Computer Integrated Manufacturing
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Lecture 50
Computers in Manufacturing Industry, current scenario (part 3 of 3)

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Hello everybody, welcome to the last lecture in the course Computer Integrated Manufacturing. Well as Ram has just discussed the feature aspects in CIM. I will like to take this lecture further and like to discuss about two or three more concepts which are coming up in the future which are now in the incipient stage in Computer Integrated Manufacturing.

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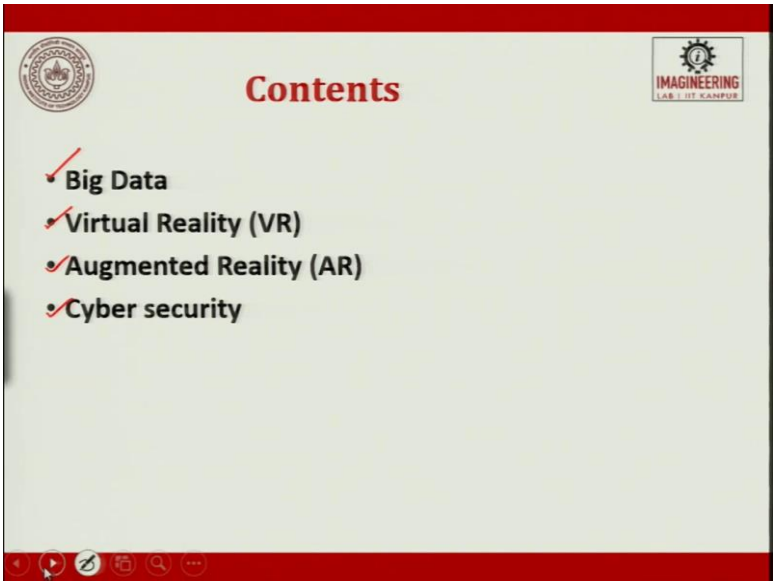

So, this is the last lecture, I am Doctor Amandeep Singh, so I will discuss about Big Data that is one of the important things and how do we cater the problems in Big Data. How computers helps in recording and then analyzing and drawing inferences from the large amount of data? What is big data we will see?

Then I will try to discuss about these two aspects Virtual Reality and Augmented Reality then also will talk about Cyber Security. VR and AR are close to each other and how does they interplay with each other that we will see.

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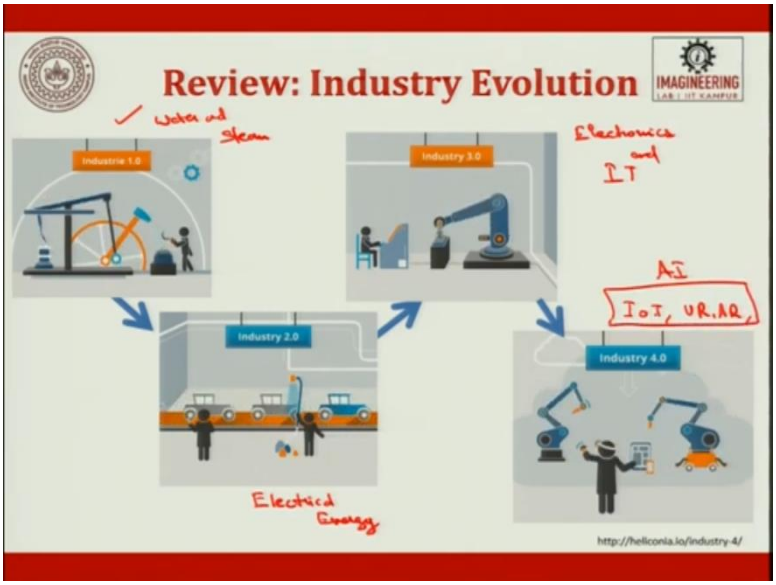

Just a recall Industry 1.0, 2.0, 3.0, and 4.0 is now what we are in. Industry 1.0 was just start of the industrial revolution that was just end of 18th century when mechanical design was there and water and steam was used for the production, that was industry 1.0 here, used water and steam.

Then came industry 2.0 where electrical energy was just been used in industry through the introduction of mass production based on division of labour and some management concepts, scientific school of management that was actually way before than classical school of management the scientific school of management took place and then HR school of management came into play.

So, that was industry 2.0 then electronics and IT, we can say that was introduced in industry 3.0, Electronics and information technology, that is in the industry 3.0 where it was duty of robots to automate the system, so IT system automate the production lines and further it started working.

Now, we are in industry 4.0, that we are discussing in which we have the concept which we have already discussed like IoT, then we have Virtual Reality, Augmented Reality, so many things are there in industry 4.0, Internet of things, Cloud Computing, Cloud Technology, Automates the process, Artificial Intelligence is the one that is covering all these AI. This is Industry 4.0.

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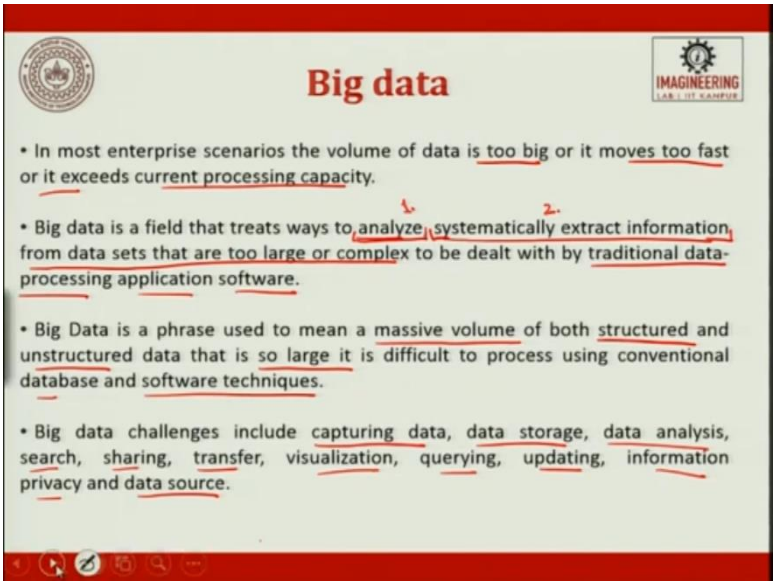

Now, what is Big Data? In most enterprise scenarios the volume of data is too big or it moves too fast or it exceeds current processing capacity. So, what is Big data? Big data is the large amount of data, data can be available in many forms we have discussed the difference between and information. Data can be structured and unstructured as well. Data is already there, there is so much of data but data is not in structured form most of times.

So, what is Big data, the large amount of data that is there that is not in the structured but it has some important information carried in. Now, that information has to be extracted, that information has to be used to have the future forecasting, to have the secondary information.

How do we address big data aspects that I will discuss very briefly here? Big data is a field that treats ways to analyze, systematically extract information from data sets that are too large or complex to be dealt with by traditional data processing application softwares. Now, big data, number 1, Analyses the data, then, number 2, systematically extract the information, these two are the important concerns that are taken care of by big data.

Big Data is a phrase used to mean a massive volume of both structured and unstructured data that is so large it is difficult to process using conventional database and software techniques.

So, what we have to do if you talk about the data or analytics, analytics can be naturally classified into 3 categories 1 is descriptive analytics, predictive analytics, and prescriptive analytics.

What is descriptive analytics? Just we describe the data, describe the data we know the general things mode, median, mean those all these things then variance, etc. Then is predictive analytics in predictive analytics we do forecasting, we do analysis of variance, these are all statistical terms. In prescriptive analytics, we come up with some prescription, we come up with some outcome from the data that we have analyzed.

So, this also happens in big data. So, Big data challenges include capturing data, data storage, data analysis, search, sharing and transferring of the data, visualization, querying, updating information, piracy and data source where the data is taken.

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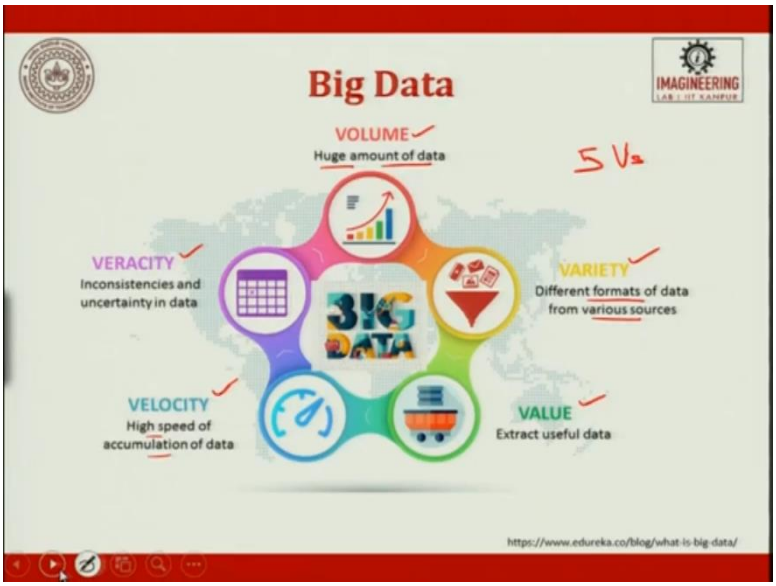

So, when we talk about Big Data in this way there are so many parameters those are to be taken care of to divided into major 5 factors, I will pick this illustration in which 5 V's are there. We have volume, variety, value, velocity, and veracity. Volume big data by name itself big means huge means tremendous, huge amount of data is there.

The Variety different formats of data is available in graphical format, in charts, in literature itself, in the form of text, so many forms of data is there. Value is the final result that we trying to extract from the data, data is both in structured and non-structured as I just said before. So, the data has to extract some information then value has to be taken from that.

Velocity data is when we get data in high speed, high speed of data accumulation is there. Veracity, inconsistencies, and uncertainty data is also there. If I take an example of medical devices in medical devices those can be divided into major 4 categories classes A, B, C, and D.

A and B go inside the body, C and D remains just on the skin is suppose a new improvised medical device has come that is a little more innovative that goes wrong in some way we have to track from where all the components which are manufactured, all the materials with which those components are manufactured, who has manufactured that, we have to track all those things.

The IFC system helps in them. So, to track that were that this component of the medical devices that come from we have to have all the information to through whom this component came through? Who Manufactured this? What is the time taken by this? And all these are the Laboratories those have tested this were certified or not all those things has to be there. So, for a simple product or I could say the data or the volume that is there is too heavy so we have to take care of all those things. This is Big Data.

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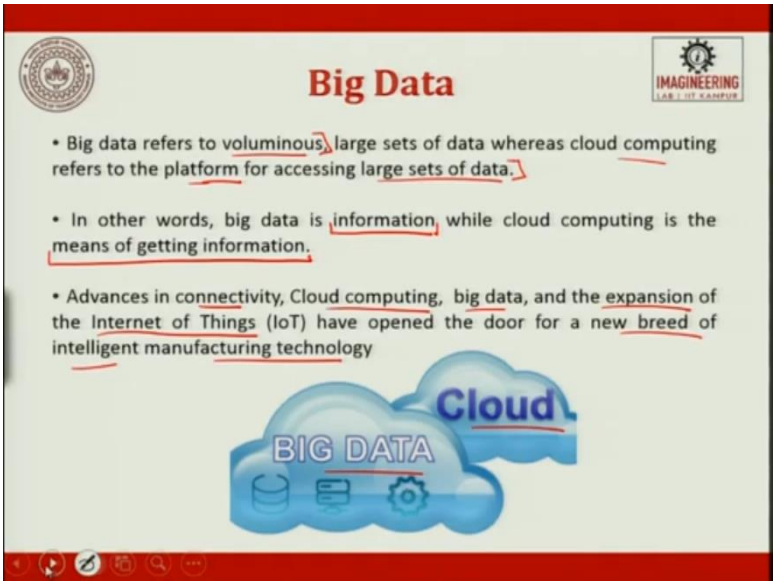

So, next, I will like to discuss cloud computing. But what is the cloud and Big Data let us see. Big data refers to voluminous large sets of data whereas cloud computing refers to the platform for accessing large sets of data. So, large set of data when Big Data we talked about the analytics data analytics, as I just said, both or the all the three types descriptive, predictive and prescriptive kind of Analytics is used and cloud computing is just a platform which is in which

cloud is used as we took the example in a Fusion 360 software in which all the computation was happening on the cloud.

So, cloud computing is a platform where the data could be kept assessment happens there and we do not need to have very high end or very fast running computational Hardware with us. In other words, big data is information while cloud computing is the means of getting information. Advances in connectivity, Cloud computing, big data, and the expansion of the IoT have opened the door for a new breed of intelligent manufacturing technology.

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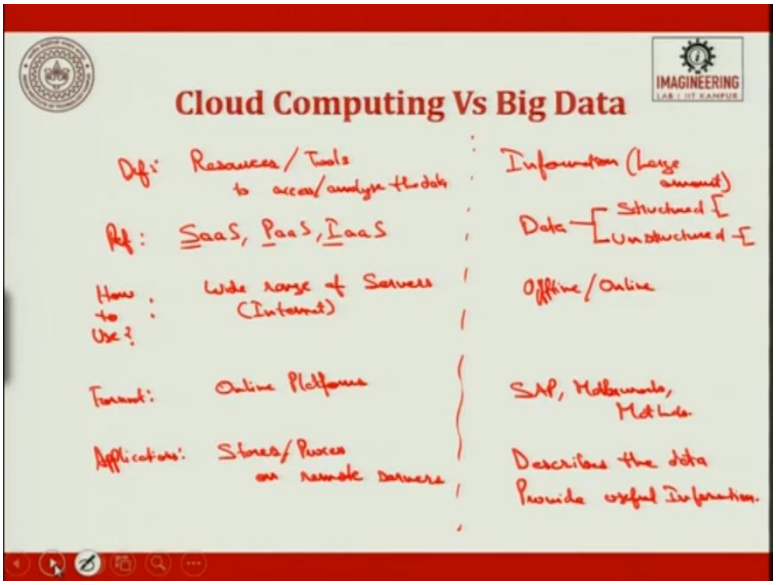

Now, what are the differences between cloud computing and Big Data? This I like to cover very quickly. First is definition as just defined big data and cloud computing different away that big data is information, that is large amount of information. However, cloud computing provides the resources or software tools to assess the data or analyse the data.

So, I will do the differences. Next is, references when we referred Big Data we are talking about the structured and unstructured data. It can be in structured and unstructured form further this we can go further for structured primary secondary, so many kinds of datasets could be available when we talk about a reference for cloud computing. It only differs in a way that what is being provided? saas or paas or iaas.

What is SAAS? SAAS is a software-as-a-service, paas is the platform-as-a-service and iaas infrastructure as a service. And how to use big data or how to use or where to use cloud computing? If I say this so this big data can be used both offline and online, however, this in

this is online or wide range of services that is required. Wide range of servers that is online mostly internet is required for this.

Then format for big data we have SAP software, we have math works. I am just visiting a few very common used math works than MATLAB not to forget. So, many Software's are there then SPSS so many software's are there that can be used for assessing big data but this only using software or online platform, I would say only online platforms. So, applications, big data does descriptive analytics mostly so it describes the data and provide useful information. However, cloud computing stores the data and process the data. On remote service.

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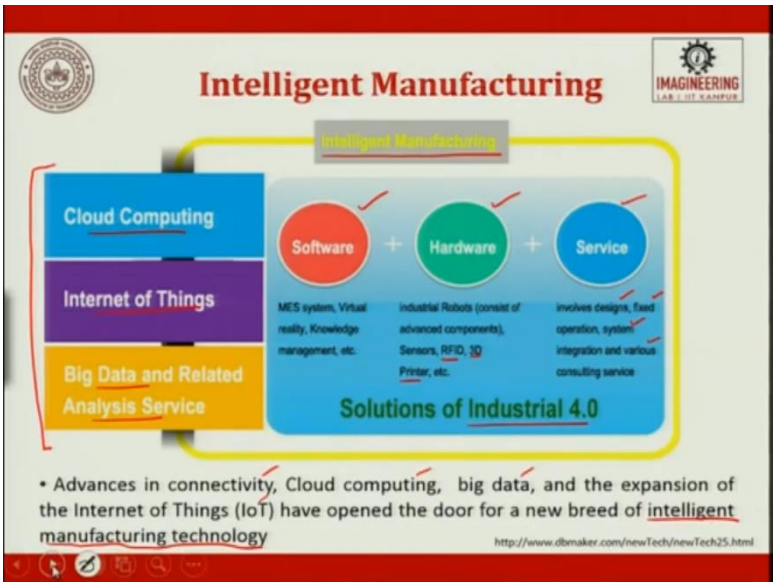

So, these are the major differences between cloud computing and big data. So, let us discuss. What is cloud computing again? In Intelligent manufacturing, these are various actors which helps to work with it cloud computing, Internet of Things, big data analytics services. So, what we have here we have software, we have Hardware we have service.

Software is a virtual reality is a Knowledge Management System Hardware or the robots or the computers, which we use are the high-quality robot or RFID or 3D printers any Machinery that we use that is hardware. This help us to provide services like producing designs for optimizing and designing operations and system integration and we discuss consultancy services.

So, this provides solutions to Industry 4.0 and this is known as intelligent manufacturing. This is intelligent manufacturing, again putting down the definition of intelligent manufacturing technology. What is this? Advances in connectivity, Cloud computing, big data, and the

expansion of IoT have opened the door for a new breed of intelligent manufacturing technology.

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So, big data where does it help in risk management? We are able to identify that what was the data? What was the structure or the behaviour of the data in the past and how in the future that would help? So this helps us in forecasting the risk and build to order configuration in Inventory management.

What is the amount invented to be kept so what is the reorder level at? At what point do we reorder the things and what is the work in progress raw materials and finished goods inventory are to be kept so those things can be identified using big data improving product quality after-sales services. This is very important.

What has been the feedback from the customer the previous product of the similar kind and what are expected to happen future for the products that is produced in a similar fashion? So, those can be tracked, then track daily production, then data-driven Enterprise growth predictive and preventive maintenance.

Maintenance is very important part from the past we can learn how maintenance is happening people can assess the maintenance data from the past and maintenance nodes at what point the machine has to be completely reset or the machine has to be taken care with some preventive or predictive maintenance of corrective maintenance.

Sometimes, breakdown happens that breakdown has to be avoided here then overhead tracking then testing and simulation of new manufacturing processes. as I said in smart manufacturing

lecture in PLM software those testing could be done in the software itself simulations can happen the software this big data I mean so much amount of data is there that can also help us to simulate what realistic or real-world system would look like, and then Logistics. Logistics transportation, in transportation data, is very helpful RFID and QR codes as we just mentioned the previous lectures is used here in manufacturing.

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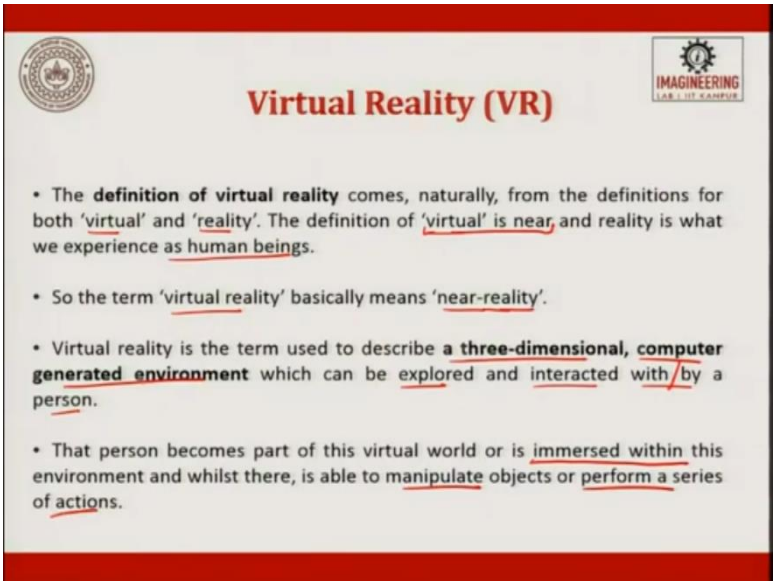

Next comes, virtual reality as discussed about two major kinds of the technologies here. One is VR, second one is AR Virtual Reality, and Augmented Reality in between them there is MR. MR is Mixed Reality the definition of virtual, the definition of virtual reality comes naturally from the definitions of both virtual and reality.

The definition of virtual is near, and the reality is what we experience as human beings. So, the term virtual reality basic means near reality that is close to reality. Actually, what happens in virtual reality we are trying to deliver a three-dimensional system that is computer and the system from we try to imitate the Real Environment.

This is a completed 3D system like the 3D video games that you play those are kind of VR environment, so you can see the whole path you can see the whole factory the whole you can when kings of fighting you can see the whole army fighting. What are the things we this is all virtual reality.

The reality is being imposed if using the computer, this is very useful in manufacturing as well. How does happen? We will see so what Virtual reality is a term used to describe a three-dimensional computer-generated environment, which can be explored and interacted with by a

person with a person or by a person. That person becomes part of this virtual world or is immersed within this environment and which there is able to manipulate objects or perform a series of actions.

I will just show you a video here that is just taken from every virtual reality developers. I have we have taken permission from them that I will show you the video here. We are both AR and VR are used in manufacturing and how does that help in realizing that what would happen to reality?

So, as I said before it is always adjustable to fail simulation, to fail VR system, to fail in an AR system, to fail in a VR system than to actually fail in reality because that financial loss could be very heavy. They could be harm to humans they could harm to the products has an infection and that could be really drastic.

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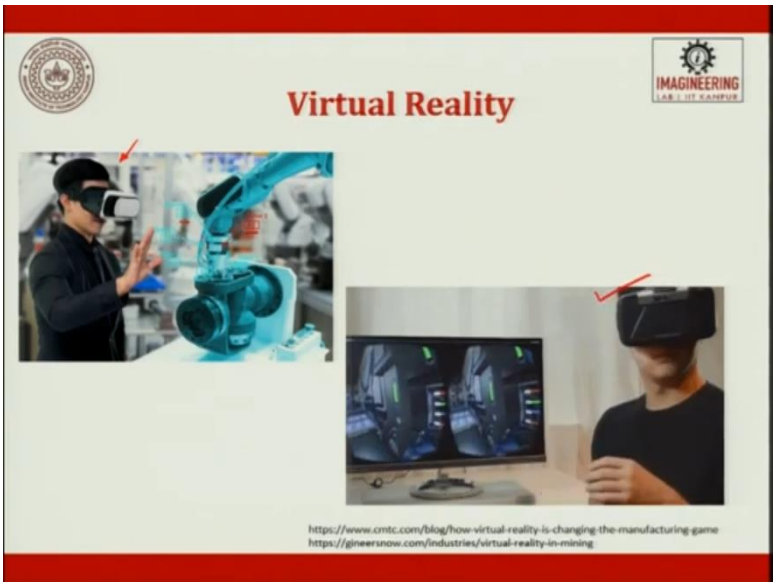

So, this is a VR system. In VR system this human is completely immersed in a virtual environment. He is coping a VR gear on its size. So, this VR gear you might have seen this Samsung and Apple are providing this kind of virtual reality gears. So, what is he doing? He is trying to connect the wires. He is just doing that in open air and the connection is being happening.

So, in this case, the VR reader, this is kind of able to say the inspector who is trying to see what are the features of your robot? What is the setting from the information? What is the angle here? What are what is the bearing size or what are the bearing types? All this information is

displayed well. He looks at the system. So, this VR system is integrated with the realistic system here. So, these are the major applications of virtual reality.

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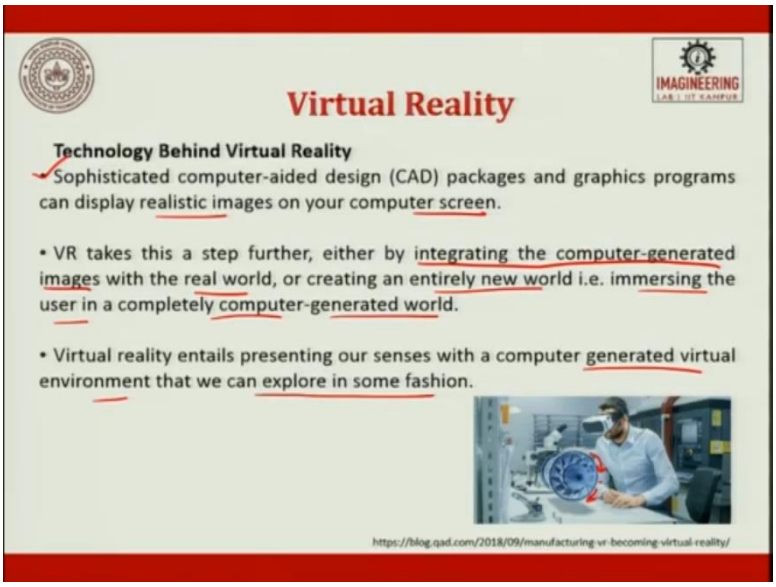

So, what is the technology behind virtual reality? CAD, it is obviously the CAD virtual reality actually an extreme extension of CAD. It is the CAD taken to the extreme and to develop these systems to develop the environment in a way so that everything that is around here is that is similar to what in real life is, so technology behind virtual reality is sophisticated computer-aided packages, and graphic program can display a realistic images on your computer.

This is the rationale behind that, now VR takes this a step further either by integrating the computer-generated images, integrating the computer-generated images with the real world, or creating an entirely new world that is immersing the user in a completely computer-generated world.

Virtual reality entails presenting our senses with a computer-generated, Virtual environment that we can explore in some fashion? This is the kind of testing that isn't happening in and virtual environment that how the system would were run over the turbine would run? How would you throw the fluid in different directions? So, these testings can also be taken care of? And can be carried out using this VR platform.

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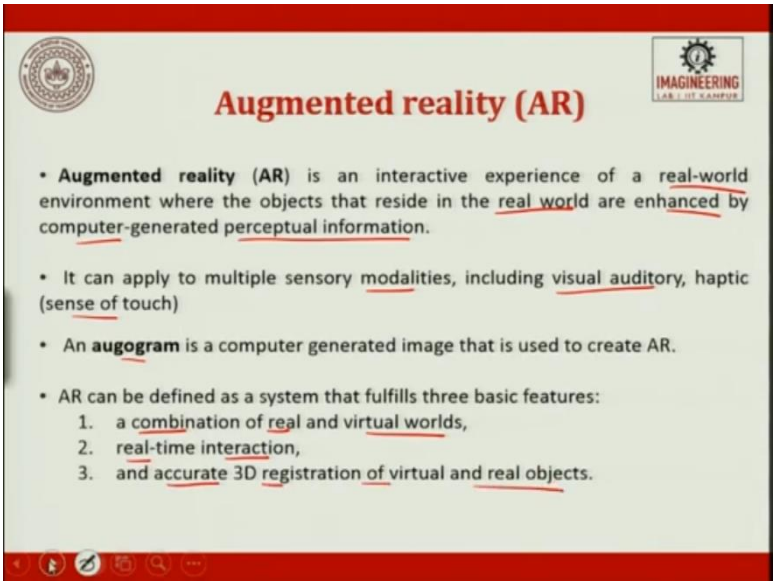

So, now what is AR? Augmented Reality is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information. Now, in virtual reality the operator or the person who is there, he is completely immersed in the system he cannot see the real system at all.

He is completely in the virtual world system, now reality augmentation of this reality this augmented reality is the real system he can also see but he can superimpose the virtual system on the real system. This is augmented reality. So, it can apply to multiple sensory modalities including visual-auditory haptic or sense of touch and Augogram is a computer-generated image that is used to create AR.

AR can be defined as a system that fulfills three basic features, number one it combination of real and virtual Worlds. Second is real-time interaction, third is accurate 3D registration of virtual and real objects.

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This is AR Augmented Reality you can see the person is standing in the Real Environment. You can see this door and so he just trying to superimpose his virtual system on this handheld tab and trying to do some inspections some graphics are being made. So this is kind of an OCR Optical Character Readers in which the real book or the real environment is augmented with a reading system, or a diagram that is made on the book is developed in a 3D form using an AR system.

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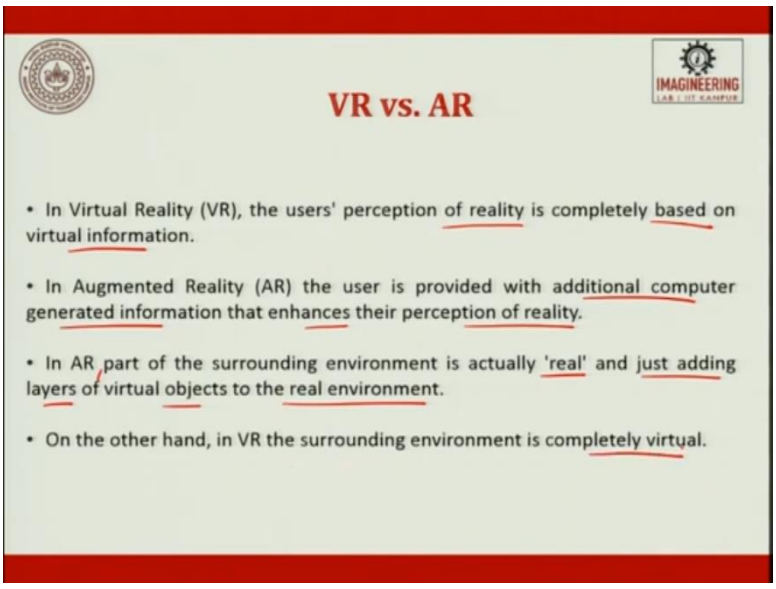

Now, VR versus AR, in VR the user's perception of reality is completely based on Virtual information in AR the users what will be the additional computer-generated information that enhances the perception of reality we have already discussed in AR the part of surrounding

environment is actually real and just adding layers of virtual objects to the Real Environment on the other hand in VR the surrounding environment is completely virtual.

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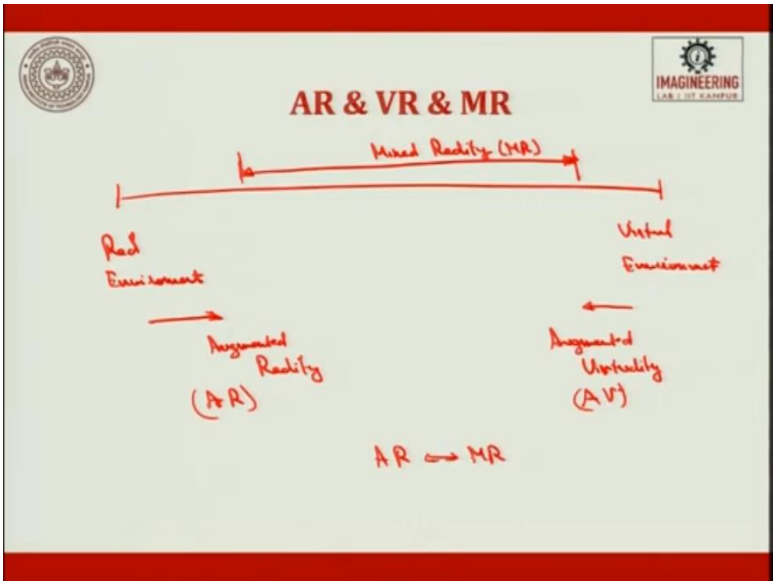

Now, AR versus VR versus MR. What is MR? MR is mixed reality. What we have actually with us is we have a real environment can say real environment here and we have the virtual environment here. So, real versus virtual, so these are two extremes. So, when I move from real to what virtual this is known as RAR augmented reality, and when I move from virtual towards real, this is my augmented virtuality.

So, AR what we are talking about is very close to the real world. But the most of the things those you can see here is the real things, but in AV is just a few things are real but most of things are just virtual so in between them what we have is the Mixed Reality between, AR and AV what we have is Mixed Reality that is MR.

So, this is Mixed Reality. The Augmented Reality all tells one sounding perception of a real-world environment, whereas virtuality completely replaces the users real-world environment with a simulated one. AR is relative to largely synonyms. Sometimes AR is also known as MR or computer-mediated reality. So, these two words are sometimes taken cinnamon say, AR and MR.

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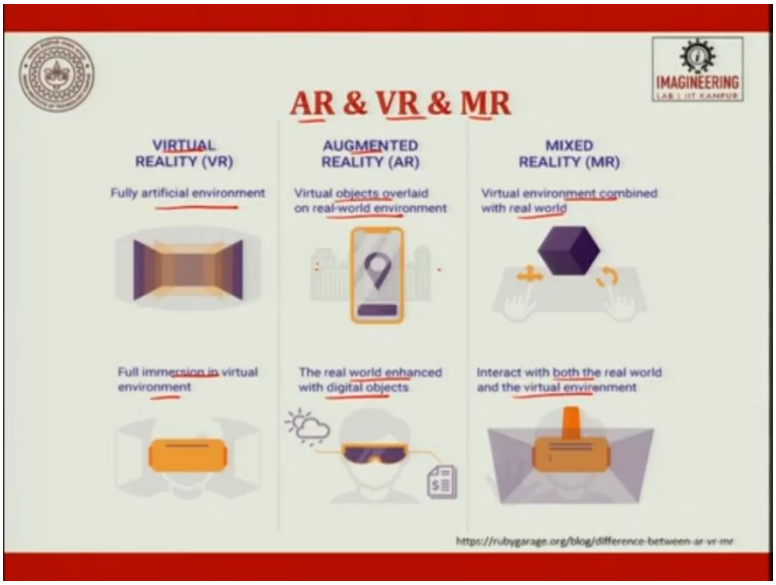

So, further about AR and VR, and MR in VR we have fully artificial environment in AR we have virtual objects overlaid on the Real Environment. So, most of the proportion is here real only virtual objects such as you can see the media's which are superimposed on your mobile or so. So, in mix reality, we can work with both environment combined in the real world.

So, we work with both of them to fully motion in which environment in VR the Real World objects enhancement with digital objects in AR and in MR interact with both the real world and the virtual environment.

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Now, applications of AR and VR. In complex assemblies systems where the components in the system are too sensitive or the so many components in the system. The number of components is too large then in complex assembly as well AR and VR used to this is AR system Augmented Reality in which the person is watching. The door he is getting the information is getting information that they the door is completely process with all the steps before it and now he is able to assemble that to the next point.

So, modern infection involves putting together, hundreds of thousands of components in the precise sequence as complete as possible. There are so many electronics hardware and systems put in a door for an advanced car. So, all the systems are to be completely spot-on for that. This AR is also used.

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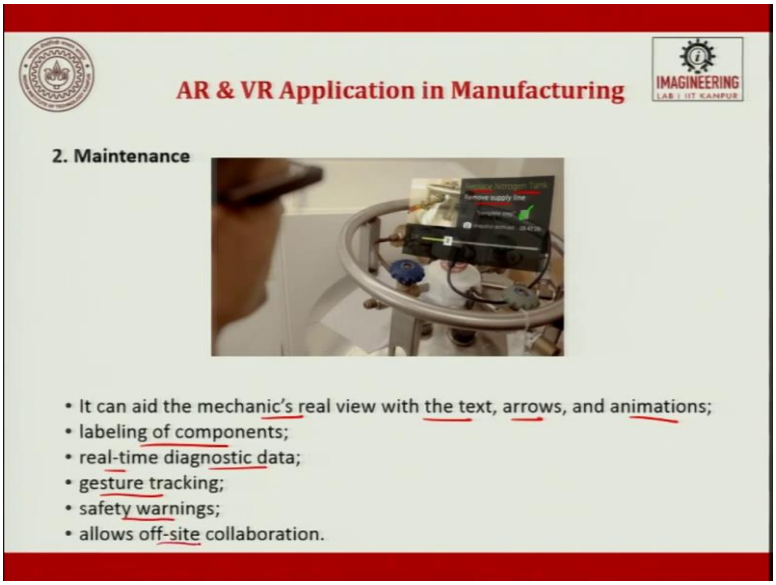

In maintenance, you can see the person can see that went to the city for the replacing a nitrogen tank. You can see remove supply line. He can see the steps those are to be taken care before actually doing or before actually operating the maintenance tasks here. So, it can aid in mechanics real view with text arrows animations that you can see here labeling of the components can be possible, real-time diagnostic data is available gesture tracking is there, safety warnings and also give some alarms here, then it allows offset collaboration.

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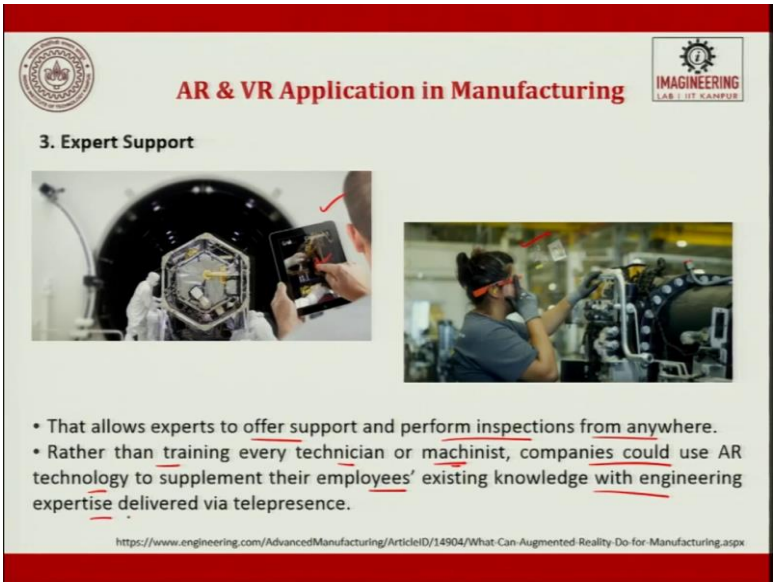

Then in expert support experts can watch and supervise all the systems running so you can see the experts can watch the system expects can just expect inspect the system where the system is running right or not, this allows experts to offer support, and perform inspections from anywhere rather than training every technician or machinist companies could use AI technology to supplement their employees existing knowledge with engineering expertise delivered via telepresence.

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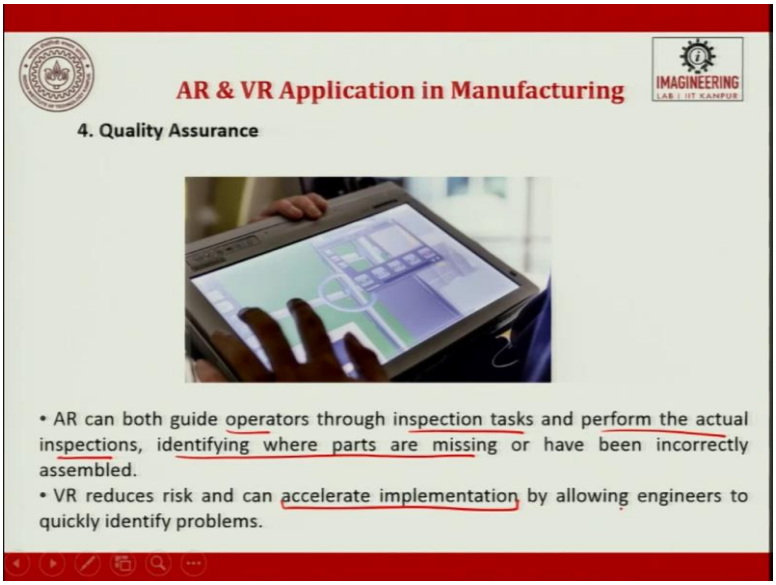

Quality assurance, in quality assurance AR and VR systems, can help in a way that they can guide operations through inspection tasks and perform the actual inspections identifying where

parts are missing or to have been correctly assembled. We are reducing risk and can accelerate implementation by alloying ingenious to quickly identify the problems.

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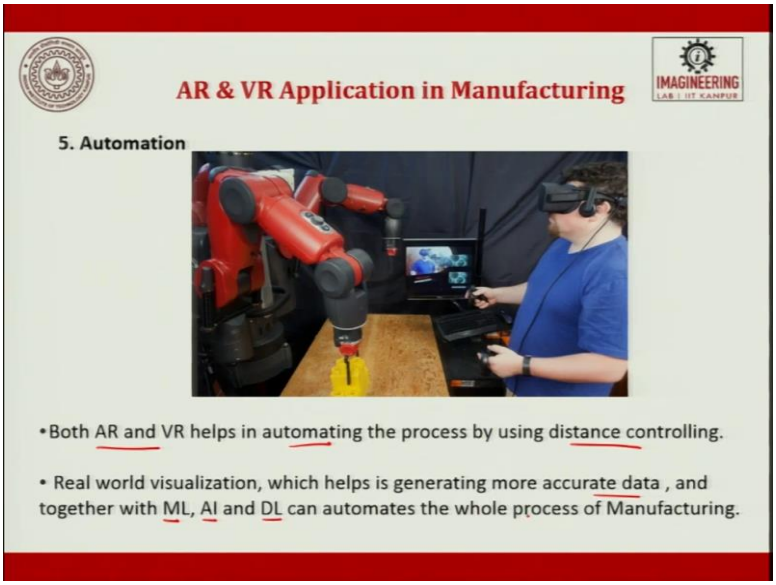

Automation obviously, this can be used not in this an automated system. You can see the person is using VR to see what is the distance that will be taken, how the robot could pick the object, both AR and VR helps in automating the process by using distance controlling then real-world visualization which helps in generating more accurate data and together with the machine learning artificial intelligence and deep learning, we can automate the whole process of manufacturing.

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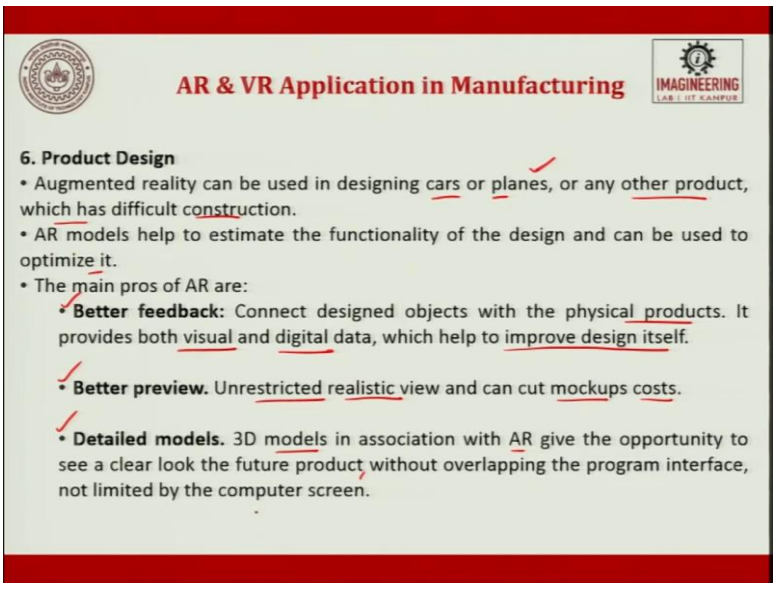

So, in product design, there are so many applications in product design augmented reality can be used in designing cars, planes or any other virtual for any other products which has difficult construction, the big products like planes, ships or so can be produced using AR and VR in environment. AR model helps to estimate the functionality of the design and can be used to optimize it, the main pros of AR here are number one is better feedback. Number two is better preview number three is detailed models.

In better feedback it connects the designed objects with physical products, it provides both Visual and digital data which help to improve design itself. In better preview unrestricted realistic view can be cut mock-ups cost, details models can be avoided such as 3D modeling association with AR give the opportunity to see a clear look the future product without overlapping the program interface, not limited by the computer screen.

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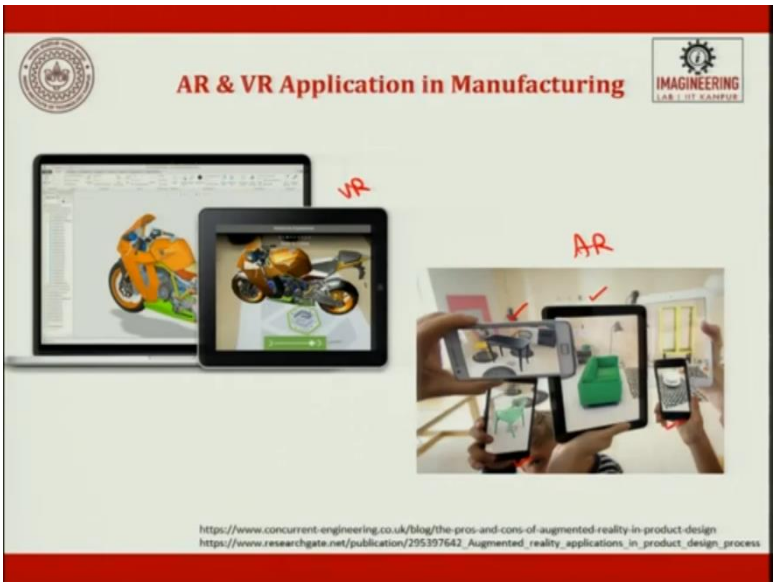

So, these are AR and VR applications this is AR this is VR this is completely virtual environment this is AR in this AR we can see the objects superimpose in your house is it can be using different platforms? You can do it in and Android phone you can use in an iOS or iPad since so many system. This can be used.

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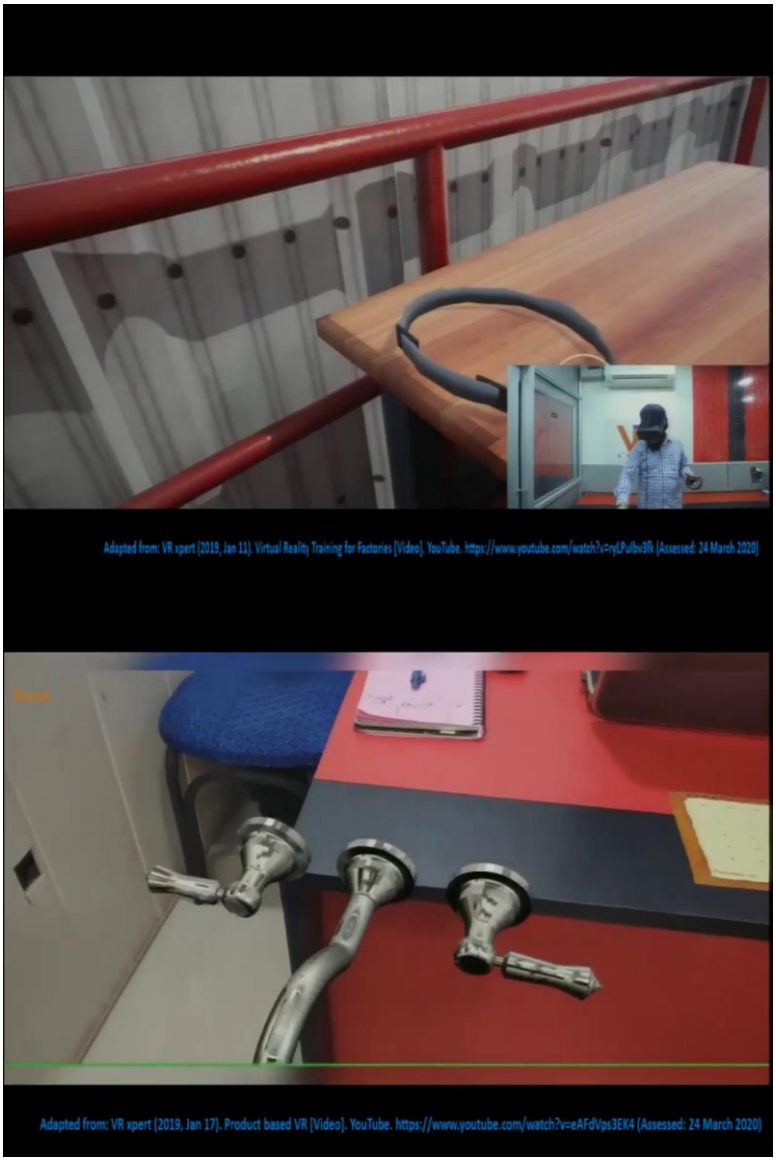

So let me show you in video which AR Augmented Reality is used to using your mobile phone. So, I will take an example here with this is an office environment in which an app is installed on the Android phone, and augmented reality is used to superimpose the images and try to see that how the product would look like when you put it on your room.

So, we have two options here, this environment if faucet and the bathtub on the left side we have faucet on the right someday of a bathtub. This can be used to see how or what would the colour of the bathtub of the faucet that you would like to Install in your washroom. So, just to show the demonstration. The bathtub is superimposed, bathtub is now clicked here it is superimposed on the table on the computer table office desk.

So, good thing about this scenario is this if you have customers walking in your office, the customers were away from your factory. You can show them how the bathtub would actually

look like. So, the clients might like this, this is a new way of advertisement so this how in some is time at in advertisement of the amendment factory products this AR is a see the depth of the object can be very well seen here, the illusion is quite well here.

So, next is faucet, left side so you can see this faucet. So, what would be the size of the force at home would look like, so AR helps in this kind of the simulation. We can zoom it in few and zoom-out to look it. So, all the four sides you can look at it so you can make it to scale. You can zoom down zoom up. You can zoom in and zoom out. You can see the tracker-less AR in which also we can give you can see human hand as it is tracker-less AR.

This was the AR environment where we saw the products those can be shown to the clients. So, next, I will show you the VR in which if in the factory layout we can see how to use Harness hook, how do we use small to go to carry small maintenance tasks in the factory, but this is the VR environment. Let us see.

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Adapted from: VR xpert (2019, Jan 11). Virtual Reality Training for Factories [Video]. YouTube. https://www.youtube.com/watch?v=ryLPulbv9fk (Assessed: 24 March 2020)

Adapted from: VR xpert (2019, Jan 11). Virtual Reality Training for Factories [Video]. YouTube. https://www.youtube.com/watch?v=ryLPulbv9fk (Assessed: 24 March 2020)

This is a VR environment you can see the human that is working here. So, they are acquiring the security apparatus here. So, protocols are to be followed here the belt with a harness is required here they are tucking the harness, then picking the Safety Shoes then goggles, then the drill is tucked here on the Belt. Is it tucked on the belt? Yeah.

So, open gate it is showing the instructions what to do. So before doing anything in the factory one have to put the harness on the belt without putting the harness one cannot move even a one step forward. So, it is being latched here the harness is moving. The human is working.

So, this is completely virtual environment in which human is completely immersed in the environment and we cannot see any real object. You can see the virtual gear that the person is operating is working. It is designed by the same person. So, the harness is taking from left to right side. See, attached to belt, all instructions are being shown here. Then went right to left.

So, in this way, these things can be done using both hands. Now, is something to be required here. So, it is they are taking out the training machine to perform the tasks that we will be seeing is unscrewing the screw from it. The task is performed. Your task is complicated. But this virtual reality is used for the virtual environment. You can see you have completed the training. This is what the training of the people so this virtual environment is used for this purpose. So you have taken examples for both virtual and the real environment.

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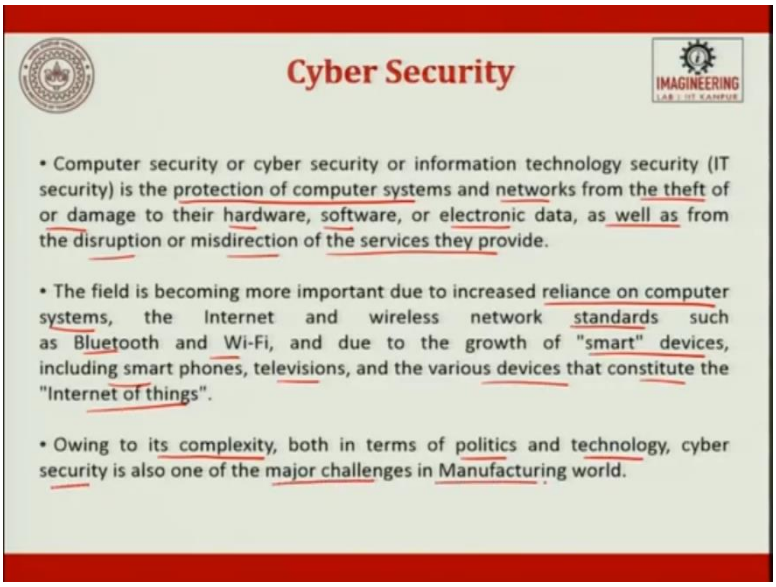

Next, I like to talk about the topic that is cybersecurity, cybersecurity is very important when we talk about computers in manufacturing the computers are to be safe in that way cybersecurity is one of the important issues that is to be considered in the future as well. So, in that, what we do what is cybersecurity let us see first.

Cybersecurity or cyber computer security or cybersecurity or information technology security identities IT security is the production of computer system and network from the theft of or damage to the hardware, software, or electronic data as well as from the deception or misdirection of the services they provide.

Cybersecurity is very important because there is more and more increased reliance on the computers these days reliance on the computer systems, these days the internet and the wireless network standards, such as Bluetooth and Wi-Fi are there and due to the growth of smart devices including smartphones televisions and various devices that constitute the Internet of Things.

The so many parameters with people where Bluetooth is there, Wi-Fi is there, your hardware is there, your software system AR, VR, so many systems are here, from any point if we have anything lose any loophole is there with breaching the system could happen. So, owning to the complexity of the present-day systems, both in terms of politics and technology cybersecurity is one of the major challenges in manufacturing world.

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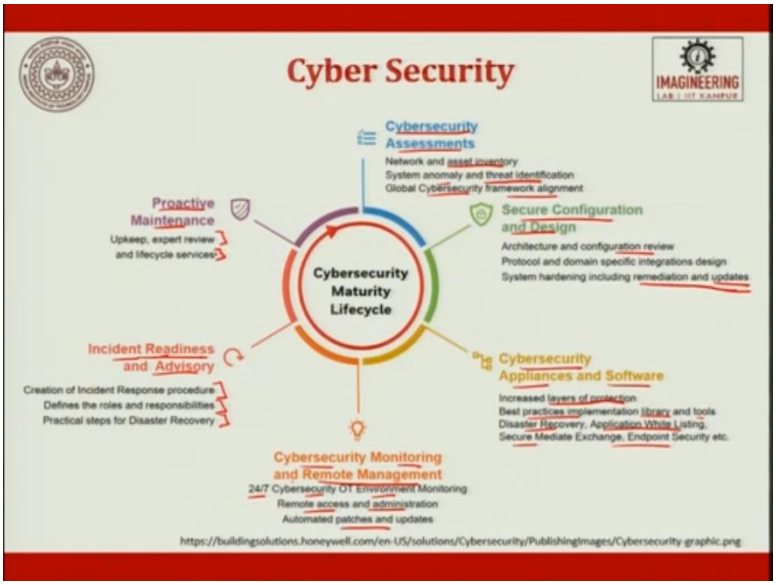

So, what cybersecurity has to look after? It has to carry out cybersecurity assessments. It has to secure configuration and design cybersecurity Appliance in your software has to be designed then cybersecurity monitoring and remote managed systems has to be developed, then incident Readiness and advisory system on advisory committees are to be developed or to be constituted proactive maintenance has to be carried out in assessments network and asset inventory has to be taken care.

System Anomaly and set identification has to be taken care, Global cybersecurity framework alignment has to be followed, in system configuration and design architecture and configuration review protocol and domain-specific integration design system hardening including remediation and updates allows very important like in your software as well over your computer system or your CAD software for the CAM software the updates are very important to be taken care of and these also helps us to keep our software's from any breach.

Then cybersecurity appliances or software increases layers of productions are there in the soft best practices implementation library and tools disaster recovery management system is to be the application while listing then secure immediate exchange and Point Security. All those

things have to be carried out, then in a remote management system, 24 by 7 Cybersecurity environment has to be developed.

Then remote access and administration has to be instituted automated patches and updates or to be there. Then creation of incident response procedures are to be developed by the advisory then the roles and responsibilities of the people then partial steps and disaster recovery has to be taken care of keep the expert review and lifecycle services are to be taken care of so many things about taken care by cybersecurity this is also very important in manufacturing.

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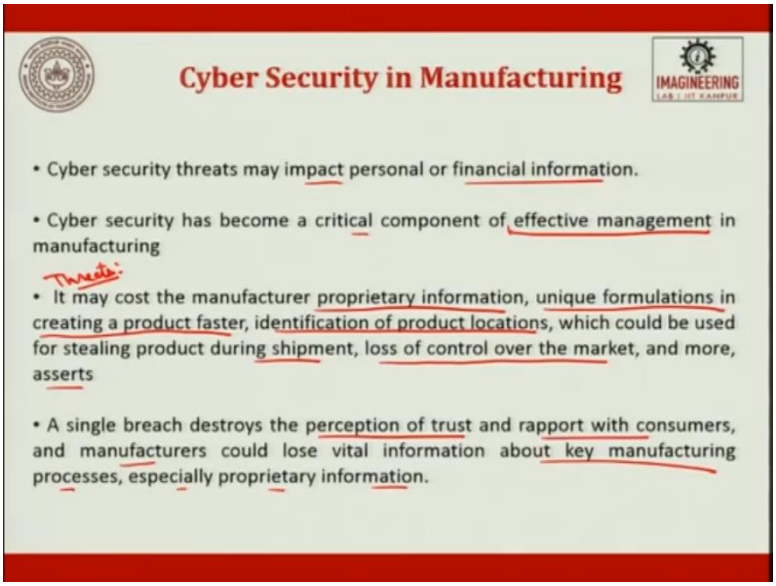

Cybersecurity threats may impact personal or financial information. The threats can be from many sides. So, cybersecurity has become a critical component of effective management in manufacturing. The certain kinds of threats. I will put threats here, so what are those threats? It may cause manufacturer proprietary information, unique formulations in creating a product faster, identification of a product location which could be used for stealing product during shipment, loss of control over the market, and more asserts.

Single breach destroys the perception of trust, as it is said a single spark can burn the complete jungle. Sorry single breach can destroy the perception of trust and rapport with our customers, and manufacturers could lose vital information about the key manufacturing processes, especially property information. So, they are various ways breach could happen. Let us see how this breach could happen and why the cybersecurity is important?

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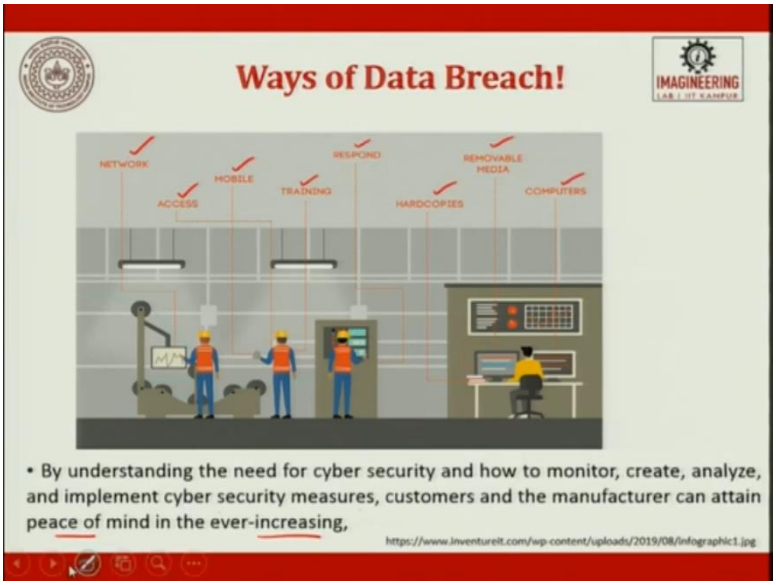

For understanding the need of cybersecurity and how to monitor create analyze and implement cybersecurity measures customers and the manufacturers can attain peace of mind in ever-increasing the certain ways of liberty bridge. It can be through our network, it can be through assess of mobile, it can be through the training that is given to an unknown person, it can be responses made by the customers the hard copies and removable media computers, all these can post threat to our cybersecurity system.

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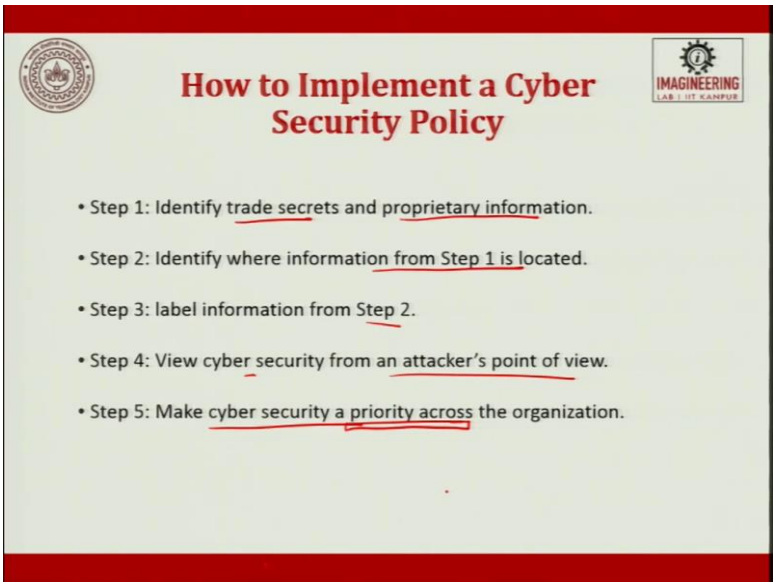

How to implement a cybersecurity policy? I have just listed down the 5 steps, for more information you can read the links added in the reference section of this lecture. So, to just drop them down step one is to identify trade secrets in property information, step 2 to identify where information from step 1 is located, step three is label information from Step 2, Step 4 is view

cybersecurity from an attacker point of view, step 5 make a cybersecurity priority across the organization

So, I would not go into detail of this, but you can definitely read about cybersecurity, security policy this is the general these are General 5 steps. Those are they are to design a cybersecurity system. With this, my major topics are covered.

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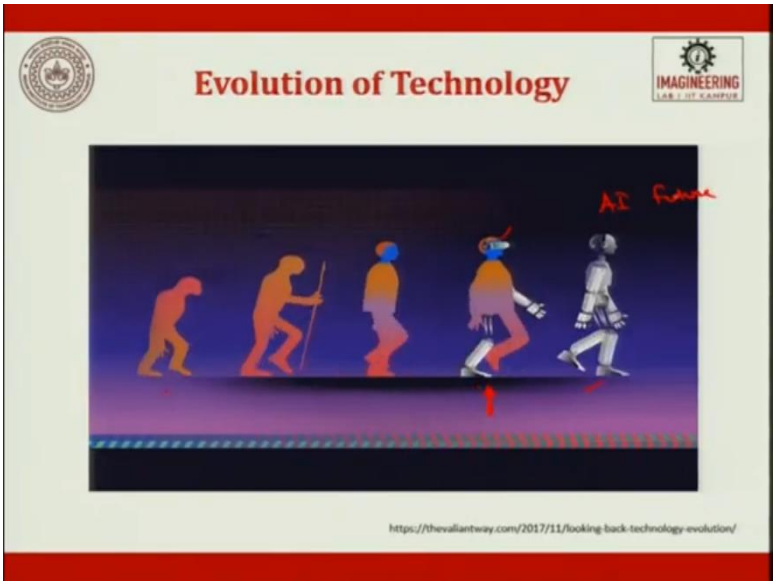

Now, finally, how the evolution of technology came up with time through the millions of years from the very ape-man to the final AI now actually we are in this stage now, we are in this stage now where the humans can use artificial limbs and they can use VR and AR tools. So, also we are moving towards as predicted by many of this scientists to be completely AI system in which complete human body can be made in an artificial system, so this is AI future, I would say here.

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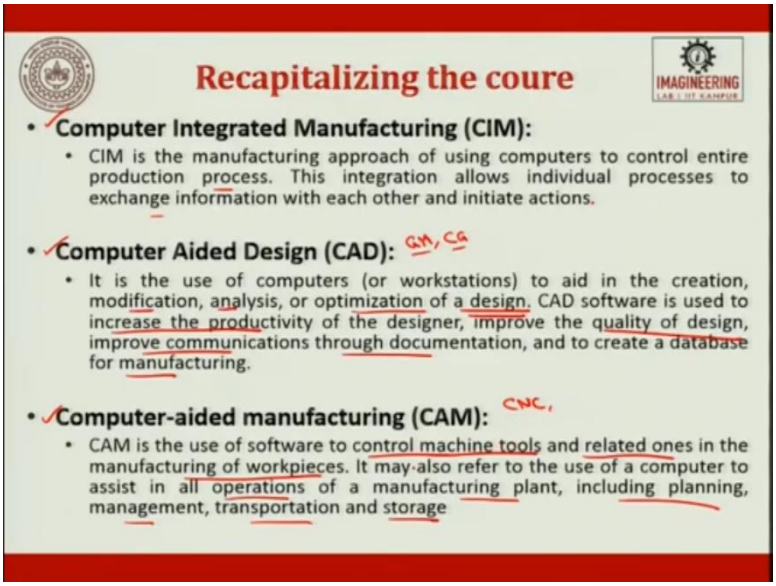

So, with this lecture is complete. I like to quickly go through the course content that we covered to recapitulate the things that we covered in the first weeks. We covered the introduction to CIM and CAD and CAM. Now, CIM is a manufacturing approach of using computers to control entire production process. This integration allows individual processes to exchange information with each other and initiate actions.

So, introduction to CIM was given in first week, then the forthcoming second third and fourth week covered CAD and CAM. So, what is CAD? CAD is the use of computers or workstations to Aid in the creation, modification, analyses, or optimization of a design. CAD software is used to increase the productivity of designer improve the quality of design and improve communication through documentation and to create database for manufacturing.

Then the use of CAD can be made in CAM. CAM is a user software to control machine tools and related ones in the manufacturing of workpieces, it may also refer to the use of computers to assist in operations of a manufacturing plant, including planning management transportation and storage. So, we discussed geometric modeling and CAD, geometric modeling, computer graphics and so on we discussed CNC, in CNC laboratory demonstrations, and CAD laboratory demonstrations interpreted in manufacturing.

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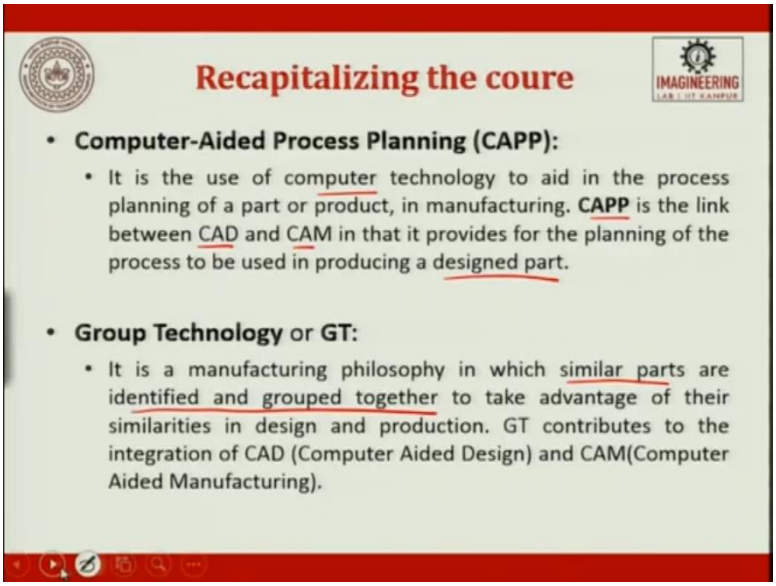

Next, we discuss the computer edit process planning. So, in the process planning was first discussed about the general process planning then group technology in process planning we discussed. So, what are these computer press process planning? It is a use of computer technology to Aid in the process of planning of a part of product in manufacturing.

CAPP is the link between CAD and CAM in that it provides for the planning of the process to be used in producing a design part. Group technology it is in manufacturing philosophy in which similar parts are identified and grouped together. This is done to take an advantage of their similarities in design and production, group technology contributes to the integration of CAD and CAM.

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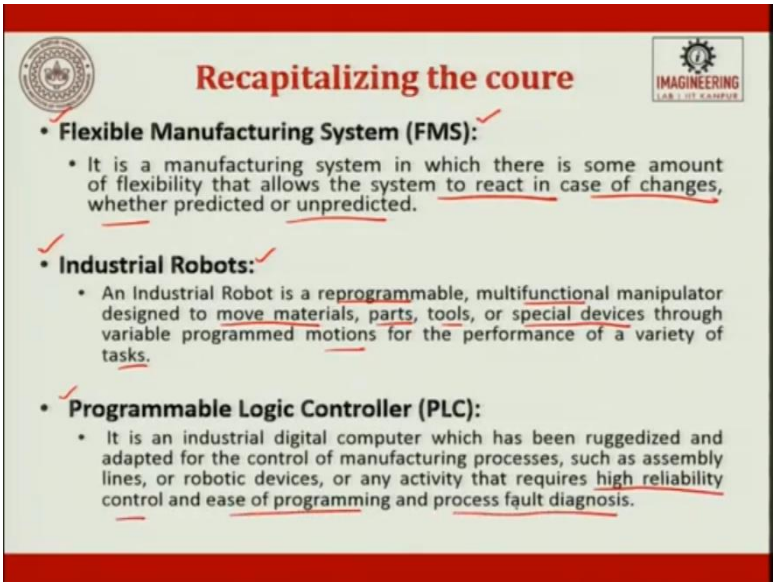

Next, we discussed about the components of a CIM system computer manufacturing system. In the system, we have FMS Flexible Manufacturing System, industrial robots, and PLC. What is FMS? It is a manufacturing system in which there is some amount of flexibility that allows the system to react in case of changes whether predicted or unpredicted industrial robots help us to do the things that human could have done in their absence and Industrial robot is a pre-programmable multifunctional manipulator designed to move materials, parts tools, or special devices through variable programmed motions for the performance of variety of tasks.

So, this we have discussed kind of the robot was are available kind of the robot with can we build kinds of the components in FMS, then also we discussed the PLC. PLC is important part of Robotics. It is an industrial digital computer which has been ruggedized and adapted for control of manufacturing processes such as assembly lines or robotic devices or any activity that requires higher reliability control and ease of programming and processed fault diagnosis.

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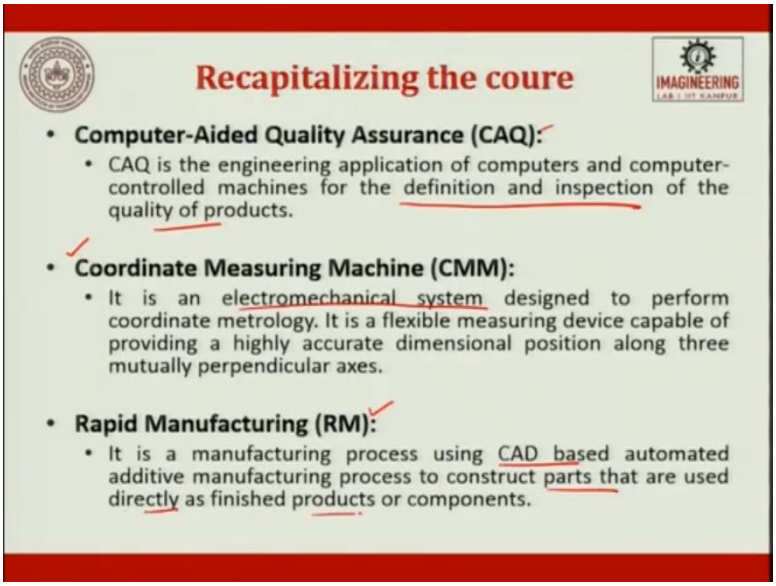

Next, we discussed about computer-aided quality assurance in which we discussed coordinate measuring machine computer is it quality assurance is engineering application of computers and computer-controlled machines for the definition and inspection of the quality products. Coordinate measuring machine is one of the electrical chemical systems that is used for computing quality assurance that we will discuss. We also had a laboratory demonstration in it.

And we discussed rapid manufacturing, rapid manufacturing these days when we talk about computer indicative of factoring we cannot ignore the rapid manufacturing rapid prototyping or rapid manufacturing techniques because additive is taking over the subtractive method in a very fast piece. So, rapid manufacturing, it is an manufacturing process using CAD base automated additive Manufacturing Processes to construct parts that are used directly as finished production components.

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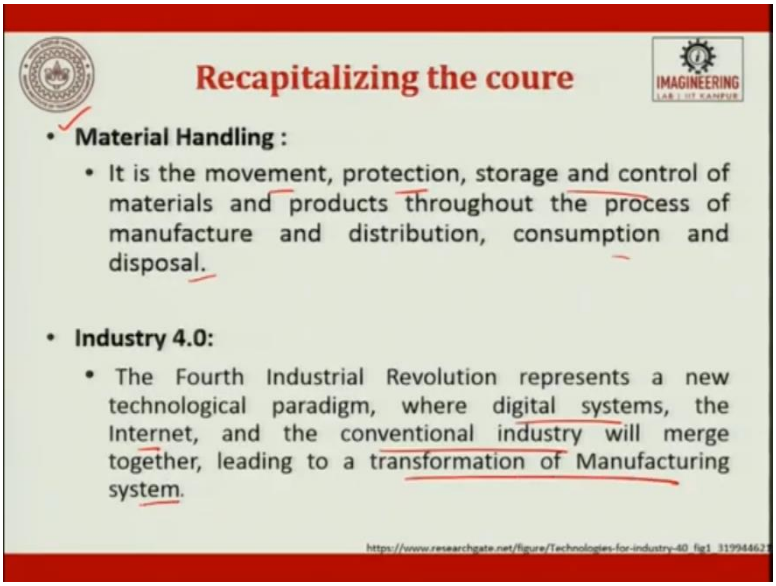

Then we discussed about material handling and Industry 4.0 in the last week we discussed about the material hanging system, we discussed about the software, the plant layout software, and product lifecycle management system. So, Material handling, the definition is here is the movement production storage and control of materials and products through the process of manufacture and distribution consumption and disposal.

We saw the various manufacturing platform, the manufacturing platform that how computers are used for beginning system. Then in this week, we discussed about industry 4.0. We discussed about the various industry 4.0 parameters and dimensions, the fourth Industrial Revolution represents a new technological Paradigm where digital systems the internet and the convention industry will merge together leading to a transformation of manufacturing system.

So, this was all in the course computer integrated manufacturing, thanks for being with us. It had been a wonderful experience for us as well, and professor Ramkumar and I would like to thank all the participants all the people who have supported us in this course all of the staff members who have helped us to record the data to edit the videos and to teachers as well who have been very helpful in answering your questions in the Forum and designing assignments, so, best of luck for the exams. Thank you so much.