Computer Integrated Manufacturing
Professor J. Ramkumar
Department of Mechanical Engineering & Design Program,
Indian Institute of Technology, Kanpur
Lecture 5
Automation Principles and Computer Aided Technologies

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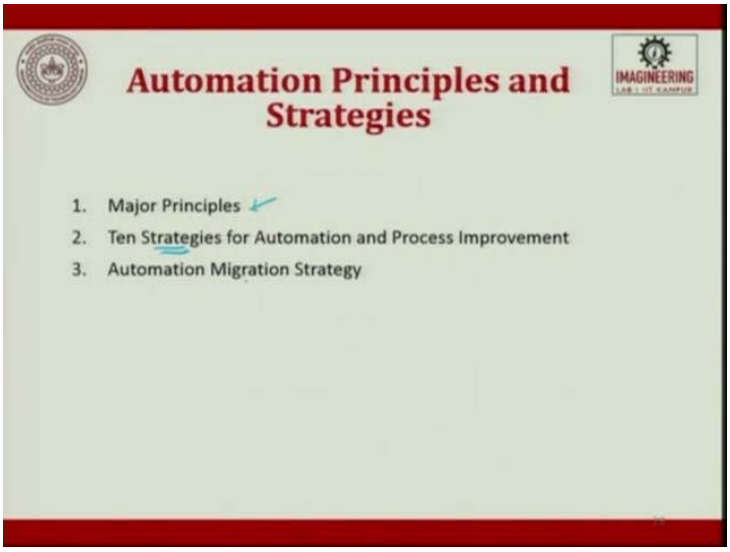

When we talk about automation principles and strategies, there are three things which we will try to cover. One is we have to understand what is the major principle. Then we will see what are the strategies which are generally followed for automation and process improvement. And the last one is automation, migration strategies.

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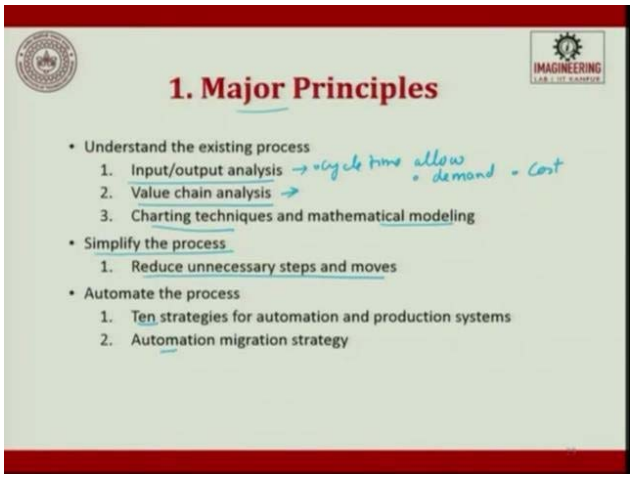

The major principles are, understanding the existing process before doing automation, you cannot directly do automation right from scratch. First thing, you, please look into the existing running factory, look into processes wherein which there is not much of variation and which is really difficult or really dirty or dangerous, look at those processes and see how you can try to automate it.

You cannot go by a strategy that just I have a device, so let me go ahead automating it, for example, producing of plastic cups, the cycle time is hardly one second. If you, if you automate it, it is that you in, in one second you will get a cup. So, if your requirements are only thousand cups if you try to automate it is not going to give you a financially viable model.

So, first, you should understand the process, understand the input-output analysis, do your value chain analysis and then decide whether to go for automation or not. So, in the understanding of the existing process, you are supposed to understand the input-output analysis, that means to say what is the cycle time you can allow? What is that demand for the product?

So, if you know this, then we know that input-output analysis, what is the cost you can give for example if I put a robo and make a plastic tumbler or a coffee cup thermoform coffee, coffee cup if I do putting a robo, it is an over killer. So, these are the output analysis then value chain analysis, at each stage, what amount of value is getting added to the manufacturing process and what is the costing which is getting done. So, if you do it manual and if you automate it, what is the difference? So, that's what is value chain analysis.

Last one is charting technique and mathematical model; you have to see what is the variation which is coming up while executing the process. So, all these things are understanding of the existing process. Then what we do is simplify the process, for example, if I am trying to write using this pen, so what I have to do is, I have to move my hand. So, the fingers only two fingers move, and then I start writing. So now, I should see how can I develop these two fingers with minimum amount of link and gives a better control for writing. So, here I will try to see the existing process, simplify the existing process and then I will try to reduce all the unnecessary steps and movements. So, then I will try to look forward for automation. So, automate the process. So, the major principle is understanding the process, simplifying the process and finally, I will go automating the process.

Automation is not the only solution, please keep it in mind when the cycle time is very low, and your demand is very high the quality required is very stringent, then you go for automation, full automation or you go for semi automation. So, costs and demand both are to be looked for.

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So, when we try to automate the process, there are strategies they have given ten strategies we will start discussing and the last one is going to be automation migration strategies. The ten strategies which are generally followed for automating the process or the equipment. First thing is it has to have a specialized session of the operation.

Wherever you can combine the two operations, you can think of automation, wherever there is a specialization required, you go for automation; wherever there is a combined operation go for automation; where you can do simultaneous go for automation, where you can integrate, combine and integrate are two things, combined is joined, increased flexibility, improved material handling and storage is part of automation.

Online inspection is one another strategy, process control and optimization. Process online inspection is one; process control is you try, you try to draw a chart, and then I tried to find out the process capability index and process capability, and then you try to do plant operation control and computer integrated manufacturing, manufacturing are the ten different strategies which are followed for doing automation in process improvement.

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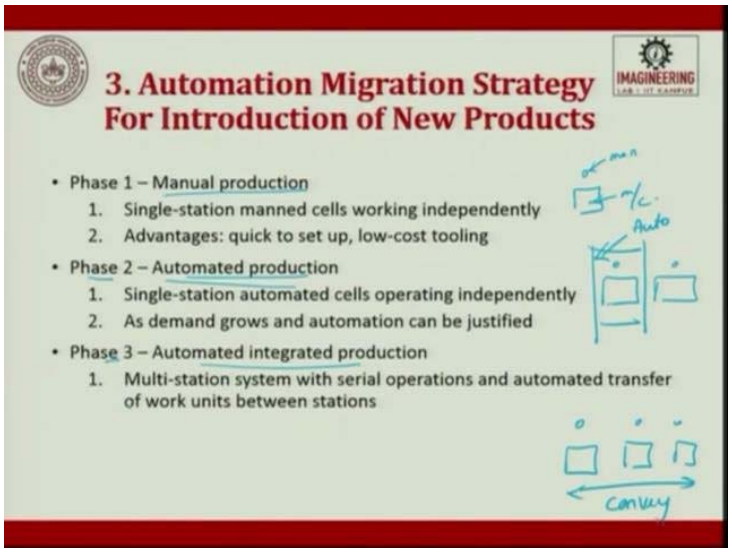

The last one is, when we talk about automation migration strategies for introduction of new products, phase one, we try to do manual operation, then phase two we try to automate the production and phase three we try to automate integrated production. Under manual production, we will look at single station manned cell working independently. So, one man one machine, so this is man, and this is machine.

So, the advantage is going to be, the setup time is going to be very fast, and the costing is going to be low. So, we are trying to move from one strategy to the other strategy automated production. You have a single station automated cell operation independently so, you have so, this fellow alone is automated. So one cell automation single station automation. So, here it is man and machine, so it is man and machine, and here alone it is automated.

The last one is going to be man, machine and it is completely moved by a conveyor, it is multi station operations, serial operations and automated transfer of work units between stations. So, phase one, phase two and phase three.

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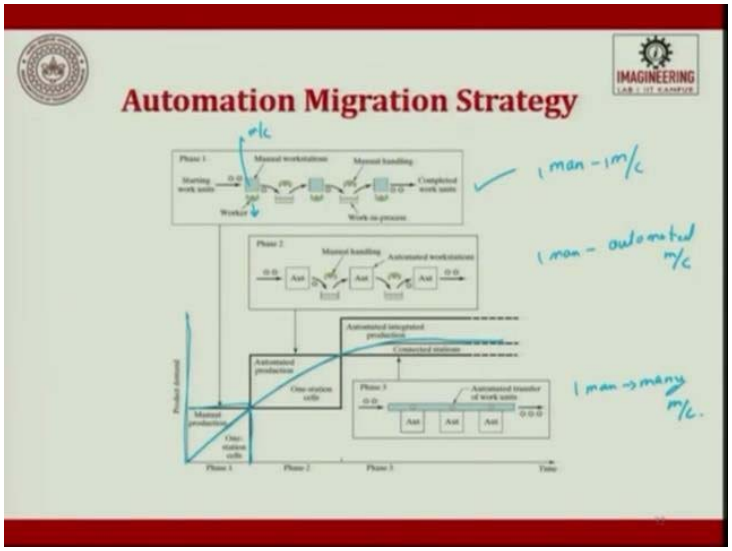

So, this is what is phase one wherein which you can see manual workstation; the jobs are here. So, there is a worker, so the worker does the job can push us the job to the next worker. He does some job push to the next worker, next worker, next worker, so here it is completely machine there and then worker. So, worker is trying to do the job, and the job is moved from station to station.

When we talk about phase two, it is an automated machine. So, the job comes here the process happens in the machine, then it comes to him. So, he handles it, manually puts it into the other machine, then he handles manually and puts it to the other machine you get an output. So, if you look at it, when we talk about product demand versus phases. So this is manual operation or one man station. So, this is called as man-machine, one man one machine. So one man, automated machine, here it is one man and many machines.

So you can see there product where I demand, and if you see time you, you see here there is a graph which goes and gets saturated. So, when it comes to manual operation happens at one man machine, when one station operation it is called us automated inspection and then automated production and then it is automated integrated production is wherein which there is a connection a conveyor which moves, and there are several machines which are there. So, the job comes here automatically it gets work done there and then puts back into the conveyor the conveyor is moved. So, this is manual; this is man machine, this is man automated machine, here it is automated machine and man is not there. So, these are the strategies.

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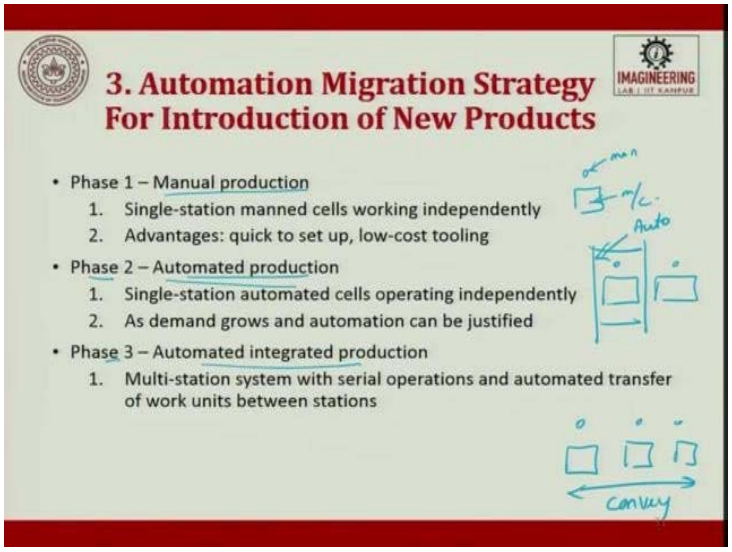

So, we have automation migration strategies from manual we will go to automated from automated we will go to fully automated.

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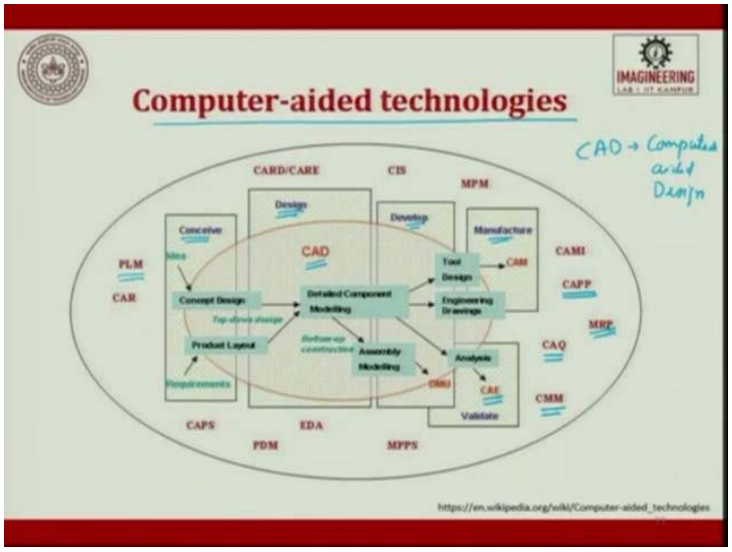

So, when we talk about computer aided technology, where all computer is used today in manufacturing system you can see here first, it is used in CAD. So, CAD is nothing but computer aided design. People initially, when they started, they called it as drafting, now we call it as design. The difference between drafting and design as drafting, we only draw, in design we draw, and also we try to optimize, we do simulation, and we optimize.

So, what all is done in here, we do conceptual design, layout, we try to do detail component modeling, assembly modeling, tool design, engineering drawing and analysis. Moment we say analysis comes Computer Aided Engineering. This is basically to validate, so you can see here so CAQ, computer used for quality control. So, quality control, one is for what data to measure, measured data to be stored and measured data stored to be processed.

Materials requirement planning, we use computer law, computer aided process planning. So, in manufacturing nothing is a unique route. For making a product there are multiple routes to be made. So, multiple processes to be involved, for example, if I want to make a shaft, I need only one shaft I cast it, I need 10 shafts I machine it, I need hundred shots I metal form it. So, process plan is very important and storing the process plan is important, why? Today's scenario is you draw a component from the component features are extracted and the process plan is laid out. So, this is what is computer aided process planning. So if you look at it, computers are involved in conceiving stage, in designing stage, in developing stage as well as in manufacturing stage. When we talk about manufacturing, you have computer aided quality control, coordinate measuring machine, all these things come into existence. When we look at conceiving, we look at product lifecycle management.

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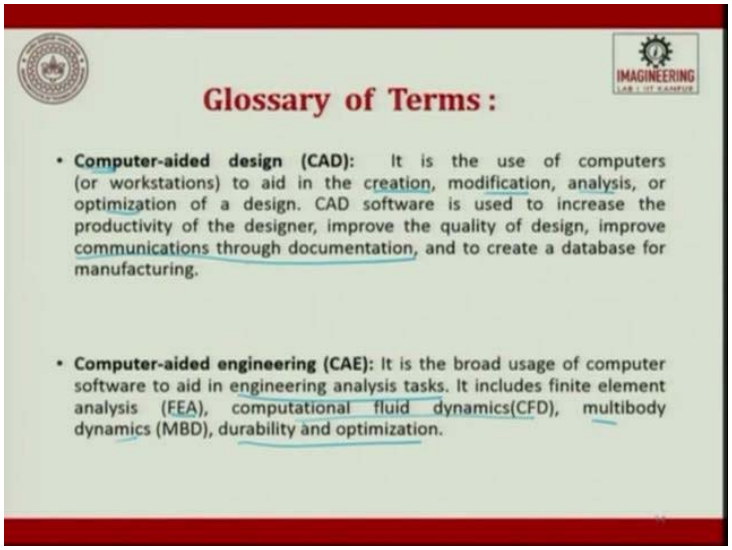

So, we have put all the glossary here. So, we will see the glossary one after the other for each terminology, when we talk about CAD It is nothing but computer aided design, it is use of computers to aid in that creation, modification, analysis and optimization of design you create,

you modify or edit you analyze and then you optimize the design. So, that is all done in CAD today.

CAD softwares is used to increase the productivity of the designer, why because he can always use a library function whatever he has created for prior he can pull it up, start working on it, edit it and then generate it, improve the quality of the design, improve the communication through documentation and to create a database for manufacturing, communication through the documentation is very important. When was this drawing made? When was it edited? How was it edited? Who edited? What is the need for editing? And today, what is it all these things gets documented when you start using a computer. Manually there is a possibility we might miss out. So, that is what is the major importance of computer getting participated in CAD.

The next one is CAE, CAE is nothing but Computer Aided Engineering. It is the broad usage of computer software to aid the engineering analysis task. So, what are the analysis tasks we do today? Finite element analysis, computational fluid dynamics, multi body dynamics and then durability and optimization are some of the analysis which we do on a product before it is getting produced. So, it is nothing but basically CAE is plays important role in validation.

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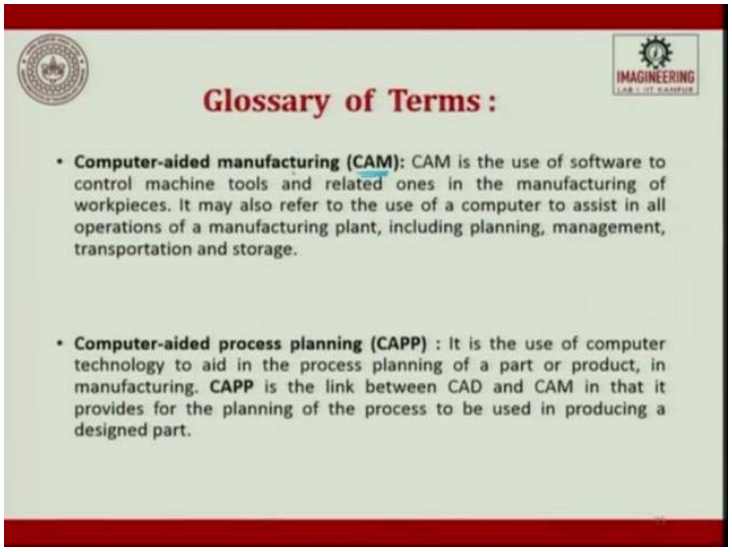

When we look at CAM, CAM is nothing but computer aided manufacturing.

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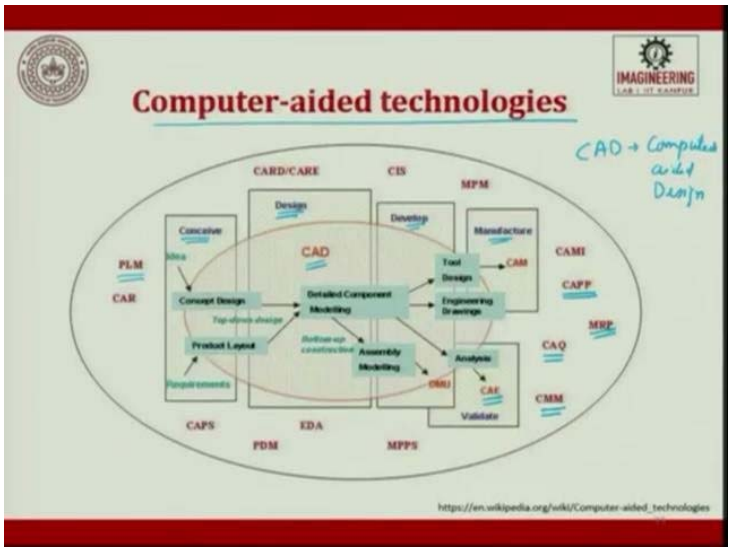

So, if you go back and look at it we have clearly stated four stages. So, or five stages, conceive, design, develop, validate, manufacture,. So, when we talk about manufacture comes CAM.

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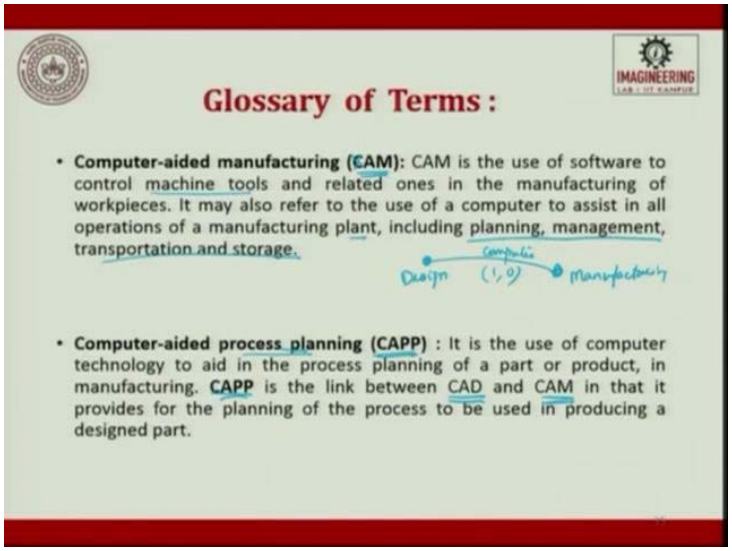

So, CAM is use of a software to control machine tool and relate once in the manufacturing of work pieces. For example, in CAM you can write you can draw a component and then generate a G code wherein which that can be used by the CNC. It may also refer to the use of a computer to assist in all operations of manufacturing plant including planning, management, transportation and storage. So, computer plays a very important role in CAM.

If computer would have not been there today, this amount of very variety of products, let it be consumer, let it be automobile, let it be in rocket science, we will not have so much of variation, and today what is happening is you have companies sitting here, and dot of the world and the manufacturer happens in the other extreme. So, here is design happening and here is manufacturing happening and these are two different parts of the world. We are able to do it, it is only because of computer which uses binary as a language to the store and retrieving data.

Next one is computer aided process plan as I told you, process planning is very important depending upon the output, you try to decide which process to be chosen. It is the use of a computer technology to aid the process plan of your part or a product. Today process planners are scarce available. So, they, process planners, they get their knowledge and skill over a period of time.

So, they acquire the skill over 20 years of working. Today, such services cannot be utilized by all of them. So, now, what has happened is computers have converted all their skill whatever they have, and they have integrated artificial intelligence and neural network. So that now if you give a feature it can extract and tell you what all possible process plans can you think about it, then a human has to intervene, edit based upon the drawing or sequence availability of the material and make a process plan in manufacturing. CAP is a link between CAD and CAM in that it provides for planning of a process to be used in producing a design part.

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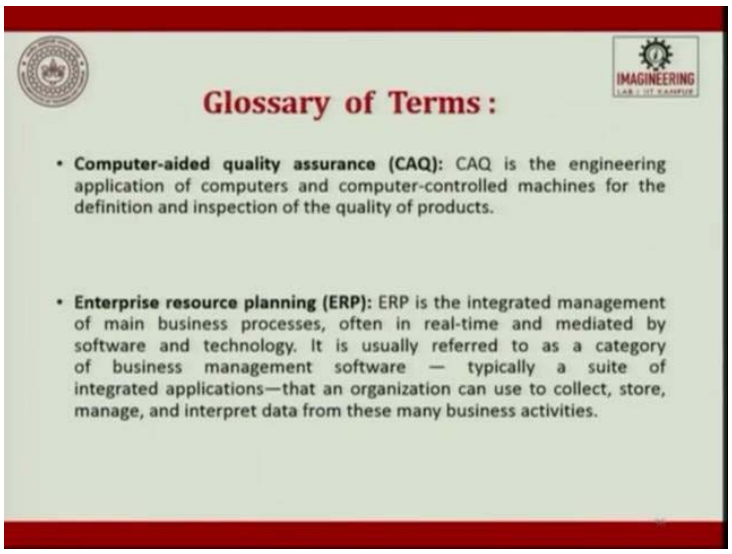

The next one is CAQ, CAQ is nothing but computer aided quality assurance, quality is nowadays inbuilt in the product. So, assurance is something when I buy a product in the market I am assured that it is supposed to perform what it is expected. So, CAQ is the engineering application of computers and computer controlled machines, for definition and inspection of the quality of the product.

Next is ERP, ERP is, is a set and in which you have MRP two then you have MRP one, all these things are there. So, this ERP is a superset. ERP is nothing but enterprise resource planning is an integrated management of main business processes, often in real time and mediated by software and technology; it is usually referred to as a category of business management software. Typically a suite of integrated applications that an organization can use to collect, store, manage, interpret data from these many business activities, ERP includes planning of machine, man, money to meet that requirements.

So then comes the money, so money I am integrating it with time also. So machine, planning the machines, planning the material, planning the money, and when I say M here, so you can also add one more for man. If I make it as material, so machine, material, money and man, so, all these things how do we use, where do we use, when do we use, how do we plan such that we have a higher productivity all these things could be done today because of ERP. Here also computer plays a major role in manufacturing scenario.

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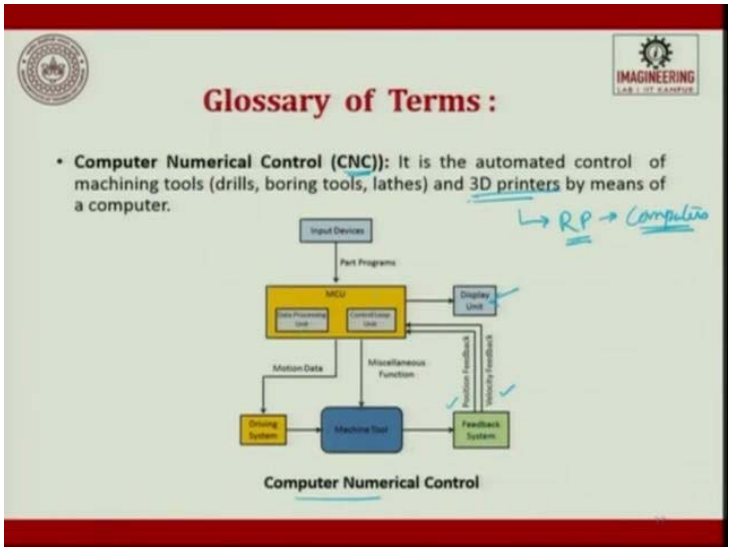

Then, if we look at manufacturing, under manufacturing comes numerical control machines, which are automated machines programmable which gives you the flexibility of writing a program to produce an output. So, if you look at a CNC machine schematic diagram, you will see input device, you see a machine control unit wherein which data processing unit and control loop unit is there, then you will have a display, you have three systems one is for motion data, the other one is for miscellaneous operations and feedback. So, feedback can be in terms of position and velocity.

So, all these things computer is used to show process and simulate is done. So, today the 3D printing where in which we talk about rapid prototyping also today we use computers. If computers would have not been there, rapid prototyping will not even exist. So, these two are important keep it in mind later we will see in detail. Positional feedback and velocity feedback are the two feedbacks which is given from the machine go back to the MCU to operate on it and control.

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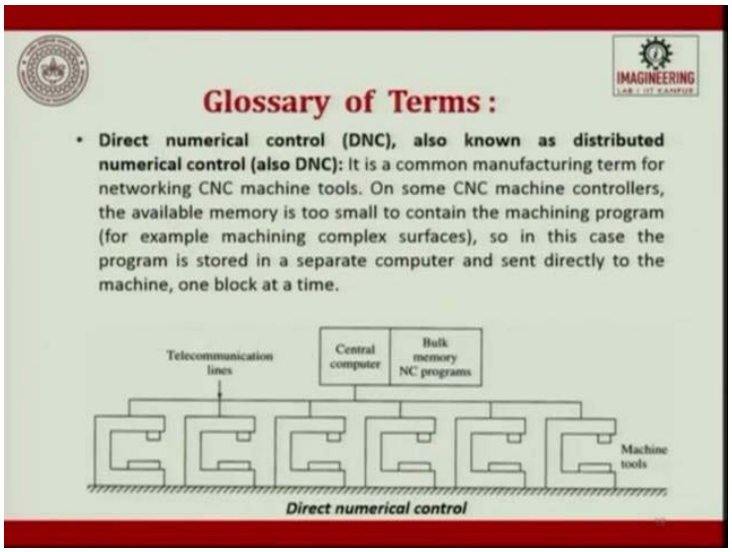

The next one is direct numerical control or it is called as distribution numerical control. So, here you have several machines, these machines are all centrally connected to a computer and in this computer you have a huge memory. So, every part after finishing certain processes will put a request through the transmission line to the central computer which will go take the knowledge what is required in processing the part, puts it back into the central computer, computer to transmission line or telecommunication line and then it comes to the machine.

So, several machines are getting connected to a computer. This is possible when we have to make complex parts or features. One, is a common manufacturing term from networking of CNC machine tools. On some CNC machine controllers, the available memory space is too small to content the machine program. So, in that case the program is stored in a separate computer and it is sent directly, it is otherwise called as Direct CNC machines where line by line or segment by segment can be pulled.

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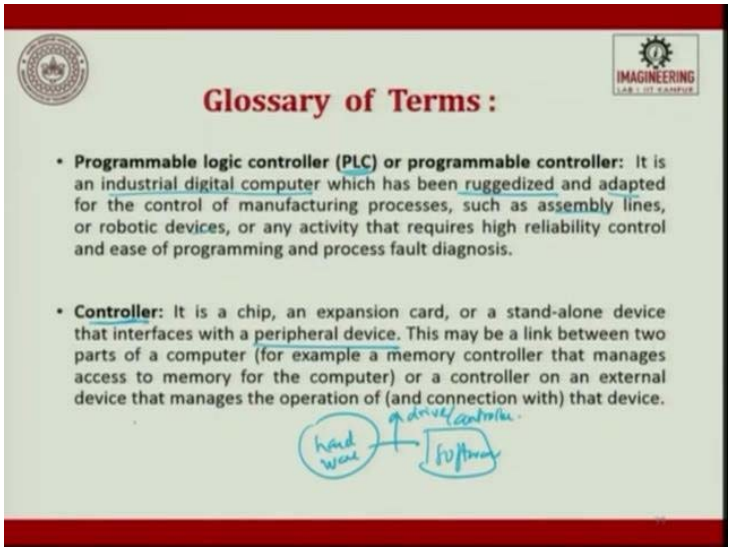

Again here, computer plays a very important role. When you look at the computers which are getting into automated machines. So, you will also have something called us program logic controller. So, this is also important part of a computer control. It is an industrial digital computer which has the ruggedness and adapted for control of manufacturing process, such as assembly line, robotic device. So, it is your industrial digital computer.

So, here in which you can count, you can put timer delay, you can sequence the operation and get the operation done. So, here in which again it is computer used controllers. It is a chip, an expansion card or a standalone device that interfaces with a periphery device. So, you have hardware and then you have a software. So, between this you have something called as a drive or a controller. So, this may be linked between two parts of a computer or a controller of any external device that manages the operation.

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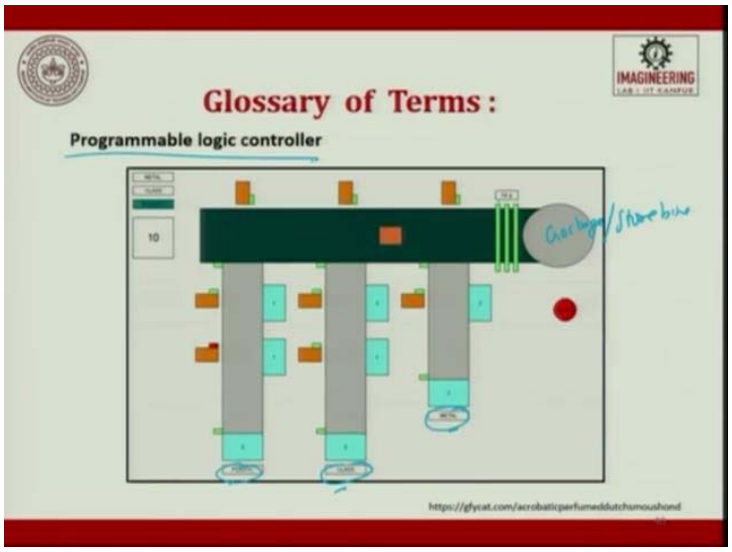

So, this is how a program logic controller works. So, you can see here an object moves. So, it is now pushed into. So, let us assume these are all plastic glass metal. So, let us assume that there is a garbage or store bin. A part comes in the controller, so, it is now looked by a sensor. So, then it identifies what is the part, moment it is identified it is communicated to this hands, automated hands these automated hands quickly identify and then push it into it. So, now, basically what happens you will have all metal parts stacked here, all glass parts stacked here, all plastic parts are stacked here. So, this entire sequence of operation is done by using a programmable logic controller.

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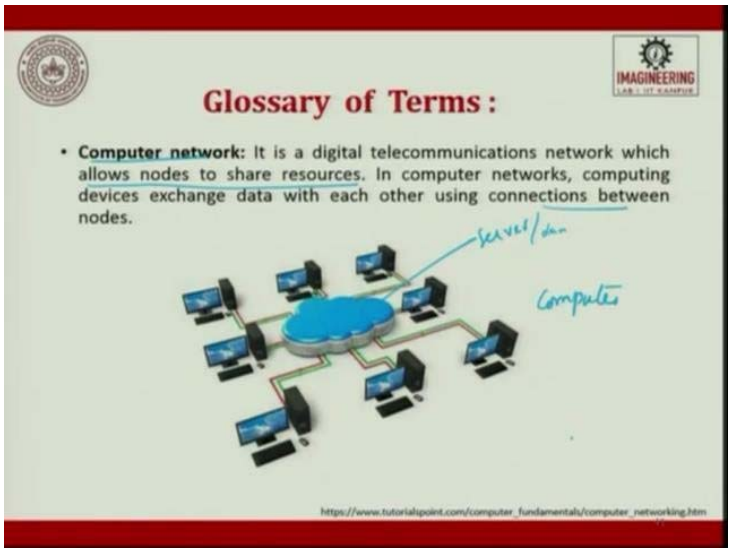

So, when we talk about networking today between several machines within your factory, outside a factory, within a country, outside a country across the globe, there is a networking done. This networking could happen and computer to computer communication. So, let us main server, so, you have so many computers attached or your LAN which is getting connected. So, you see in the digital telecommunication network, which allows nodes to share resources, so it can share resources, it can pull, get information, solve the problem and then communicate to the machine. So here allows nodes to share the resources. So in computer network, computer devices exchange data with each other using the connection between the loads. So, all these people could talk to each other because of the existence of a computer. So computer plays a very important role in manufacturing.

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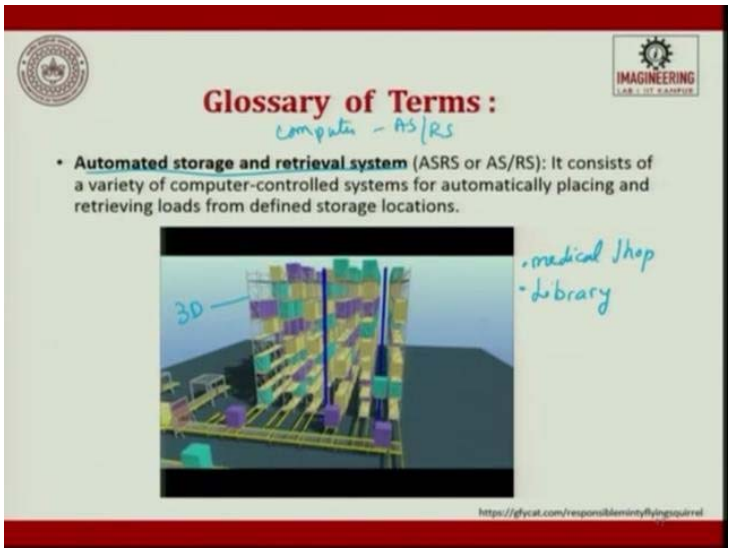

So, when we talk about automated storage and retrieval system, this is what I gave you an example of a medical shop or a library I was talking to you about. So, if you see here, there are three dimensional, these are all three dimensional arrays, which are there. So where in which the material is stored here. So, moment you a new material comes in or this is a shuttle so the part comes and puts on the shuttle. So, then you can try to take it for the production or you can also try to store it for warehouse. So, here it consists of a variety of computer control systems for automatically placing and retrieving load from a pre-defined storage space. So, for this also computer plays a very important role. So, computer involved in ASRS, ASRS is automatic storage and retrieval system.

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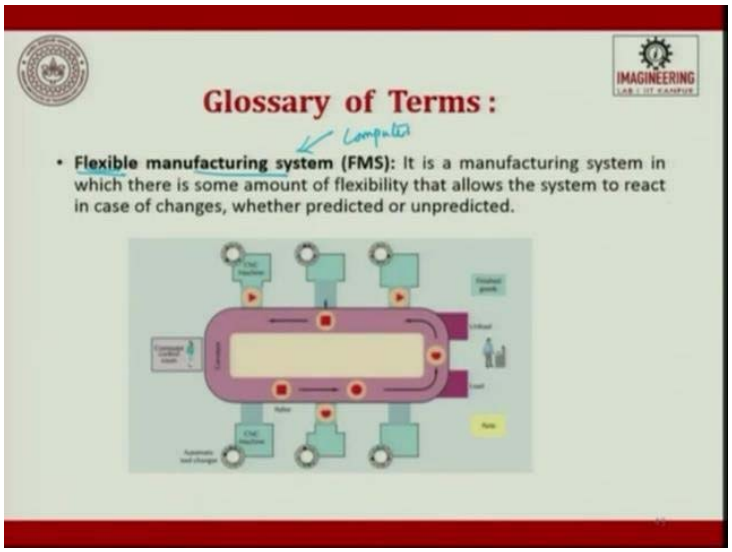

So, then when we talk about flexible manufacturing system. So, here again computer plays a very-very important role. It is the manufacturing system in which there is a small amount of flexibility that allows the system to react in case of changes, whether predicted or unpredicted. So, if you want to do small variation in the product and small changes, we can do and that is why we call it as flexible. If flexible has to be introduced in manufacturing system, you need a computer. So, I am just trying to emphasize, where all computers are used exhaustively in manufacturing system, such that we are leading towards the better and a higher productive environment.

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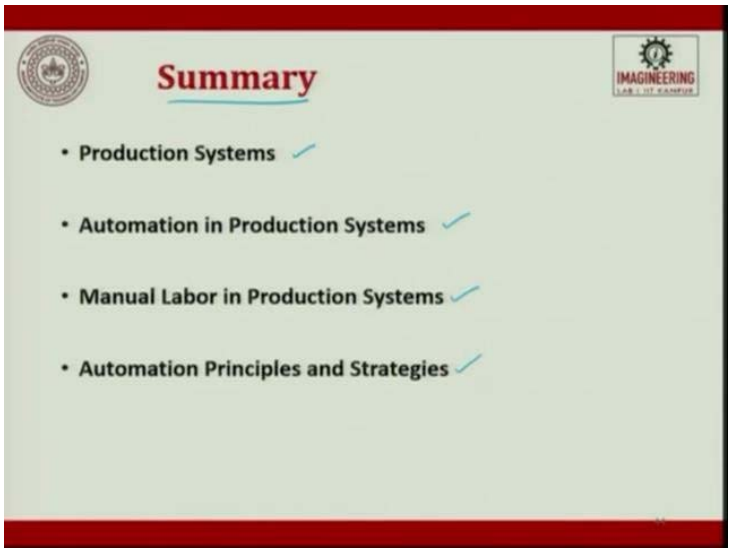

To summarize, what all we covered in this particular lecture is, we discussed about what is production system, what all our parts of a production system, then what are all the automations which can happen in a production system, manual labor in production system and then finally we were looking into automation principles and strategies. You would have now started understanding the need of a computer and how is that used inside a factory and in a factory, what are all the levels where computers can be used.

When we talked about the manufacturing system, we were talking about enterprise level as well as in factory level, at both places computers involvement is very much required in manufacturing. Thank you very much.