Product Design and Manufacturing
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Lecture - 30
Computer Integrated Manufacturing (Part 1 of 2)

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The topic of discussion is going to be Computer Integrated Manufacturing because of the innovation or invention of this computer life has become very easy. Today we enjoy digital world, we digitize the document; the document when it is digital

- it is easy to store,
- it is easy to retrieve,
- it is easy to edit.

So, it is all happening because of computer. So, once the computer start getting integrated into manufacturing then there was or there is a revolutionary change which is happening in the manufacturing segment or sector. So, this discussion is more focus towards computer integrated manufacturing.

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We will see introduction to CIMs, then

- Elements of your production system,
- Automated manufacturing system,
- Automation strategies,
- Metrics in production system,
- Advanced automation functions and
- Finally, the integration of CAD and CAM together

which leads to CIM. So, we will see all these topics, this is very-very relevant and it is the need of the, our topic for the youngsters to understand and start using computers more in manufacturing.

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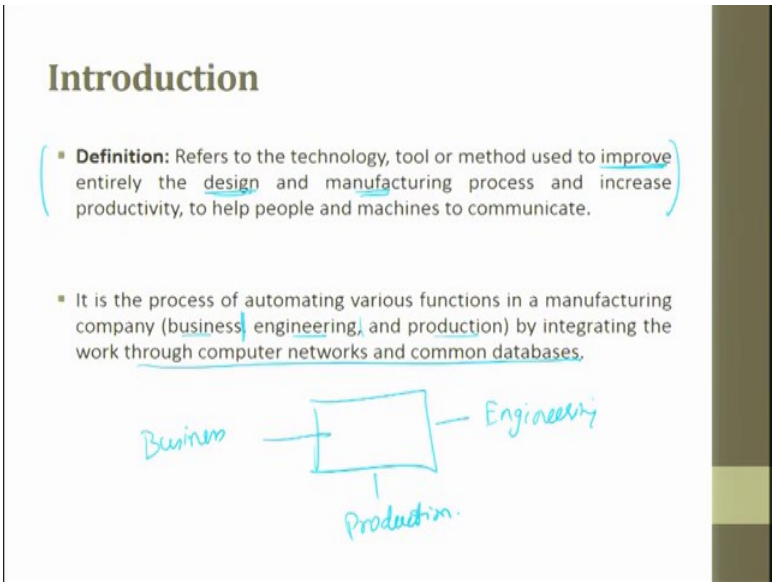

- ✓ The definition for CIMs is referred to the technology tool or method used to improve entirely the design and manufacturing process and increase productivity to help people and machines to communicate.

So, this is the definition which is given. So, it is the technology tool or method used to improve entirely the design and manufacturing process, when you talk about design today there is a difference between design and drafting.

- Drafting is only to draw whatever you have physically you just draw on a piece of paper and you can also do it virtually that is drafting, what is there I look at it and then I mess up the dimensions and draw, what I have in mind I draw. So, these are drafting;

- Designing means there has to be a calculation involved, there has to be an optimization involved, there has to be an iteration involved. So, we try to take for example, you decide to use a nut and a bolt in an assembly.

So, first you have to decide what size m1, m2, m3, m4, which one to choose and how do you fasten. So, for that we have to do the design and today what is happening is the software whatever are available today gives you a wonderful support for designing and in the same way when you try to draw a part and then leave the option to the computer itself, it uses artificial intelligence, it uses expert system, it uses genetic algorithm and

looking at the component, looking at the tolerance, it is now suggesting the list of all processes which are to be involved in making it. It is not only the process it is also the sequence of process, it is also saying this in the manufacturing process. So, that is getting completely redefined, computer has to have the data and then you will use artificial intelligence, decision table, decision tree to store all the data and then start making it for the real time use.

So, the method used to improve entirely the design manufacturing process and increase productivity. So, the life cycle, the designing cycle time is reduced drastically when you start using computer and help people machines to communicate in a standard fashion and in a best fashion. This is the process of automating various functions in manufacturing company like business, engineering, production. Business is the customer and outside world, engineering is the design whatever happens and manufacturing is a production by integrating the work through a computer network under common database. So, you have a common database where in which business people are attached, engineering are attached and production are attached.

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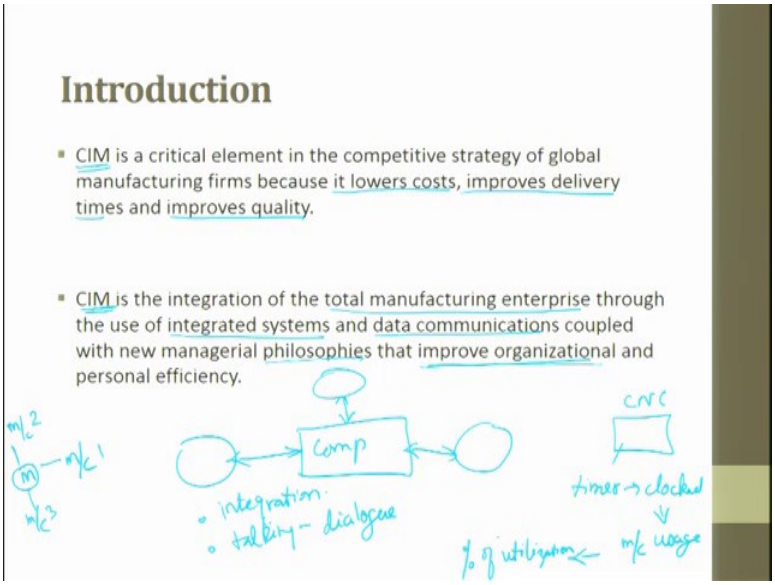

CIMs is a critical element in the competitive strategy of global manufacturing firms because

- it lowers the cost,

- improves delivery time and
- improves the quality.

So, moment as the company starts using CIM. So, the cost is reduced because you do not have to do several iterations. Now today you do optimization of design, you do simulation, understand the part, iterate the part and even the first part what you manufacture will be the original part live part which is used for application.

So, when we start using it when CIMs environment are used, the cost goes down, the delivery time is also more and more. for example, every project when we start we talk about milestones and along with the milestones, we also try to talk about the time frame. So, now, you are able to talk more about the delivery ,the time frames where in which the project is executed and when will you meet out the output and it also tries to talk about improved quality which is their in the product. CIM is an integration of total manufacturing enterprise through the use of integrated systems and data communication.

So, what it is clearly stating is you have a computer, you have several systems and now you should understand all the systems must have a common language to talk, first of all it is integration and the next one is talking. First one is to integrate, integrate can be on off that is all, but once you start talking that is a dialogue then it means to say you are receiving, you are taking the data, you are understanding the data, giving back what was the query raised. So, if this happens so that is what is CIMs. So, a use of integrated systems and data communication coupled with new managerial philosophies that improve the organizational and the personal efficiency, that is CIMs.

You have a CNC machine, the CNC machine has a time or a timer. So, this timer is clocked for the amount of time the machine is used machine usage. So, everyday you can try to find out what is the efficiency of utilization, if you know the percentage of utilization then if it is low or high we can start loading this machine or trying to train the operator or trying to modernize or make some attachment such that the productivity of the CNC machine can go high as well as the personal involved his efficiency also can be calculated.

So, if you understand where the problem is then you can try to solve the problem. So, to understand the problem, moment it becomes computerized, you are able to track most of

the events which are happening. So, that is what it is told up to improve organizational and personal efficiency, organizational is earlier we used to talk about man-machine. So, one man-one machine. So, now, what is happening one man-two machine, now people since they know how to optimize the time and other things. So, a single man is used to operate three machines. Now you see there is an organizational change and then there is a personal efficiency also recorded and improved. if you want to do all these things you have to have a CIMs environment.

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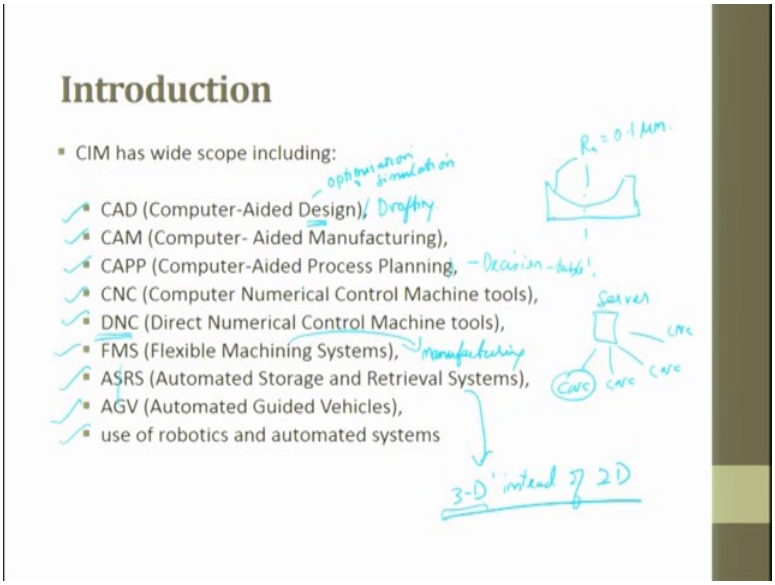

CIMs has a wide scope including CAD. So, when some company says we are a CIMs based company or our company follows CIMs environment then; that means, to say they have computer aided design, there is a difference between design and drafting. So, design is more of optimization and simulation, next is Computer Aided Manufacturing CAM, computer aided manufacturing, the third one is computer aided process planning. So, if you look at a part and then please see it is a small offset I have given here. So, it starts from here and it goes.

So, what is a part? Let us not worry about it but I have given an offset. So, now, this part has to be fabricated. So, moment you draw and then you say the Ra is nothing is roundabout 0.1 micron. So, now, the challenges by looking at the drawing then the computer itself goes back and it iterates and it finds out which process to be used or it gives you a guidance, which process to be used so that the process planner can quickly

take, it may be he has to iterate it little bit, but at least the starting solution is given to him so that he can start working on it.

Here the component is offset so, when you use lathe machine you have to be careful. So, these details will be given by the process plan for this to establish you should have a standard database. So, that standard database should look at features, first it has to recognize features and then each feature has to be linked to the process and it should have the data and by and large people try to use decision table to store the data. Next one is computer numerically control, machine tools CNC is also part of CIMs when there is a single server, a single server and you have more CNC machines attached.

- So, then it is called as direct numerical control machines because if you have a complex job and the program runs for 10000 lines, there are parts in turbine blades in aerospace industry, turbine blades machining of a turbine blades including machining of a very small nozzle or very small parts where in which there are 1000 lines, 10000 lines program.

So, all the program cannot be stored in the memory of the CNC machine. So, what they are do is they try to couple up segment and segment of the program and it is executed and it is transferred back to the main server. So, when we start doing it is called as direct numerical control machines and today people have gone one step ahead and they say that if any of the machines are free and then what they do is they try to find out what is the capability of the machine, the program from the server is dump on to the CNC machine which has the capability of producing a part. So, the program is dumped and then the machine utility is increased, for that they also try to use direct numerical control machine tools. It is only one computer assisted or computer attached numerical control machine in direct is several of the CNC machines are attached to a server and you start using it.

The next one is flexible manufacturing system, it can be called as machining system or it can to be more generic, it can be called as manufacturing system, manufacturing system. And then we have ASRS which is the Automated Storage and Retrieval System, people have realized the need to go for 3D space instead of 2D space. So, if you look at a medical shop, if you look at the mall. So, the they utilize a 3D space look at a library if the library all the books have to be stored and kept in a place if it is only 2D it occupies lot of space.

So, 3D is now talked about. automatic store when you moment start using 3D and there are lot of racks in it then comes the system of automatic storage and retrieval system. Then moment you have this automatic storage and retrieval system, then once the item is retrieved it has to be moved to the required space for that automated guided vehicles are also used today they are AGVs. So, AGVs are basically used to transport material from one location to the another location, it can be loading station, unloading station, CNC machine it can be a central store, ware house.

So, it is a automatic machine, driverless machine which is operated with or by a computer control in a central location or by a server. So, AGVs are also thought of, when somebody says I am using the CIMs environment it is also understood that they are using automated guided vehicles and the last the robots are used for some of the operations and for example, like hazardous operations painting, welding, heat treatment, nuclear, a dirty environment ,the our robots are used and it can also be used for automatic system. So, it can be used for storing and retrieving.

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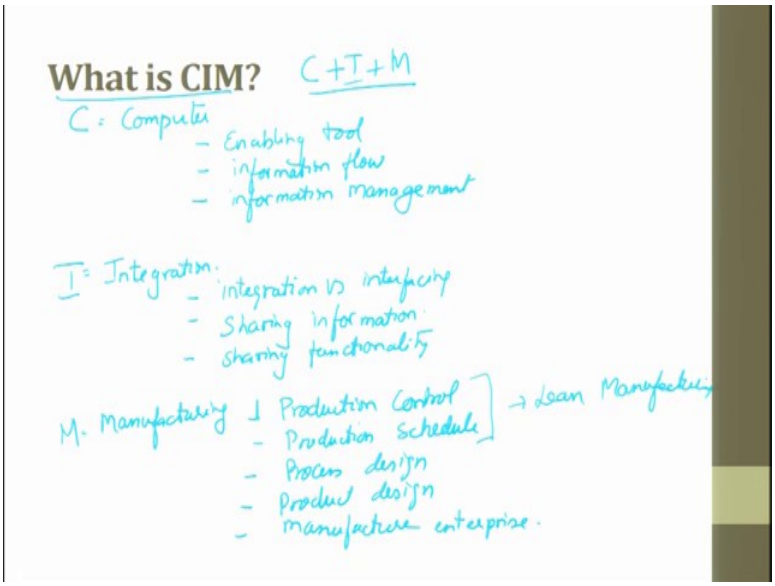

So, let us see what is the expansion for CIMs. So, the CIMs C, I will divide this into three parts I and M.

What does C represents?

- **C** is for Computer which does it is an enable, enabling tool, next one it is it helps in information flow, the next one is it helps in information management.

- **I** stands for Integration or integrator. So, it tries to do integration versus interface, both it does and then it helps in sharing of information this integration and it also has sharing of functionality.

- **M** stands for Manufacturing. So, manufacturing is production control. Then it is production scheduling then it is process design.

These are some of the functions and it is product design and then it is manufacturing enterprise. This is what CIMs is all about, a computer is an enabling tool which is used to enable, to its an enabling tool which is used for connecting, then integration has two things one is interfacing and integration they are different interface and integration are different then sharing of information ,sharing of functionality that is all part of integration and manufacturing this production control production schedule because today we talk about lean manufacturing. So, where this place a very-very important role.

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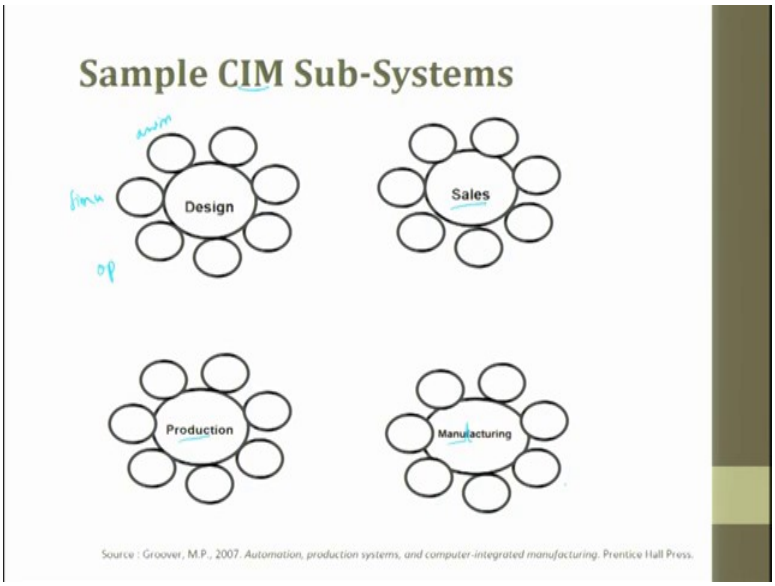

Sample of CIM subsystem, CIM sub it can have a design. So, design you can have several subsystems of design. So, because in design as I told you can be for optimization can be for simulation, can be for animation whatever it is. So, so many things are

involved in the design state then you can have sales. So, you can have several subsystems.

So, CIMs itself has a design as a subsystem, then design can have several subsystems, sales can have several subsystems production can have and manufacturing also can have . Several subsystems these are all several subsystems which are part of a CIMs which is a bigger environment.

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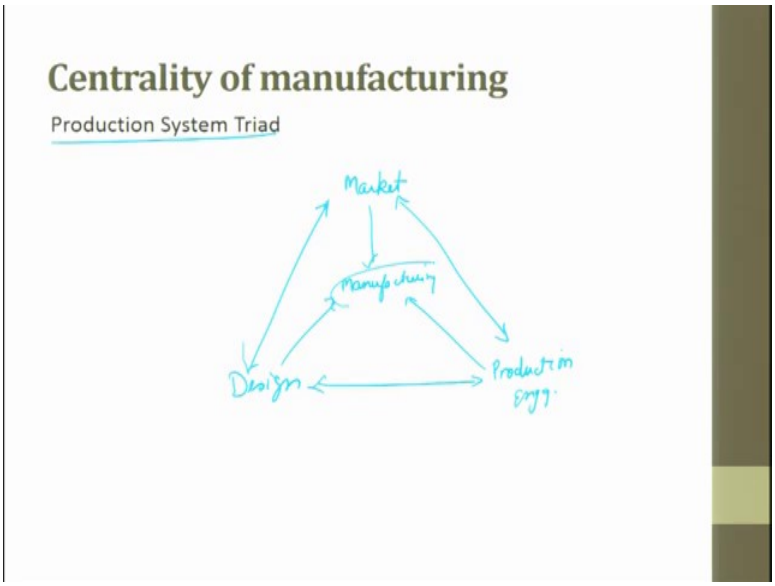

So, what is a production system triad? So, it is nothing, but market, then design and production engineering. So, it is a connection between this and this and then market and production engineering design and this and this. So, all of them come and meet at a point called which is manufacturing . So, this is at site which is used and this is designed. So, market and production engineering after all these things integrated to produce one thing called as manufacturing.

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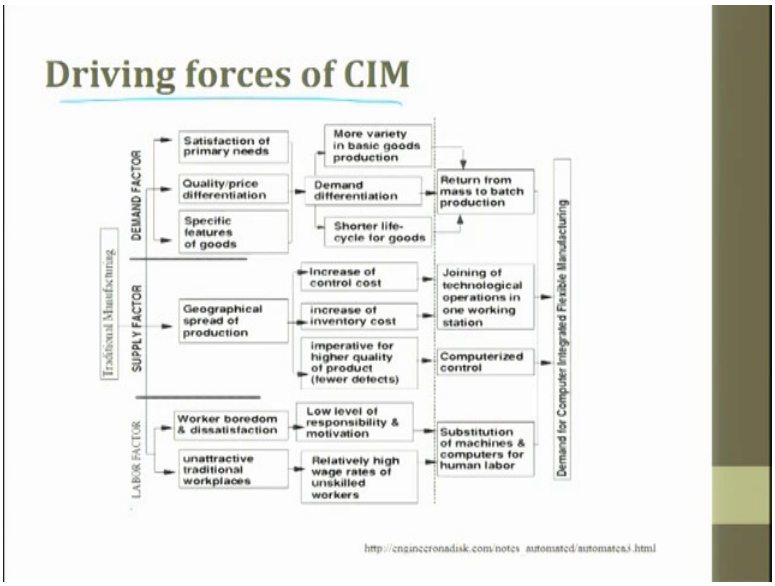

When you look at the driving force for CIMs, there are several driving forces if you look at it traditional manufacturing it is here. So, it has labor factor supply factor and demand factor. So, there are three factors. So, one is

- demand factor,
- supply factor and
- labor factor;

labor factor has labor boredom and dissatisfaction then if he is dissatisfied thus the responsibility and motivation is very low,

it is a relatively high wage rates of unskilled labor worker. So, then it requires for these labors to be substituted by machines and computer for human labor, when you look at supply factors, geographically spread of production. So, supply coming from various place increasing the cost, increasing the inventory and imperative for higher quality of products with fewer defects.

So, these are the driving force for supply factor, then here joining of technology operation in one working station or computerized control will lead to a demand for computer integrated flexible manufacturing. In the same way when you talk about demand factors it can go like satisfaction of primary needs, quality price differentiation

and then specific feature of goods. So, this leads to more variety of basic goods, demand differentiator quality and price differentiator, demand differentiator and shorter life cycle for goods this helps you to go for return from mass to batch production. So, all these things are the driving force for CIMs.

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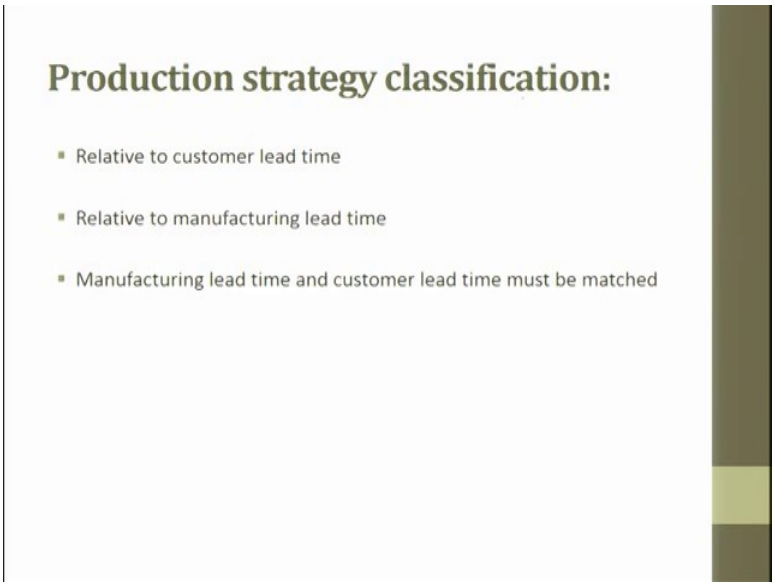

When you look at the production strategy classification

- relative to customer lead time, thus low customer lead time,
- relative to manufacturing lead time and
- manufacturing lead time and customer lead time must be match.

The strategy classification can be relative to customer lead time, customer understanding, the customer converting it then once the customer voice is understood, you have placed an order then comes the manufacturing lead time then it will be manufacturing lead time and customer lead time must match. So; that means, to say if you promise that you will deliver it within 30 minutes, you should be able to deliver the product in 30 minutes.

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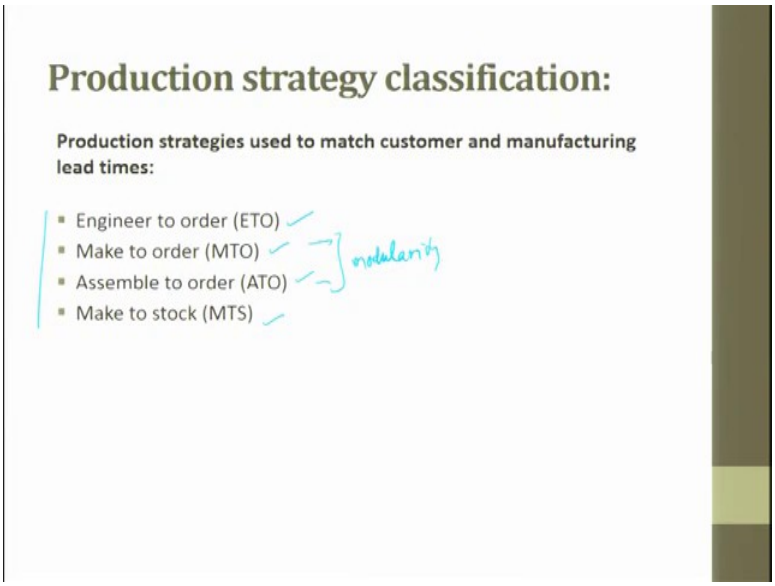

When you look at the production strategy , are generally classified into four. So, we have at back of our mind production strategy used to match customer and manufacturing lead time. So, we have to do this, otherwise we will be losing the product in the market. So, we should make sure the customer lead time and manufacturing lead time is the same, you promise you deliver. So, if you have to do that then your product should have several strategies.

So, here are the basic four strategies which are used which is called as

- Engineer to order,
- Make to order,
- Assemble to order and
- Make to stock

we will see one after the other. So, when you talk about

engineer to order. Engineer to order is so you have all the knowledge with you and moment there is a customer requirement, you try to take the customer requirement-tweak the knowledge little bit to meet out to the customer requirement;

make to order :make to order is again a customer wants and everything. So, engineer to order is you know all the strategies, but you have not exactly build a same product which could be delivered.

Make to order is to a large extent, what happens is you have everything optimized and kept ready. So, moment there is a customer who comes and he says please make it you start making it that is called as make to order.

Engineer to order: if you meet a blacksmith and tell him that I want to make a wheel for the horse cart if you say. So, he knows the skill, he knows the skill he draws the drawing in the in the floor and then he gets your engineering approval for the drawing in the floor, floor means on the ground and then he starts making it that is engineer to order. You give the money he goes to the market buys the raw material, buys this, buys that looking into your doing looking into your requirements, he customizes it. Make to order is almost all the designs are ready portion, all he has to do is he gets the money, he pulls the design executes.

Engineer to order he has to still customize it ,make to order is I need a car. So, then I know the tire has to be there, this has to be there that has to be there, small optimization has to be done and then you start making. So, this is make to order assemble to order is pizza. So, pizza what happens the, you know the ingredient, you know all the ingredients are kept ready it has to be just to process and it has to be delivered, more of modularity.

So, that is assemble to order.

Make to stock: is you make things and keep it ready for example, samosa in the tea shop it is made to stock. So, it is kept that so you go pick it up. Assemble to order is everything is there ready with you, but moment you pay money they start doing it for example, any fast food restaurant moves under the concept of assemble to order. Every ingredient is ready, they have to just process it deliver it all food chains follow this .

Now you have to decide which category your product falls, if you say make to order. So, you do not have anything readymade with you, but you have the all skill sets ready with you, machines ready with you and then you get the money and start doing a part. This is modularity and then and of course, if you see all these things follow modularity; engineer to order is it is like a flat building.

Fot house building, I go to architect and I say I have money, I have plan I want a house like this then architect understanding, your voice he starts building, as he starts drafting or constructing a model and then he will try to get back to you and say look at it is it fine for you then it goes back and for titrations finalize and then do it. So, that is engineer to order. It takes more time it takes lesser as compared to the previous one then it takes in days and a last one you go pick it up and come. So, you have to decide your product which strategy you follow

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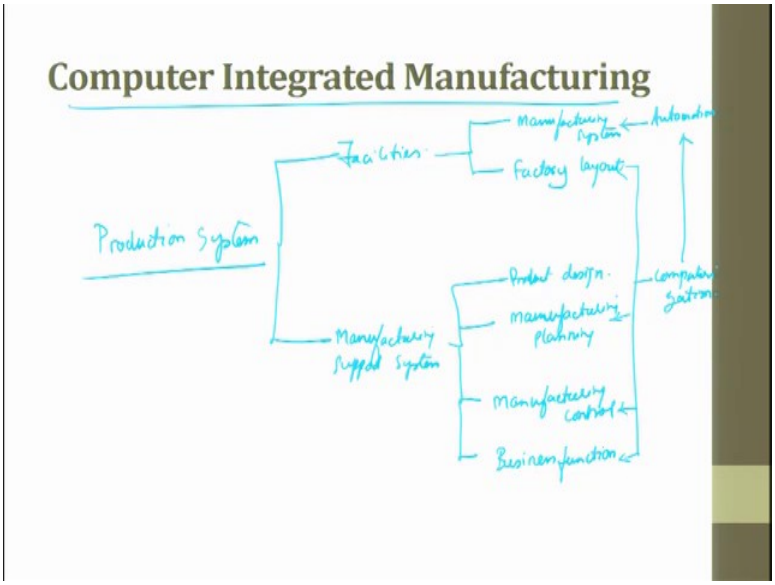

So, when we talk about computer integrated manufacturing, it is a production system, which has facilities and which has manufacturing support system , then facilities are of two. So, one is called as manufacturing system the other one is called as factory layout, then this has product design, then it has manufacturing planning, then it is manufacture control and the last one is going to be business function . So, if you look at it all these things are computerization and manufacturing system is more of automation and computer and automation are also controlled.

This is a typical manufacturing system or a production system which is involved, when we talk about computer integrated manufacturing facilities and manufacturing support system. So, they have manufacturing system which can be automated, factory layout, product design, manufacturing, planning, manufacturing control and business functions

are part of it so you can get computerized . So, computerization plays a very important role in all these four factors. So, you get to know the result.

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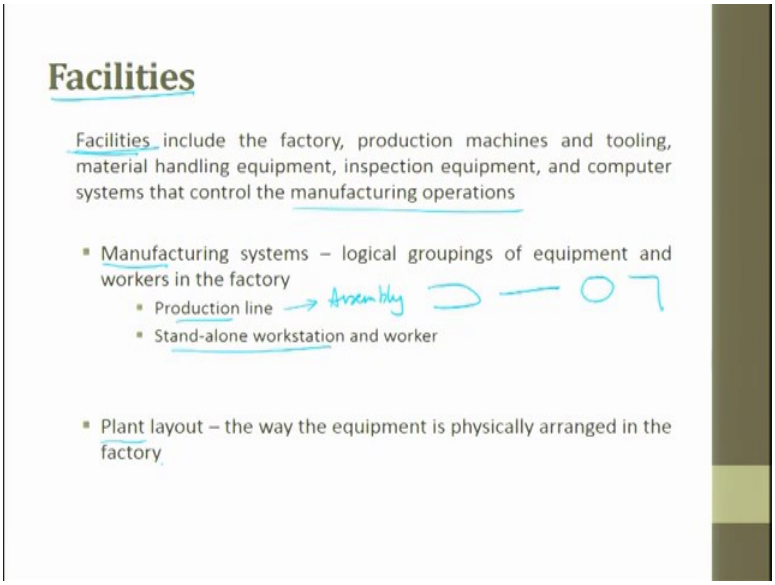

- what are facilities? Facilities include the factory, production machine, tooling, material handling equipment, inspection equipment and computer systems that control the manufacturing operation are called as facilities in the manufacturing scenario.

Manufacturing systems, logically grouping of equipments and workers in the factory is manufacturing system. production line and standalone machines. when we talk about production lines it is called more of assembly line. So, you can have U type, you can have straight, you can have a circle, you can have L type. So, these are all different production lines and which is more focus towards assembly .

This is manufacturing systems, when we talk about layout the way the equipments is physically arranged in the factory is called as a layout. Layout is very important because layout tries to make sure that the part does not move randomly inside a factory. So, arranging of machines, arranging of operators is very important.

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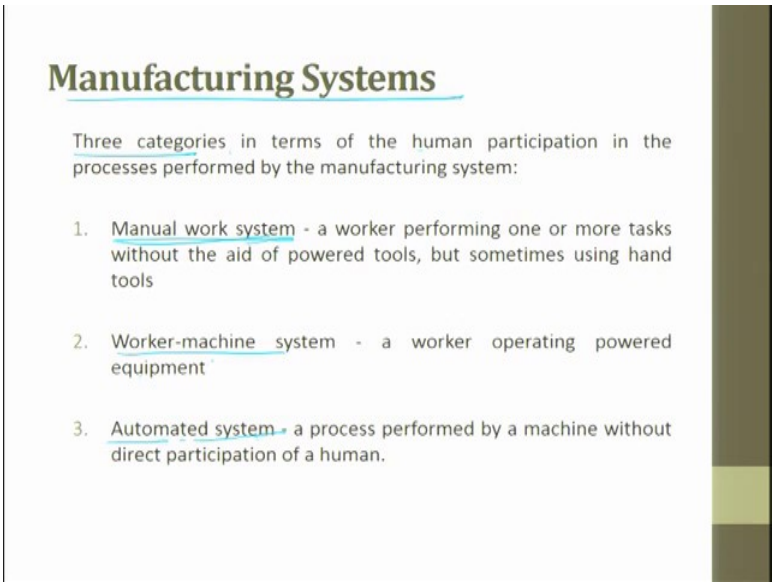

There are three categories in terms of human participation in the process performed by manufacturing system,

- It can be manual work system,
- It can be worker machine system,
- It can be automated system.
- It is manual, semi-automatic, automatic

In manual work system a worker performing one or more tasks without the aid of powered tool, but sometimes using hand tool is called as manual work system .

Fitting assembly or sometimes using hammer the blacksmith, he uses whatever he does is manual work system worker and machine system is drilling, you have a workpiece, you have automated machine. So, you use automated machine you have a workpiece, it is held in a fixture and then a worker start using it.

It is worker machine system, a worker operates the power equipment .automated system the part goes there the part is fixed in a fixture and then the drilling machine is automated, the loading happens automatic, unloading happens automatic, machining also

happens automatic then that is called as automated system, a process performed by machine without direct participation of human being is called as automated system.

The manufacturing system is categorized into three which is manual, semi-automatic and automatic. So, semi-automatic is otherwise called as worker machine system.

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When you look at manufacturing support systems, the manufacturing support system involves a sequence of activities that consists of four functions, business function. What is falling under business function? Sales, marketing, order, order entry, cost, accounting, customer, billing. All these things are business functions when we talk about product design it is research and development, design engineering and prototype shop all are part of product design. When we talk about manufacturing planning its process planning, production planning, MRP materials or Manufacturing Resource Planning, today it is also called as Enterprise Resource Planning ERP a higher version of MRP then capacity planning.

Example: Capacity planning is whether I can take the order and whether I can put, suppose if somebody comes and says I have to make 1000 samosas in next 3 hours. So, I have only 1 tawa and I have only 1 burner. So, first thing which flash you should flash in my mind is I cannot make 1000 samosas with 1 burner. So, quickly what I have to do, I have to add multiple burners. So, then what I will do, I know burners to be added, but I do not know how many to be added, then now I will start calculating the cycle time for

making for making 1 samosa what will be the time. And then the 1 samosa does not matter here because it is going to be an array of samosas has to be done.

You will make ten samosas and drop it into the oil and the cycle time start from what time you start dropping into the oil and what is the frying time. So, it is a batch production . So, if you know what has happened you have added number of burners and you have to do find out, what is the, how many number of burners to be added. So, you will try to calculate the cycle time divided by 1000 and then you will say this much time it takes. So, my burner has to operate for so, many hours and I cannot do it. So, I need. So, many burners and then finally, you start. So, that is nothing, but capacity planning .

Then manufacturing control, shop floor control, inventory control and quality control: So, here capacity planning, I talked about a term called as cycle time and then I know the production required. So, for example, 1000 samosas in 3 hours so, then I know 1 burner can produce 100 samosas in an hour by calculation I do. So, I need 10 burners so, that calculation, that is capacity planning .

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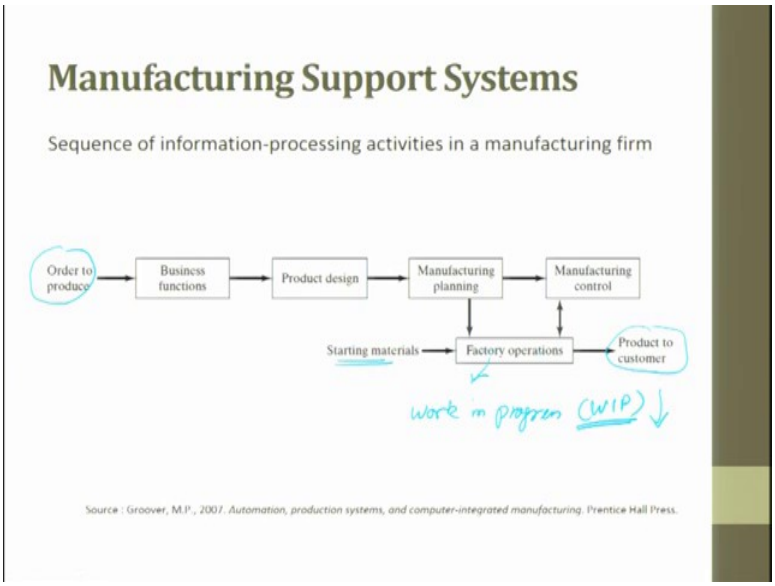

The sequence of information process activities in manufacturing firm it goes like this, order to produce, then business function whatever we studied then product design comes into existence, manufacturing planning comes then manufacturing control comes.

This is manufacturing planning and manufacturing control keep negotiating with a factory operation and moment the factory operation, they know the machine, they know the manpower, they know everything and then what they do is once it is accepted then they start the machine, they start material to come inside the factory and start working on it. And finally, what they produced to meet out the customer requirement, whatever order is been placed. So, inside this there is a term called as Work In Progress which is called as WIP but the raw material has entered into the factory and it has started getting into function, but it has not left the factory to the customer.

Those internally or holding the pieces inside the factory without delivering it to the customer is called as WIP, all companies we will try to have as minimum WIP as possible because whatever comes into the factory if it gets out only they get the money out, otherwise the money is getting locked and it builds up inventory at several places. So, WIP is one thing which happens inside the factory environment.

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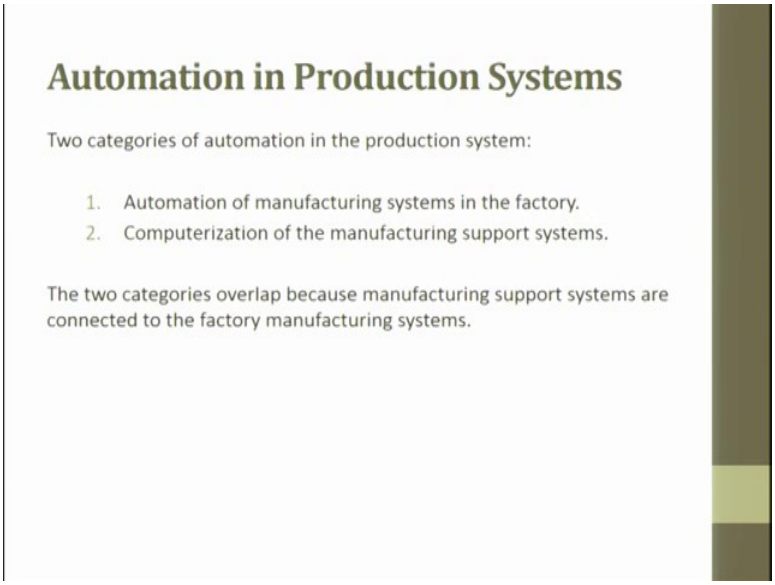

There are two categories of automation in production system one is called as

- Automation of manufacturing system in the factory.
- Computerization of the manufacturing support system.

these two are the two categories of automation in production system, the two categories overlap because the manufacturing support system are connected to the factory

manufacturing system. So, manufacturing support system is a overlap, it overlap between the factory manufacturing system.

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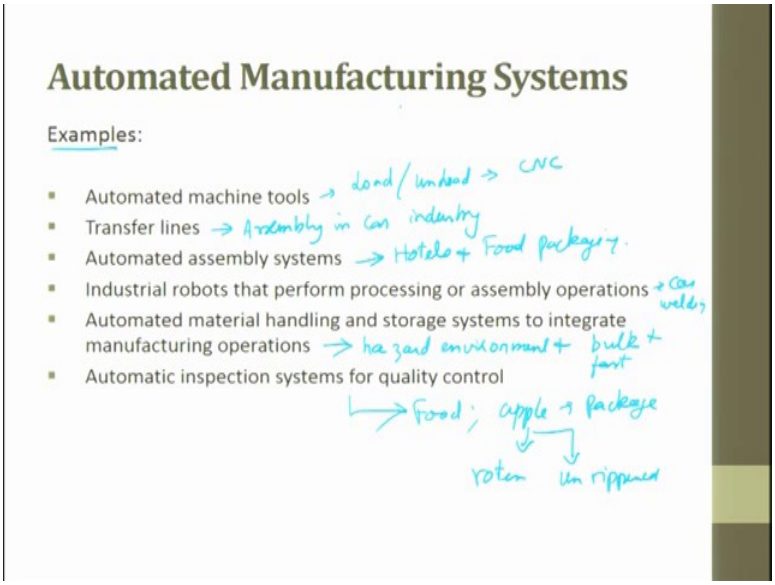

Let us take some of the examples for automated manufacturing system. example first is automated machine tool. So, here it is loading, unloading on a CNC machine , transfer line which is a car assembly, assembly in car industry-auto industry or it can have sub industry also, automated assembly system. Today you see a lot of hotels they make an automated assembly system , or food packets . So, there it is talked about.

Then industrial robot that performs operation and assembly operations, this is used in car industry for welding, or automated in manufacturing system. So, automated material handling and storage system to integrate manufacturing corporation, this happens in hazardous environment, hazardous environment as well as in a place where the automation has to happen in a bulk, bulk and fast they use it. For example, pcb assembly comes in automated assembly line, automatic inspection systems for quality control, today what is happening the again if you go back to food industry the apples are getting packaged.

By looking at the apple they try to figure out rotten and un ripened apples are noted and then immediately it is pulled out of the assembly line and it is thrown. So, those are some of the examples of automated systems which are existing today.

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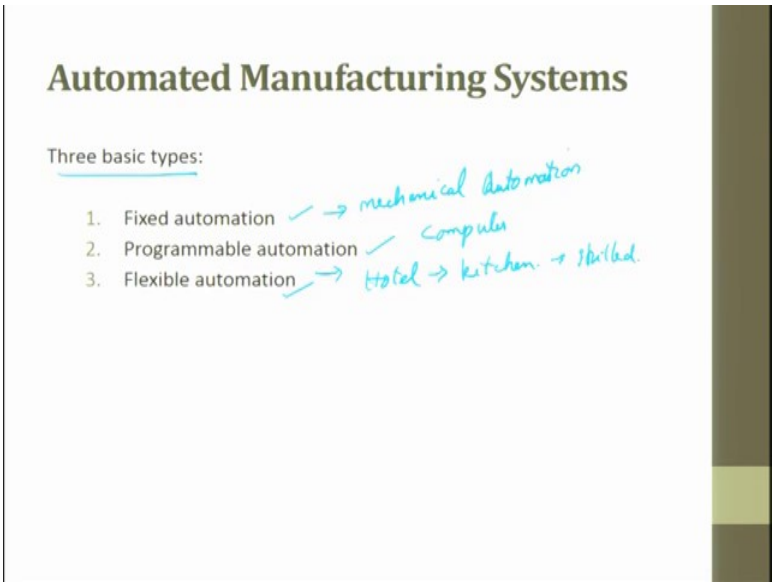

There are three types of automated manufacturing system one is called as

- Fixed automation,
- Programmable automation and
- Flexible automation.

In fixed automation the input and the output is to a large extent fixed, there is a small variation for example, the length can vary, diameter can vary, nut producing industry, a nail producing industry, a bolt producing industry the diameters can change, but a bolt making machine will produce only bolt, steel rods extrusion machine will produce only steel for example, packaging industry if it is has to make small sachet packets, the based upon the volume the length and the and the volume can change.

So, those things are called as fixed automation, when we talk about programmable automation CNC machines are programmable automations. So, where in which by changing the program a small amount of flexibility or more amount of flexibility can be introduced as compared to that of the fixed automation. So, here we use more of mechanical automation, In programmable automation,we start using computer is assisted to some extent and we start using, flexible automation is giving a huge flexibility. For example, if you are running a hotel and if you have a kitchen, it the man is highly skilled and based upon the order whatever he it comes into he has a set of utensils, he starts

making with to the customer requirement, everything and customizing it the here it is more of skilled based . So, these two can be unskilled or semi-skilled.

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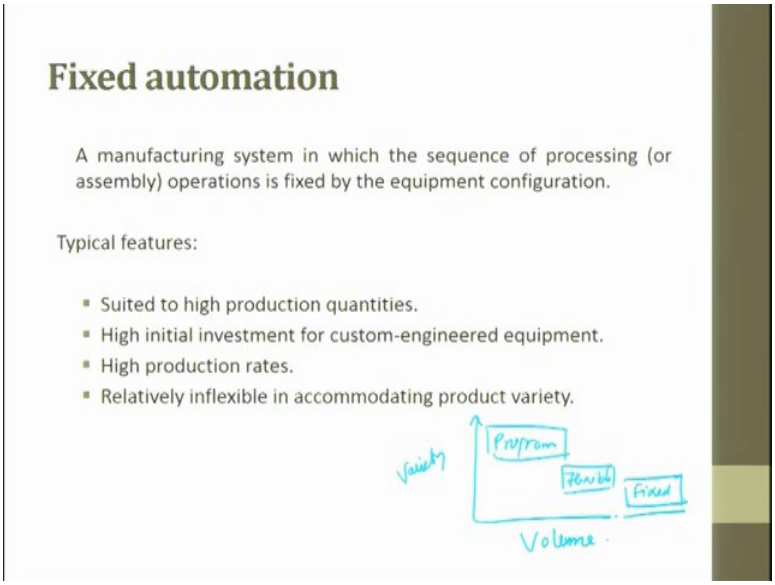

So, when we talk about fixed automation, the manufacturing system in which the sequence of processing operation is fixed by the equipment configuration .it is suited for high volume production , it has a very high initial investment cost, its production rate is very high it is relatively inflexible in accommodating product variety.

So, when you look at it suppose if you look at, variety and automation so automation means or let me change it to volume. So, volume is very high, variety is very low. So, this is fixed then comes programmable and then comes flexibility . So, here the volume is very high that is what we have said very high volume, very high investment.

So, I can also say that very high investment so, it is also costly, but they are produced so much so per-piece price falls down. So, it is always good for mass production.

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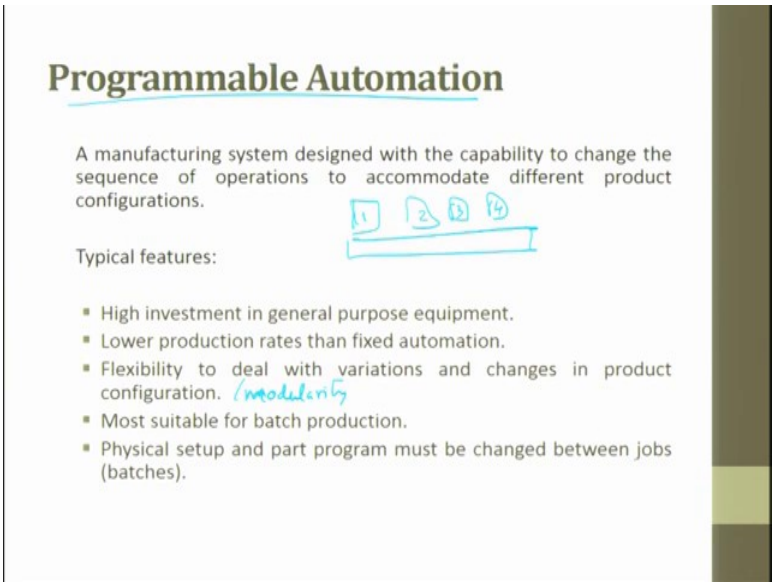

Next to programmable, the manufacturing system designed with the capability to change the sequence of operation to accommodate different product configuration is called as programmable automation. So, in the fixed the say stations. So, there are several stations each station has a fixed job and every time it does the same and the sequence 1, 2, 3, 4 is also fixed ,when you talk about programmable, there is a small flexibility given. So, it can skip or it can do anything to make the outputs.

So, programmable automation, a manufacturing system design with the capability to change the sequence of operation to accommodate different production configuration is programmable automation. So, the typical features are high investment in general purpose equipments, low production rate than fixed automation, flexibility to deal with variation and change in the product configuration. So, it is more of modularity and most suitable for batch production, physical setup and part programming must be changed between jobs.

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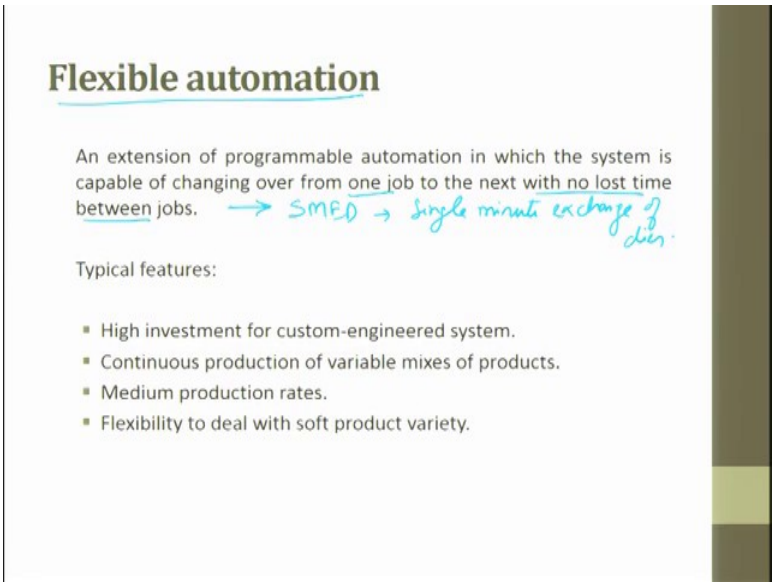

When we talked about flexible automation and extension of programmable automation in which the system is capable of changing over from one job to the next with no loss of time between the job is called as flexible automation.

we talk about the term called as SMED which is nothing, but Single Minute Exchange of Dies , in metal forming industry that punch and die assembly takes a hell a lot of time if you want to set a punch and die assembly put all the things it might take several shifts. So, what people are come out with the new concept is, they say you while the machine is running at the outside keep getting things ready so that moment the production is over you just swap and push that new die inside and start your production.

what is an extension of programmable automation in which the system is capable of changing over from one job to the next without loss of time is flexible automation, high investment for customer engineering system, continuous production of variable mixes of production, medium production rate and flexibility to deal with soft product variety. So, these are all the advantages and disadvantages of various production systems as I have already drawn.

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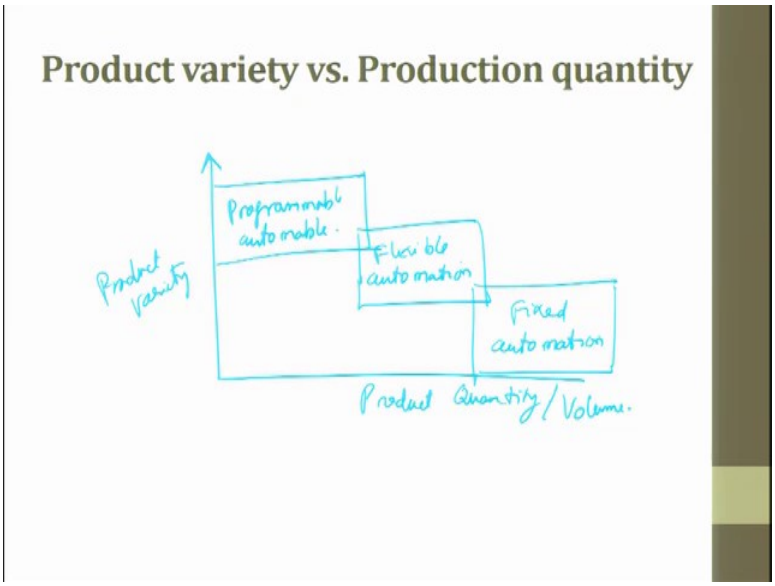

Let me make it with more clarity. So, here you have programmable automation, then we have flexible automation and last we have fixed automation . So, here is product variety and here is product quantity or volume.

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The computerized manufacturing support system, objectives of automating the manufacturing support system are to reduce the manual and clerical efforts in product design, manufacturing planning and control and the business functions.

So, that is the need, then integrates computer aided design and manufacturing in CAD CAM. So, that is what is CIMs; CIMs include CAD, CAM and the business functions of the firm. So, all these things are the objective of automating the manufacturing support system.

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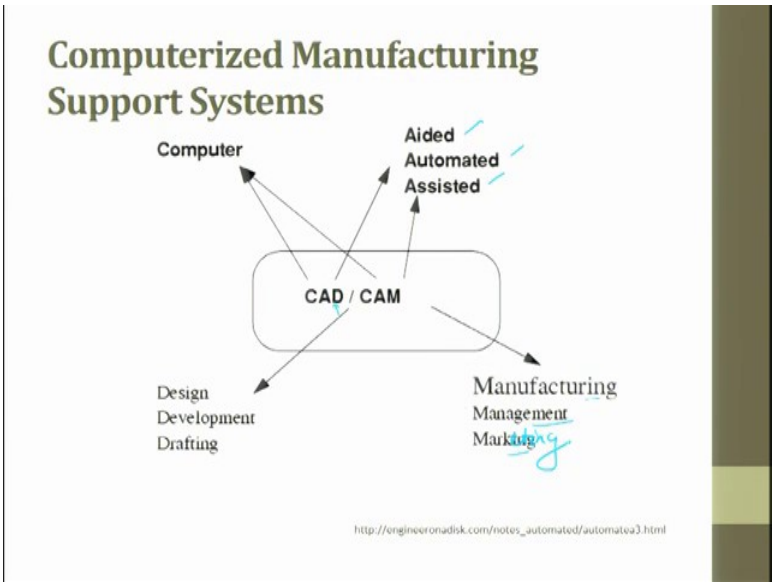

when you look at it, when you talk about CAD, it is computer aided automated assisted. So, CAM is also same, A can be used for computer aided manufacturing, computer automated manufacturing, computer assisted manufacturing ,then you see C is nothing, but the computer. And this is the design, development and drafting so this is what is D represents for and M represents for manufacturing, management and marketing it has to be marketing . So, so this is what is the computerized manufacturing support system all about.

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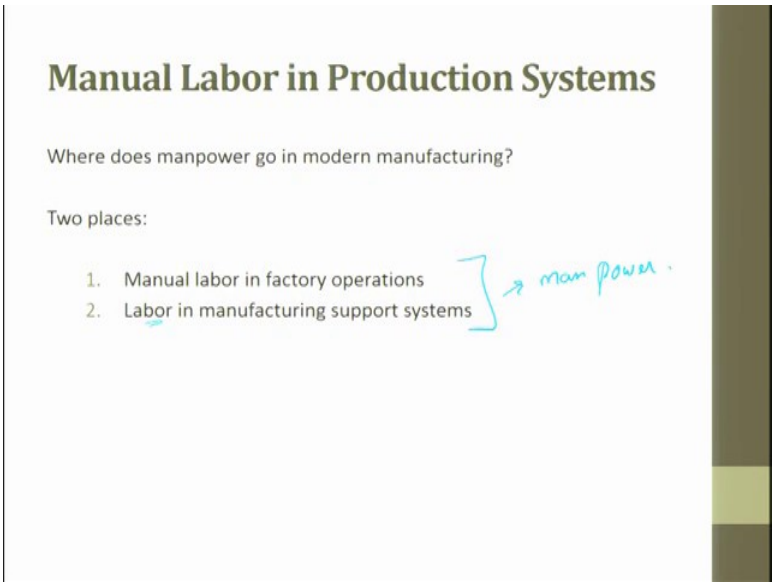

When we talk about manual labor in production system, where does the manpower go in modern manufacturing at two places, you should know the manual labor in factory operation and labor in manufacturing support systems, at these two places today we still need manpower. These are the two places manpower used in factory automation ,loading and unloading may be and then manufacturing support system, understanding the customers voice, converting it into engineering specs, putting into the system. So, that is again we need a skilled manpower for this usage.

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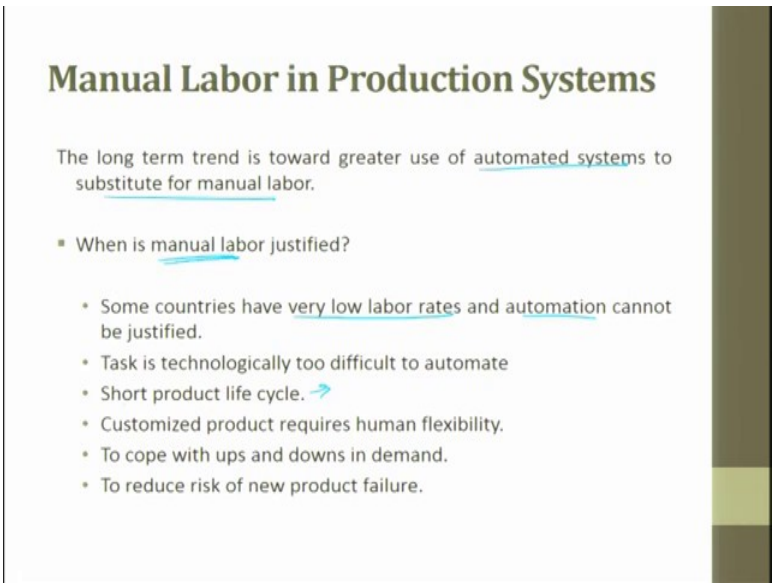

So, manual labor in production system, the long term trend is towards greater use of automated system to substitute for manual labor, this is the long term achievement that is why in India also we are talking about highly skilling people so, that they can be flexible to shift jobs very fast and they are quality conscious and they produce what customer wants.

In long term what will happen is we will have more of automated systems, we need operators to make, to maintained this automated systems and the manpower will be substituted towards that rather than doing simple jobs. When is manual labor justified? When the countries have very low labor rates it is justified to have manual when automation cannot be justified. For example, if the operation is too flexible you cannot automate so then you still need a manual.

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The task is technologically too difficult to automate, we still go for manual shorter product life time, we would go for manual labor if the product if the life cycle of the product is too short for example, seasonal based, we go for manual. It is only for one season then we go for it, customized product requirements human flexibility and then to cope up with ups and downs in demands, to reduce risk of new product failures. So, all these things even today pushes us to have a go for manual labor and we justify using manual labor in these places.

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The product designer who brings creativity to the design desk, there we need a manual labor manufacturing engineer who designs the production equipment and tooling we need a manual labor.

Planning the production methods and routing. So, there we need a manual labor, maintenance we need a manual labor, programming and computer operation yes for writing algorithms we need yes, engineering project work we need and plant management we need labors. So, these are all the places where labors are required in real time even today in manufacturing support system.

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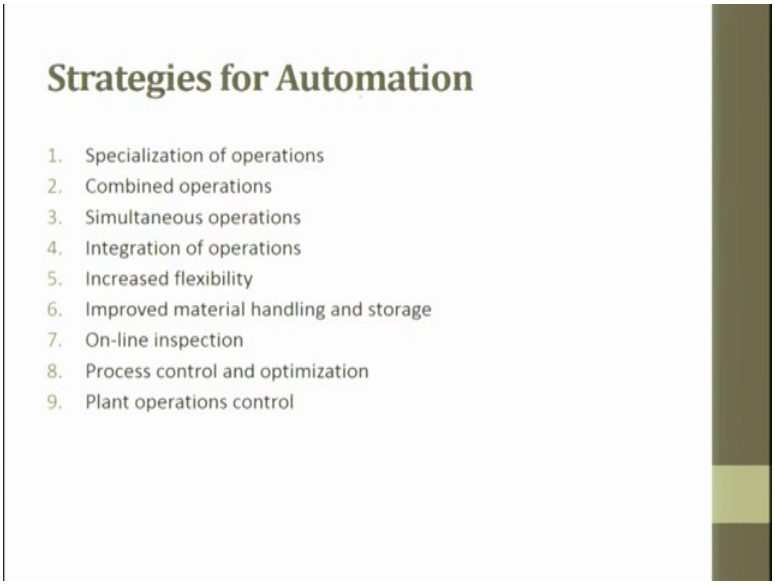

what are the strategies to go for automation? You should have strategies so to go for automation, these strategies are specialization of operation, combine into operations we always go for automation. Simultaneously we go for automation, integration of operation ,you want to do we go for automation, increasing flexibility we go for automation then improved material handling and storage, online inspection, process control and optimization, plant operation control.

So, all these places are the different strategies for automation. These are the 9 strategies for automation.

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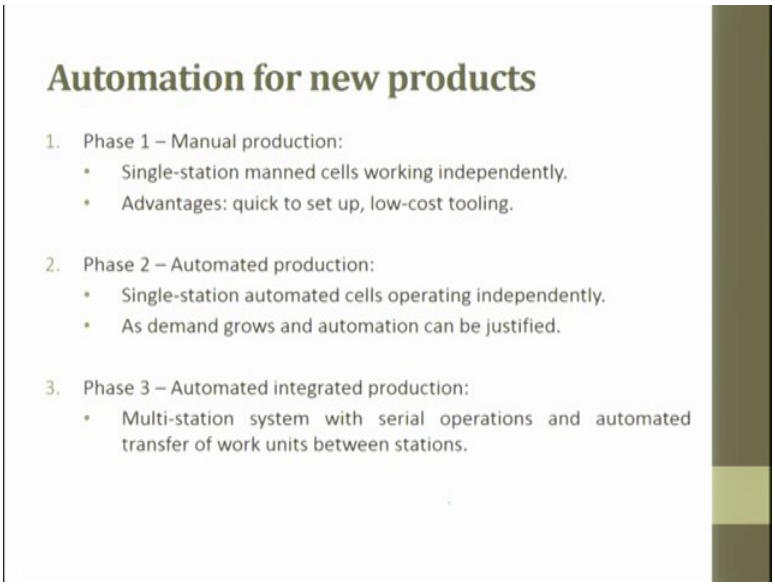

Automation of new products, there are several phases, the first phase is the manual production, single station, manned cell working independently with this is a first phase of automation of our new product.

Then automated production single station automated cells operating independently, as the demand grows and automation can be justified, in phase 3 automating the entire production where multiple stage machines with serial operations and automatic transfer of working units between stations are done. So, if at upfront, you cannot think of going for automation, first what you are supposed to do is you have to do a trial run of the entire sequence of operation in producing a part or a product. So, you will do it manually, moment you do manually, you understand what are the difficulties and what are the cycle times involved for individual events for producing the entire part, moment you know that you will also see what are all the different directions in which the part has to be oriented for doing the operation.

All these things you have to understand, moment you understand then we try to know see, what are all individual events which can be combined in producing the part. So, moment we start understanding what all can be combined, then what we do is we try to do the sequence of operation in multiple ways to see, then what do you do is we start looking for what should be the cycle time, maximum you can give in this particular station to produce the output, by knowing that then what do we do is we start choosing

the drives. And then we try to automate only a single station, we start producing, first we do it manual then we do auto, then we try to do single station automation. And ones that is successful then we start integrating several of these individual stations to meet out the company's overall requirement.

So, that is complete integration automation. what is discussed here first we do manual then we do automatic then we try to do integration several of the automated device. These are the phases by which a automation can be thought of in developing new products.