will appreciate the need for all these Internet of things, Cloud computing, all this things you will appreciate. How useful it is in real-time. Thank You.