Computer Integrated Manufacturing
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Lecture 01
Introduction to CIM

Welcome to the lecture on introduction to CIMs, CIM is Computer Integrated Manufacturing, Computer Integrated Manufacturing as the name itself says the manufacturing is getting integrated because in manufacturing you all know there are several islands of automation. These islands of automation has to be bridged. So, that is what is integration, and how is this integration done? By the use of a computer.

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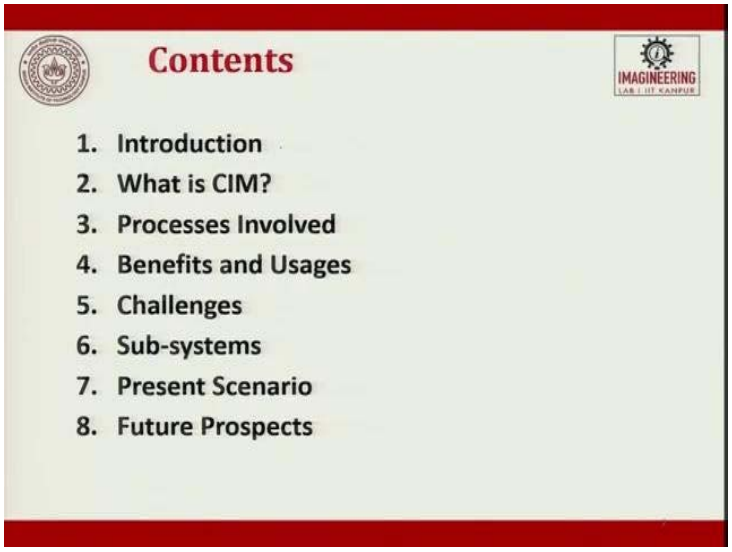

So, this course is focused on computer based integration to manufacturing. So, what all will be covered in this lecture, we will first try to have a small introduction, then what is CIM, then processes involved, benefits and usage, challenges, sub-systems, present scenario and future prospectives.

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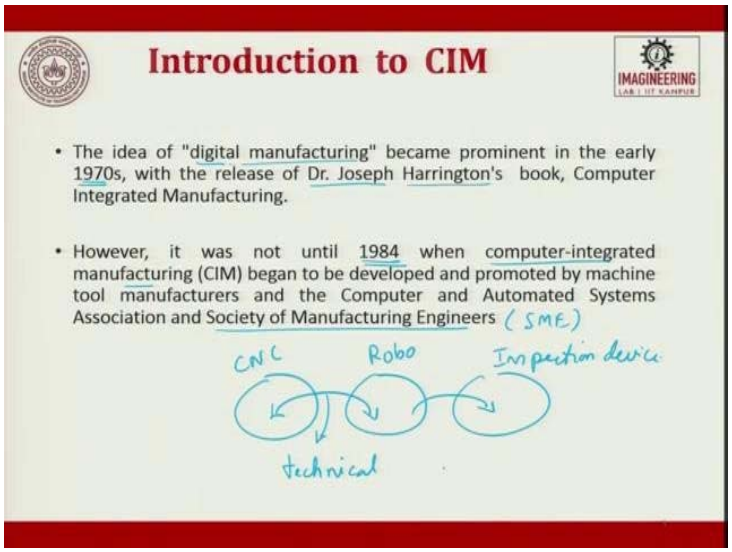

Today the world is moving towards digitization. So, manufacturing is also moving towards digital manufacturing. So, the idea of "digital manufacturing" became prominent in the early 1970s, with the release of Dr. Joseph Harrington's book, Computer Integrated Manufacturing. This gentleman, in his book, talked about digital manufacturing. He said that, by using computers, manufacturing is going to touch sky heights, which is true, at one point of time where all we did manufacturing using hand. Now, we are using computers and from virtual idea to a finished product by using the process of rapid prototyping. So, all these things fall under a major umbrella called digital manufacturing. However, it was not until 1984, when computer integrated manufacturing began to develop and promote, promote by machine tool manufacturers, the Computer and Automated System Association and Society of Manufacturing Engineers. So this is nothing but SME.

So, all these societies join hands in 1984 thought of why don't we start a new era on computer integrated manufacturing, a thought process of 1970 came into existence, at least on books in 1984. Then on started growing. What made them a big bottleneck? Because in manufacturing as I told you, you will have several islands. These islands to communicate, we always had a problem, or this problem is, it is a technical problem. So, this is an island; for example, this can be a CNC machine; this can be a Robo; this can be an inspection device. They all had different-different hardware, different- different operating systems.

They were not able to communicate with each other. Today, they all have understood that until and unless we bridge everybody, we will not succeed. Today we have a standard backbone

platforms wherein which CNC can talk, robo can talk and inspection devices can talk. So, that is computer integrated manufacturing.

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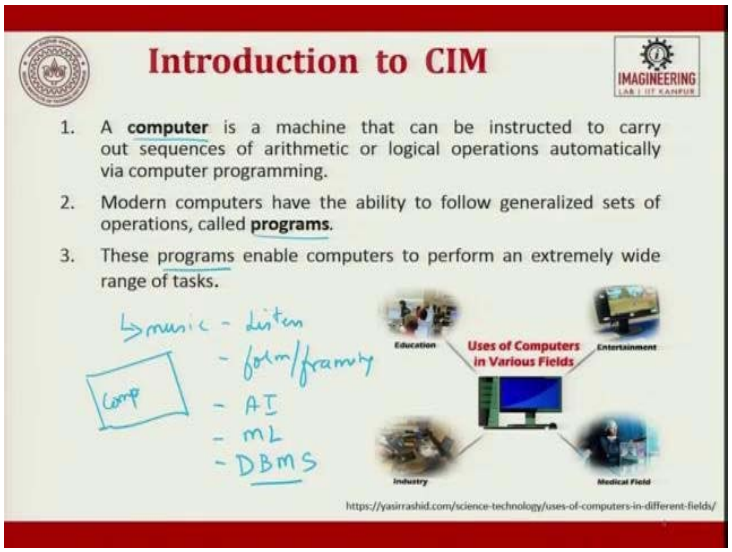

A computer is a machine that can be instructed to carry out sequences of arithmetic or logical operations automatically via a computer program. Today, computers have become palmtops. Computer desktops then became laptops today it has become palmtops. So, it is a machine, that can be instructed to carry out sequences of arithmetic and logical operations automatically via a computer program. Modern computers have the ability to follow generalized set of operations called programs. These programs can enable computers to perform an extremely wide range of tasks. Right from music, listening, framing; it can be done, okay. Artificial Intelligent program writing, machine learning, data database management system, all these things are possible today by different- different programs, but done on a single machine called computer.

So, that is a beauty of computer and computer is the first word in the CIM that is C.

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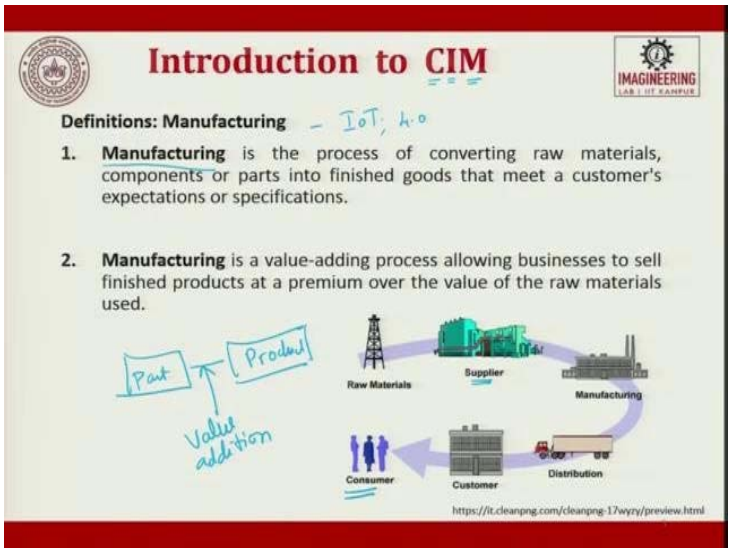

Manufacturing, so, manufacturing definition there are two ways. One is manufacturing is the process of converting a raw material component or a part into a finished good that meets a customer expectation or specification, that is manufacturing. This is hardcore manufacturing definition which happens in a shop floor.

Suppose, let us assume that you are trying to do a service sector work. So, then the definition goes like this manufacturing is a value adding process, allowing businesses to sell finished products at a premium over the value of the raw materials used. So, you have your part, you convert that part into your product, and here you do something called as value addition.

So, this is what we are talking about. So, you look at it. Raw material, you have a supplier, so raw material, it goes to supplier, supplier to manufacturing, manufacturing to distribution, distribution to customer, customer to consumer. So, distributor, the distribution give it to a customer and generally the customers are called as consumers.

So, so this is what is the thing. So, manufacturing is today very much talked about. Today we talk about IOT, Internet of Things getting integrated into manufacturing. We are talking about four point, industry four point zero in manufacturing, wherein which we are trying to talk about various sensors, these sensors getting integrated. So, you do online process monitoring, and you produce good products. Let it be textile, let it be automobile, let it be a continuous part, let it be a discrete part, this is what is today happening and these are the advancements which are happening.

So, I have already given the definition for C, I have given now the definition for M. So, integration is a word which tries to blend these two.

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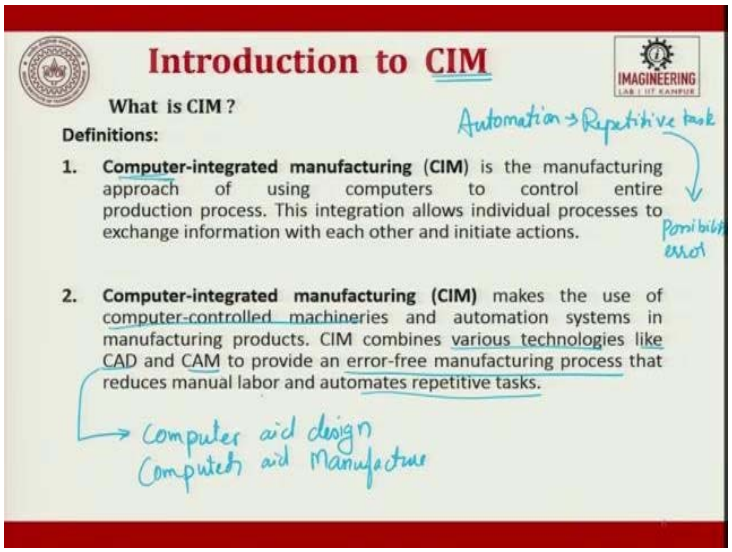

So, now, let us see the definition for CIM, Computer Integrated Manufacturing is called as CIM, is the manufacturing approach of using computers to control entire production process. This integration allows the individual processes to exchange information with each other and initiate action. For example, if there is a part and in that part, several process sequence are happening once the process sequence are over, the part is told that it is finished. So, the next machine understands the (prop), the sequence of operation which went on the previous process, and then they try to do the next. Suppose, in case if there is one of the processes, which are there in sequence is missed. So, the product now is not worthy for getting converted in the further steps. Now, the information will be passed to the sequential machines which are in line that please do not operate anything on this part because there is a defect which is coming. Or there is a process which is missed one feature is missed in the next subsequent operation if it could be taken care, then please take care of it.

So, a defective product can be thrown out; a product can be repaired, so, all these things can happen; it is because of this computer presence. Computer integrated manufacturing makes the use of a computer controlled machinery and automation systems in manufacturing products. CIM combined various technologies like CAD and CAM. CAD is nothing but Computer Aided Design there is a big difference between drafting and design, what we do just as on a drawing board as only to draw the dimensions, then that is called as drafting.

Designing is drafting plus simulation and optimization is called as designing. So, here we are talking about Computer Aided Designing, and CAM is nothing but computer Aided Manufacturing, wherein which we try to use computers to control NC machines that is why it is called a CNC machines.

And CNC machine alone getting automated, but the system for movement if, it is not automated and if this does not talk to a CNC machine, then there is no point in integrating these two. So, why do we want to integrate? We have to provide error free manufacturing process, that reduces manual labor and automates repetitive task.

Today, automation is thought of in a big way to remove repetitive task. Why repetitive task has to be removed from a manual operation? Because when you do a repetitive task, there is a possibility of error. There is a possibility for error, and that is why people nowadays try to automate the process and remove the error. So, that is what is the function of this CIM to provide an error free manufacturing process. In order to improve productivity in manufacturing, we are trying to interface it with a computer, that is the major advantage of going for CIM. Today, it is not only manufacturing, but it is also documentation along with manufacturing. When I talk about documentation, it is a record on the day of manufacturing on the day of delivery, how is it delivered? What is this performance? All these things fall under this CIM category.

So, here is what, is the generalized definition makes the use of various computer control missionary and automated systems in manufacturing product. It combines various techniques like CAD and CAM, to provide an error free manufacturing process. To reduce the manual labour and automates repetitive task.

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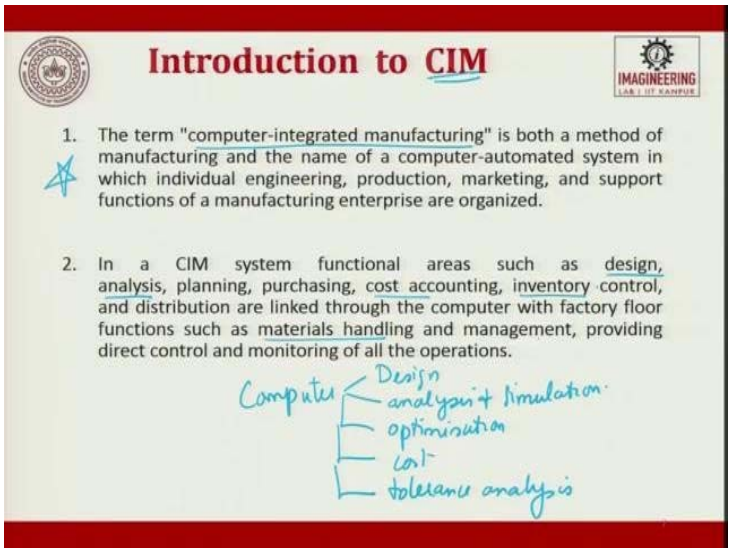

The term computer integrated manufacturing is both a method of manufacturing and the name of a computer-automated system in which individual engineering production, marketing, support functions of a manufacturing enterprise are organized. This is the true definition for CIM. It is both, a method of manufacturing and the name of computer automated system in which individual engineering, production, marketing and support functions of a manufacturing enterprise are organized.

In a CIM system, functional areas such as design, analysis, see using computer you can do first is design, then you can do analysis, then you can do optimization and simulation you can do, then you can do cost analysis, you can do tolerance analysis you see so many things can be done.

So, a functional area such as design, analysis, planning, purchasing, cost accounting, inventory control and the distribution are linked through the computer with factory floor function such as material handling and management. Though we say material handling looks to be a very primitive job, but material handling today plays a very, very important role.

For example, today when you do an online shopping, moment you try to shop and then you transfer the money from that day till the time of delivery you are able to track where all your part is moving, who all is handling it? When is it moving from one place to the other? And what is the likely time you are supposed to get?

So, that is very, very important today, material handling was earlier only delivery it is delivery the right quantity at the right time is material handling today. So, material handling has also

improvised today, so that there is a lot of value addition done here and that also becomes part of CIM system. And Management providing a direct control and monitoring of all the operations today, there are companies where the headquarters is at Delhi and then you have factories at several locations in this country.

So, these people sitting at the headquarter would regularly monitor what is the production going on? What are all the quality issues? What are all the quantity issues? What are all the maintenance issues? How to solve it? Then how do, if a major machine is breakdown, how do people start moving?

Interestingly, we at IIT Kanpur bought a machine, and that machine gives a service that we connect the machine to internet while running machine if there is any problem anticipated, immediately the information is passed on to the headquarter of the company, they try to send us a mail saying that these are the parts which are likely to fail, please take care and then if you have to take care, our services charges this much our replacement charges are this much. So, all these things are now integrated. So, a company sitting across the globe is able to control and talk about our production process very neatly and precisely all these things happen only because of CIM. So, that is what is this major emphasis for this, CIM is integrating various manufacturing sectors. Costing is also part of manufacturing, inventory control is manufacturing, planning purchase, purchase is also manufacturing. So, purchase is also part of a manufacturing segment today.

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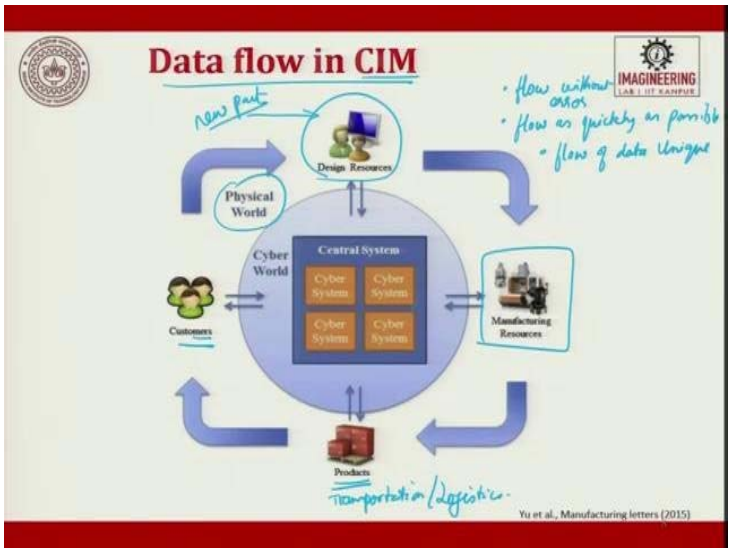

So, if you see at CIM environment, the data flow is very very important. There is a data flow, because of this ease in data flow only CIM comes into existence. Data flow is very, very important when I try to flow the data, what are the major things? I should flow data without error; I should flow data as quickly as possible, I should push data, the flow of data should be unique, that means to say it should not add anything else while the data is getting transferred in before ten years or 15 years when we try to send a mail. So, the mail transmission was never 100 percent. So today, whatever you send through WhatsApp or mail it is hundred percent, why? Because the data flow is now streamlined and the errors are being taken care and rectified. So, if you look at a manufacturing environment design is the first step. So, the design resources are passed on to the manufacturing resources. So, design engineer tries to develop a part and then that part is he converts it into a part drawing, and the manufacturing drawing is sent to manufacturing resources. When the design engineer does when a new part comes into existence a new part. So, the design engineer looks at the part, does a similarity index within his database, and if there is a similar product, then he tries to pull out that product. Then he tries to work on that product and tweak it to the new product design. And from there, they try to give the process plan which is given to the manufacturing scenario; the manufacturing scenario looks into it produces it and then it is now getting shipped.

Today, what we are trying to say is directly from the customer the manufacturing environment is getting what is the requirements? How have they to plan their shifts and execute their shifts? Such that the product is made and shipped to the customer. So, they do not even go to this point. So, if you see that there is a data flow cyclically happening between the design, manufacturing, products, this is basically transportation or inventory or logistics.

So, logistics to the customer it takes care. So, here is a physical world customer to the design. So, here is a physical world happening. So, the data transfer can happen with the central system, and this central system is called a cyber world. So, all these four can talk to a cyber world communicate between themselves or they can flow in one direction, so that they try to transfer data instantly.

Today we are able to enjoy online transaction is only because the data flow happens easily. Sitting in front of a computer you are able to transfer money from the bank to and to shop or a warehouse or to a website from the website immediately it is authenticated, the item is released, the item is then packed and from the packaging it is now done delivery. So, this data flow is the most critical part and the best part of CIM.

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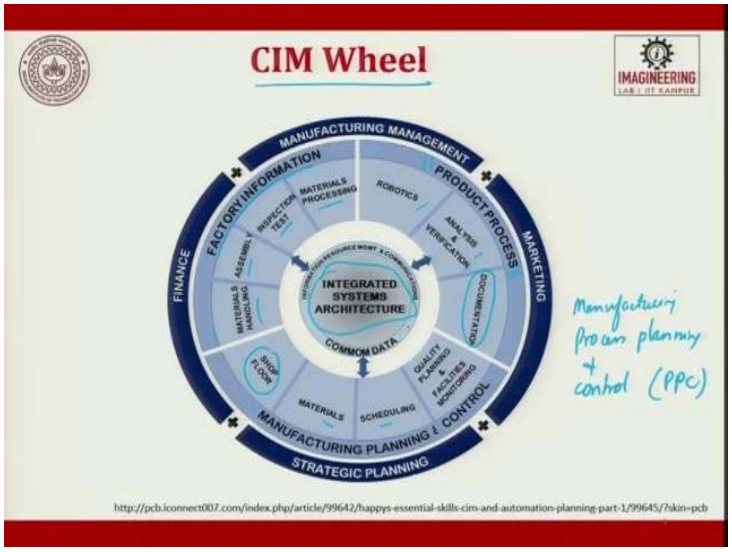

This is a CIM wheel. So, in a CIM wheel, you see manufacturing management, plus marketing plus strategic planning and the finance. So, though you might see all these people are not of manufacturing were in which the part is been touched by them, but they all play a very, very important role in CIM field, manufacturing management, marketing, strategic planning and finance.

In the next level of the wheel, you will see factory information, product process and manufacturing planning and control. Under manufacturing planning and control, you will see shop floor, material, scheduling, quality planning and facility monitoring. These are all part of manufacturing, process planning, and control.

If you look at bookish, we call it as PPC it is all here. So, we talk about scheduling, and predominantly operation research happens here. Though it might look that what is manufacturing here but with this people optimization, logistic control, you save a lot of money. So, that is why they put in under strategic, and then next you see in the inside a

factory, you will have assembly, you will have material processing, you will have inspection station and material handling.

So, all these people are part of manufacturing information, a process wherein which it is product is made, the inspected the produced product is inspected and then if at all there are several parts going to be assembled, then there is an assembly, and there will be a material handling during assembly or before this. All these fellows there is a data transfer has to happen, and that one is manufacturing information.

As far as product related thing, so we work on product process is robotics analysis and verification, documentation. These are the three things which come under for product process. Why is documentation very much talked about today is? Today when you see at any industry that will be the first version of a part, this first version of a part gets improvised. So, then the second version is released, when was it released who released it? So, that is a documentation they hold.

Second thing is, suppose today there is a part which is made from one industry and that gets into an assembly and then finally it goes to a customer. So, if there is a customer defect which comes into existence, they w1ould like to trace back and then find out what was the problem in the part and why did this fail in the service in the customer end. So, those things are called us documentation.

Today, when we talk about car assembly, we are also interested to know which are the machines involved? What is the status of those machines? Who are all the operators? All those information are stored, and that is called us documentation. So, this all these things are integrated at the a central place which is a common data. So, this is called as integrated system architecture. So, this entire process is, or the entire drawing is called as CIM wheel.

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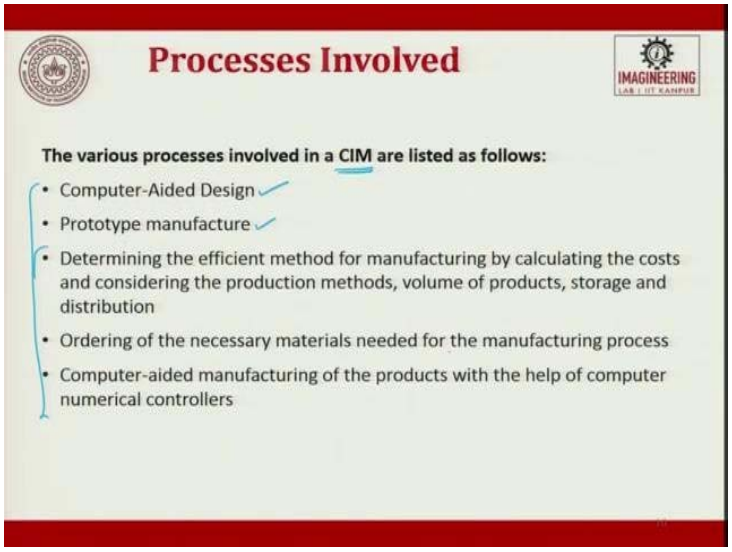

The processes generally which are involved in CIM are computer aided design and prototype manufacturing. So, they are determining the efficient method for manufacturing by calculating the costs and considering the production method, volume of products, storage and distribution.

So, CIM. Ordering of the necessary materials needed for the manufacturing process, computer aided manufacturing of the product with the help of computer numerical controls.

So, all these things these are the various processes which are involved in CIM, computer aided design, prototyping, then manufacturing, then material handling and then the numerical control machines.

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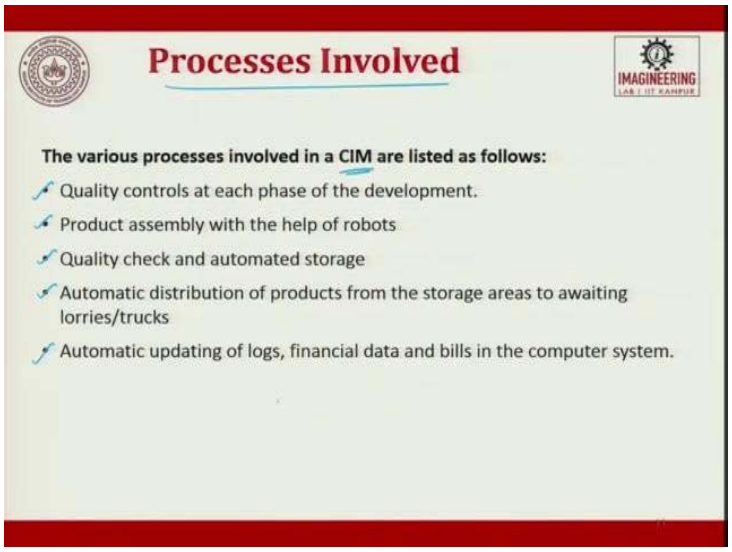

The various processes involved in CIM when we look from the process involved, it is the quality control, product assembly, quality checking, automatic distribution of the product and automatic updating of logs. So, all these things are processes involved in CIM.

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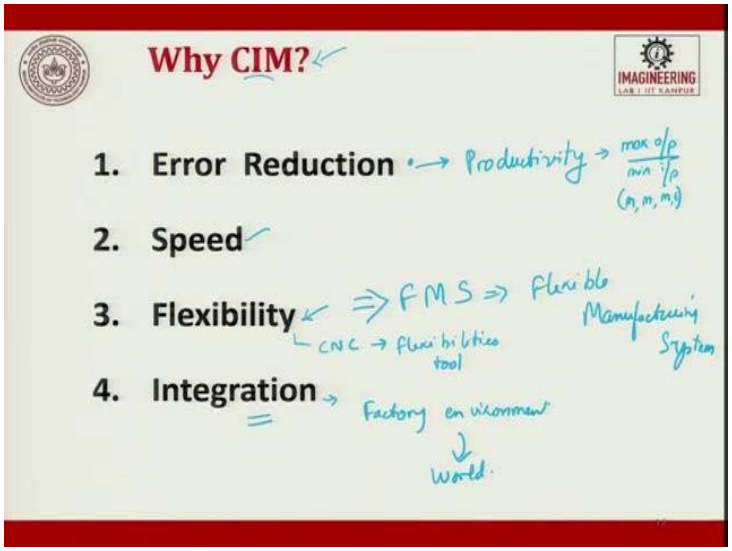

So, why? Finally, when we nail down to CIM is because CIM gives error reduction. So, thus leading to productivity. Productivity is max output by mean input. So, for example, producing maximum output with respect to minimum input means where I am talking about input is man, material, machine and today, people also talk about energy. So with minimum trying to get the maximum production.

So, it also tries to increase the speed of production, when we talked to about CIM, we also talk about flexibility. That is why CIM environment we talk about FMS, which is nothing but Flexible Manufacturing Systems, FMS. So, why is this more important? Because the change over time from one product to the other product they would try to optimize, and they would try to do it very quickly. So, that is why flexibility comes into existence. So, if you talk about a CNC machine, it has flexibility in tools. So, you can make any shape every shape, provided those tools are available in the CNC machine magazine.

Then the last point is integration. I am trying to integrate both factory environment with the world. When I talk about the world is wherein which talks about the logistic control, transportation everything put together. So, CIM tries to give a error reduction; it tries to increase the speed of production; it tries to give me flexibility in the product; it also tries to talk about integration. So, these are the main advantages of CIM.

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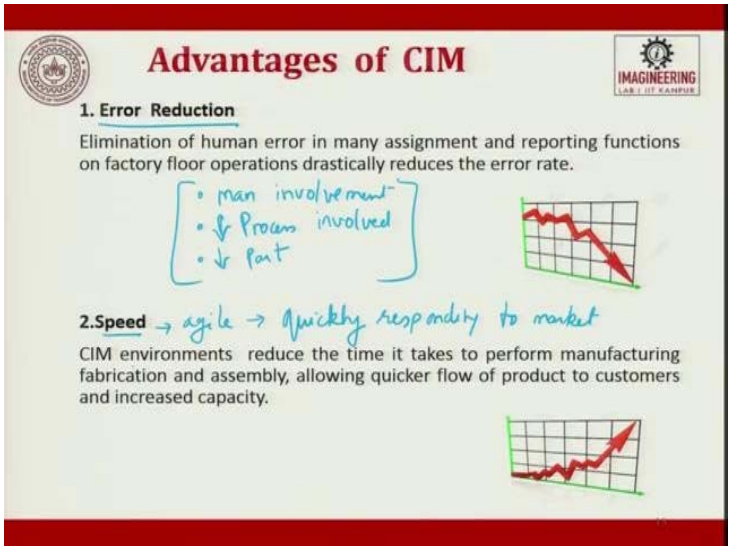

Error reduction, elimination of human error in many assignments and reporting functions on a factory floor, operating drastically reduces the error rate. So, that is why we try to reduce man involvement. In fact, nowadays, we are also trying to reduce the processes involved. So, if we

reduce the part processes, then the number of defects happening in the process are reduced. We are also trying to talk about reducing the number of parts.

So, all these things will lead to error reduction. So, we are talking about human error. So that is what the elimination of human error in many assignments and reporting functions.

Speed: CIM environments, reduce the time it takes to perform manufacturing fabrication and assembly line. So, speed here we are talking about a agile.

Agile means how quickly I can respond to market quickly responding to market. So that means to say when the market there is a change, quickly it is communicated to the factory, and factory people start changing their requirements to meet out to the customer need. So, this is the speed which we talk about.

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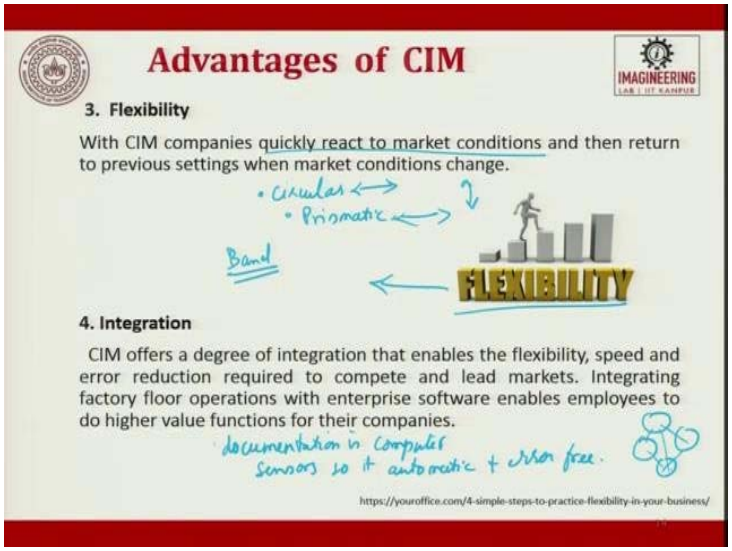
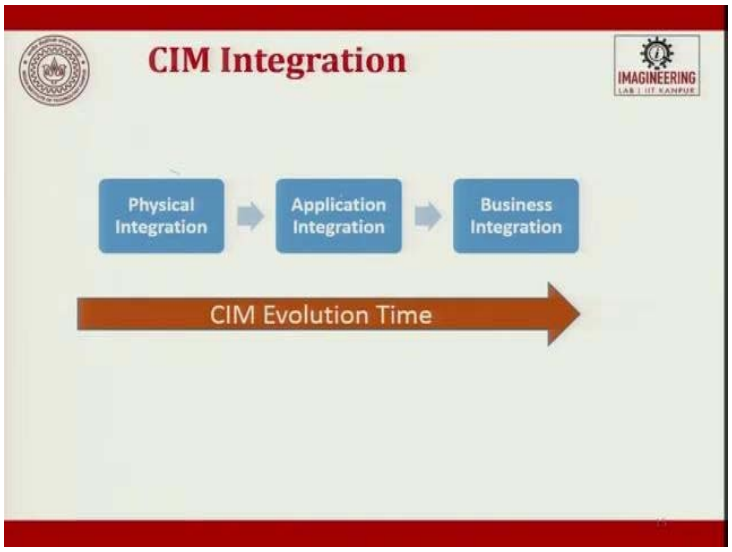


Then we talk about flexibility in with CIM company quickly react to the market conditions and then return to the previous setting when market conditions change. So, flexibility we are talking about. So, here flexibility is within the band. For example, there are circular parts, circular parts, and there are prismatic parts. So, the flexibility will be within prismatic or within circular; it will never be in the vertical.

Of course, today there are five access machine, six access machines, there are two axis CNC machines coming out where in which both the circular jobs and prismatic jobs can both be done in one machine, but generally speaking, the flexibility is within the band, whatever you give, circular shapes, all circular shapes they will not work on prismatic shapes. Integration, CIM

offers a degree of integration that enables the flexibility, speed and the error reduction required to compete and lead market. Integrating factory floor operations with enterprise software enables people to do higher value functions for their company. So, what we are trying to do is, mundane job of documentation is now computerized. Documentation is computerized, and the data is taken from the sensors. So, it is automatic and automatic and error free. So, the integration here means integrating different-different segments trying to talk to each other. (Refer Slide Time: 29:47)



So, CIMs evolution over a period of time, it was first started with physical integration. Then it started with application integration. Today we are talking about business integration. Physical means a wire connection between the two. Application means where wire is not there. Today we are talking about business which come into existence.

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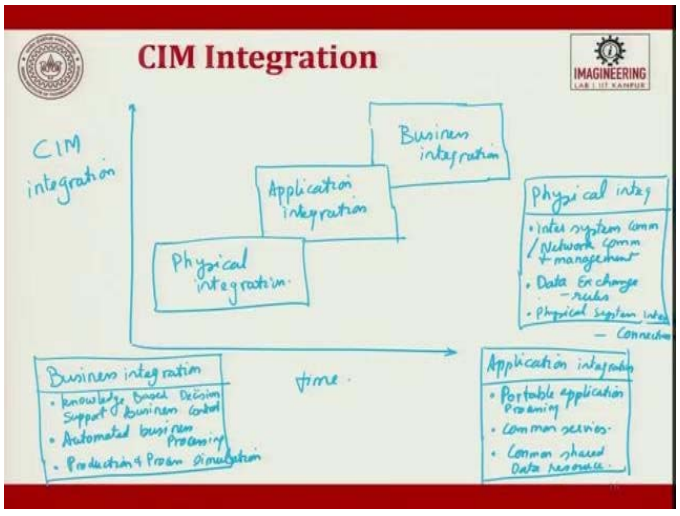

So, if we wanted to make a plot of CIM integration with respect to time. So, it was physical integration; then it was application integration the last one was business integration. In each integration, we will see what are all steps were there. So, let me start from here, physical integration, we were talking about inter system communication. Then we were talking about network.

See all these things; networking is the major thing which happen, network communication, and management. So, then we were talking about data exchange, data exchange, so we today have lot of neutral files. So, those things all started with data exchange, so rules were framed during this time, and then physical system integration, physical system integration happened. So, these are all part of interconnection, physical system interconnection.

So next let us see in application integration what all happen. So, portable applications came into existence. See today you look at the Wi-Fi, what we are enjoying these are portable application processing smart-phone, these are all application oriented, and the enjoyment of smart-phone could happen only because of these application integration.

Then we also have common services, and the last one is common shared data resource. So, these are the things which are under application software. Then last, let us see business integration. In business integration, we are now talking about knowledge based decisions. This is all nothing but your machine learning, artificial intelligence, all these things are part of it, support knowledge base decision, support business control. The next one is automated business processing automated, and so you have here production, production and process simulation. See all these things if you see physical integration application integration, business integration, we do today process integration. So, here I was very much fascinated, or I was astonished when I saw one of my friend who is working for a power generation corporation, he could show in his smart-phone, what are all the different turbines, and what are they generating and what is their efficiency going on? What is the consumption of the power and how are he how is he going to meet it and he was even alerted 12 hours before saying that there is going to be a major power requirement and for which he has to switch on the next turbine for generating. So all these simulation, knowledge base understanding happens at the business integration.