Industrial Engineering
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Module - 01
Lecture - 01
Production Planning and Control

I welcome you to this lecture on Production Planning and Control, I am P.K. Jain professor in the Department Mechanical and Industrial Engineering Indian Institute of Technology, Roorkee.

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The contents of this lecture are as I will cover concepts of production planning, concepts of production control, sub functions of production planning and control, type of production systems; and then finally I will summarize the lecture contents. First we will talk about the production planning and control.

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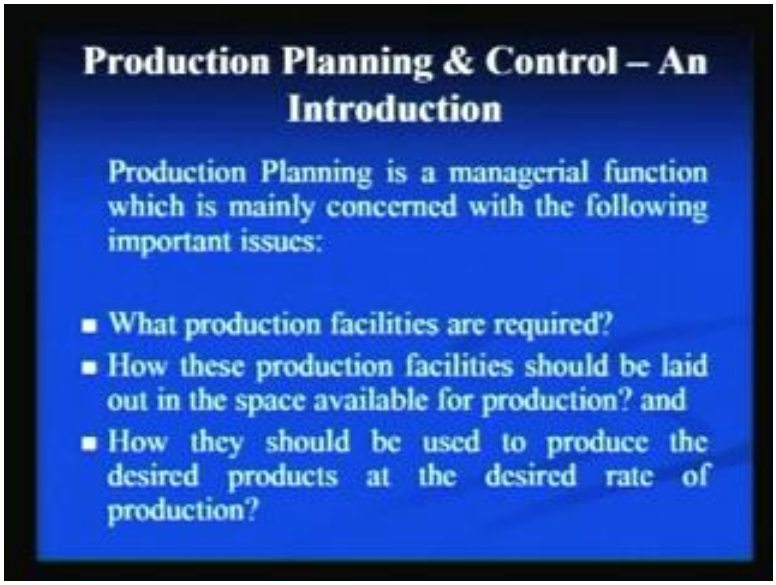

Production planning is basically is a managerial function, which is mainly concerned with the following important issues, so we can say this function is performed by the managers in any manufacturing organization. First issue that is covered during process planning and control is what production facilities are required. So first of all we have to determine, what are our requirements, as per the requirements of the product, as per the requirements of our raw materials and other inputs, and as per the constraints imposed by the availability of the funds in the organization.

So, here we have to determine equipments which are required for the production of the products, we have to determine testing facilities which are required for quality control and other inspection purposes, and we have to determine the number of such facilities required in the organization. Once these facilities are known or determined, then we have to determine how these production facilities should be laid out in the space available for production.

So, basically here we try to lay down all the facilities on the shop floor, so this is basically the physical location of the facilities on the shop floor and we say, this is a sort of exercise we do in the plant lay out. So, here we have to take in to account, the material flow direction we have to take in to account the volume of material flow and the cost of material flow, while preparing the plant layout of any organization or any plant.

Third and most important issue that is covered in production planning and control is how these facilities should be used to produce the desired products at the desired rate of

production. So, basically here we have to meet the demand rate and accordingly we have to produce products in our plant.

So, when we go for this step, we mean basically have to prepare the schedules, so that the demand of the product can be satisfied. Now, I will talk about production planning and production control separately first, and then I will cover the sub functions which we deal in this, particular function.

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Production planning is dynamic in nature and always remains in fluid state as plans may have to be changed according to the change in, changes in circumstances. Why we need to change our plans Because, there may be a change in the requirements of the customers, there may be a change in the raw materials available, there may be some uncertainties on the shop floor. That means, some breakdown, failures or some other reasons may be there, so in that case we have to change our production plan.

So, that is why it is said that, this stage is dynamic in nature and our production plan should remain in fluid state, so that they can be changed as per the requirements of the manufacturing system. Production planning is usually down at the following three horizon levels, one is long term that we call as capacity planning also medium term, we call it aggregate planning and short term that is operational planning.

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And if we talk about the long term planning that is capacity planning, it is usually done for 5 years or more, this is particularly true in those organizations which are capital intensive; that means, industries like cement industry, petroleum industry, automobile industry and like that. So, demand of the product will remain for long; that means, they have to plan for 10 years, 15 years, 20 years. So, in that case, they have to go for the capacitive planning as per the requirements of the products, as per the requirements of the markets.

In this type of planning we deal with the business issues, we deal with the strategic issues; that means we have to deal with those issues, which help us in creating the demand of our product. This will help us in, generating the sufficient revenues for the company to run, to run our operations.

And this is reflected in the choice of the processes, equipments, etcetera, because when we select the equipments and other facilities that will involve lot of investment. So, when we go for capacitive planning or long term planning, then we have to select our processes over equipments very carefully by looking at the trends in the market, by looking at the requirements of the customer and by looking at the rate of demand in the market.

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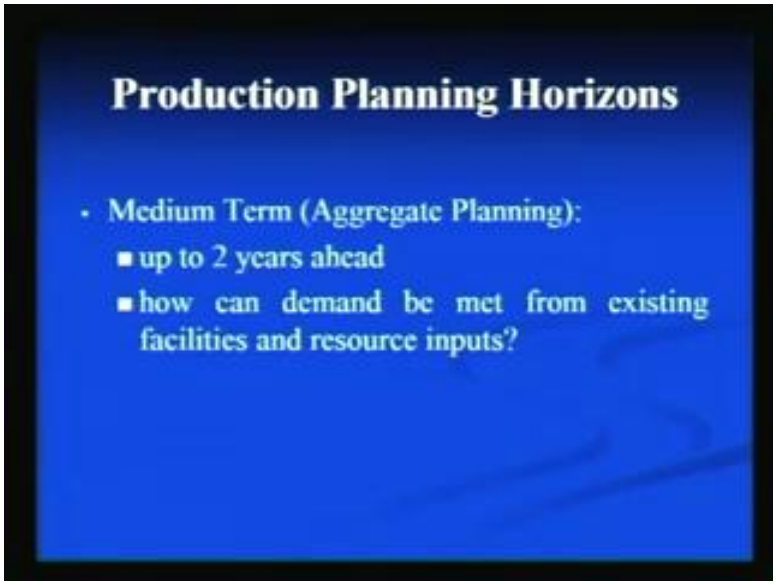

Another type of planning is medium term planning that we call as aggregate planning and this planning is done up to 2 years ahead; that means, it is not long term planning, but we do it for 2 or 3 years at the most. And here, basically the issue which we cover is, how can demand be met from adjusting facilities and resources.

That means here in aggregate planning, we plan for the materials we plan for resources which are available to ours, we plan for the maximization of the utilization of the resources which are available to us. So, basically here what we do, we try to utilize our resources optimally to satisfy a certain demand in the market.

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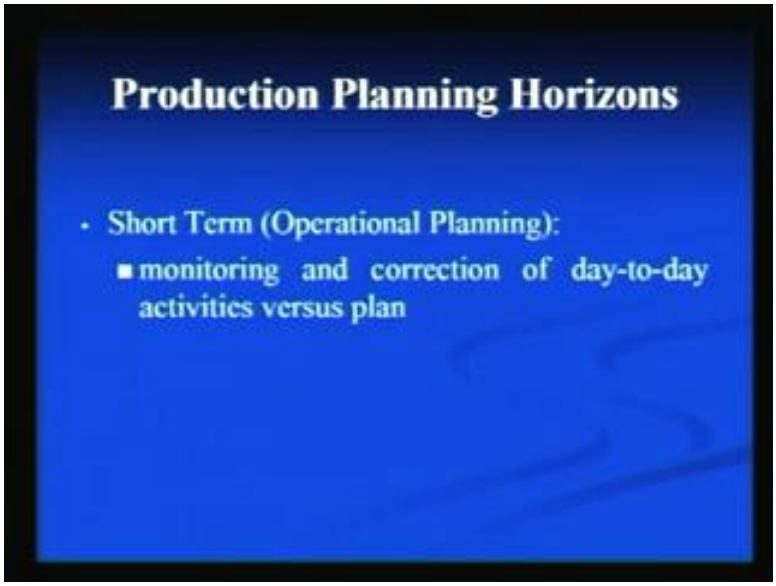

The third type of production planning is short term planning that we also call as operational planning. And here, basically it is day to day planning and here we try to monitor and take corrective actions, on day to day basis. So, if we are not able to meet our predefined targets in that case, we try to take some corrective actions. So, this is basically how to move material on day to day basis from one machine to another machine. How to schedule our operations on day to day basis or if there is any other requirement that has to be done on day to day basis, then we have to go for short term planning.

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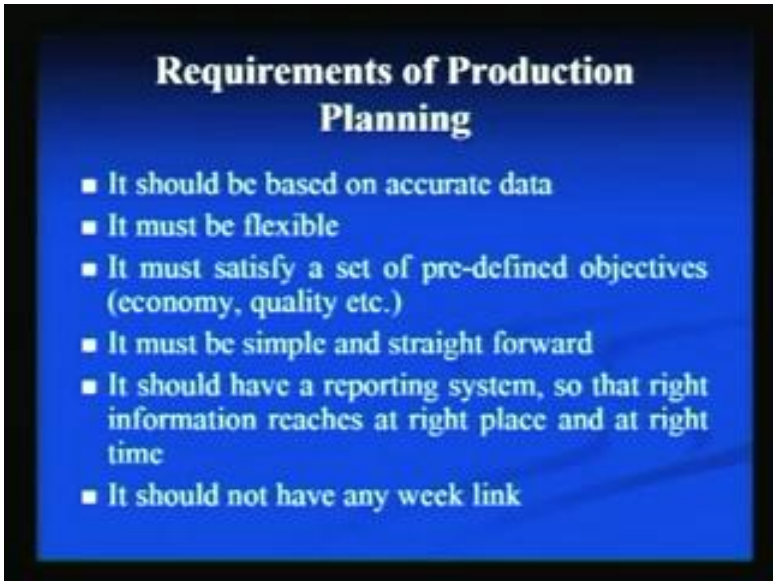

If you look at the requirements of production planning, first requirement is that, it should be based on accurate data, this data may come either from the historical data or the past data or sometime this data may come from the shop floor from the consultants and accordingly, we have to prepare our production plane. So, if our data is accurate then only, we can say that the production plans which are prepared, they will satisfy their requirement, they will be able to meet the predefined objectives.

It must be flexible as we have already discussed earlier that, the production plan should be dynamic in nature and they should remain in fluid state, so the production plans which we prepare they should remain, they should be flexible in nature; that means, if there is any change in the circumstances. If there is any change in the requirements of the customer, there is a change on the shop floor, so we should be able to modify our production plans accordingly.

Third requirement is that, it must satisfy a set of pre-defined production plan, objectives may be the economy, economic production it may the good quality of the products. It may be on time delivery to the customers or it may be any other objective or a combination of two or more objectives, so this has to be satisfied by the management in the beginning and then accordingly they have to prepare the production plans.

Another requirement is that, the production plans which we prepare it must be simple and straight forward. What I mean here, that the production plans which we prepared that should be clear to the lower level workers or staff of the organization because these plans are basically executed or implemented by the shop floor workers. So, if they are not able to understand the production plans properly, they may ask the management to clarify some of the issues and the delay in the production of the products may occur.

So, that is why it is always necessary that the production plans which we prepare that must be simple and straight forward, another requirement is that it should have a reporting system, so that right information reaches at right time and at right place. So, basically what is the idea behind this requirement is that, when we need a piece of information at a particular place.

That place may be a machine tool may be the stock may be that inspection department or section, so that information should be available at that particular place at the right time. So, basically we have to design a mechanism to deliver right information at right place at right time and that should have a reporting system also, there should be a feedback channel also to ensure that right information has reached at the right place.

Another requirement is that, it should not have any weak link, weak like here mean, if there is any weak in the chain in the production plan that, will affect the overall efficiency of the manufacturing system, that means we will not be able to meet our objectives, we will not be able to deliver our products on time, we will not be able to meet our quality standards. Now, I will come to the another important aspect of production planning and control that is production control.

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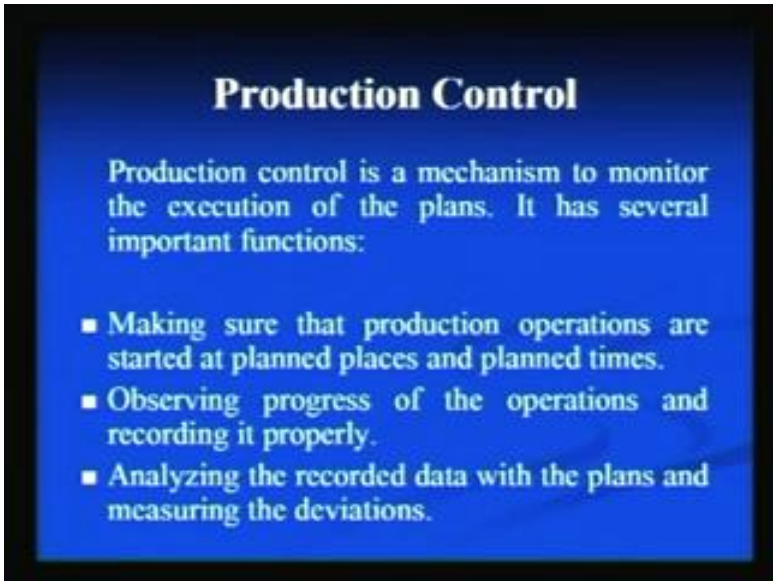

Basically production control is a mechanism to monitor, monitor the execution of the plans and it has several important functions, when we talk about the mechanism to monitor the executions of the plan that means that production control is a mechanism which will monitor the executions of the production plans prepared by the management. So, they are basically responsible or this function is basically responsible for the implementation of the production plans on the shop floor.

And, the important issues that are covered by production control function is or making sure that production operations are started at planned places and planned time, so right type of information should start at right place and right time. So, production control system has to make sure that, the planned activities are started at the planned times, another important function is that observing progress of the operations and recording it properly.

Because, once the activity is started, then we have to ensure that the progress of that activity is satisfactory, so basically here we try to or we have to observe the progress of the operation, and then we have to record it properly. If there is any deviation from the pre-planned schedules, then we have to report it back to the planning section for any corrective action or for in re-planning in some cases.

Third important function that is performed under this function is analyzing the recorded data with the plans and measuring the deviation. So, basically here we try to find the deviation between the plans and the actual output, if deviations are significant in size,

then they are reported to the planning section and some corrective actions are taken as discussed earlier.

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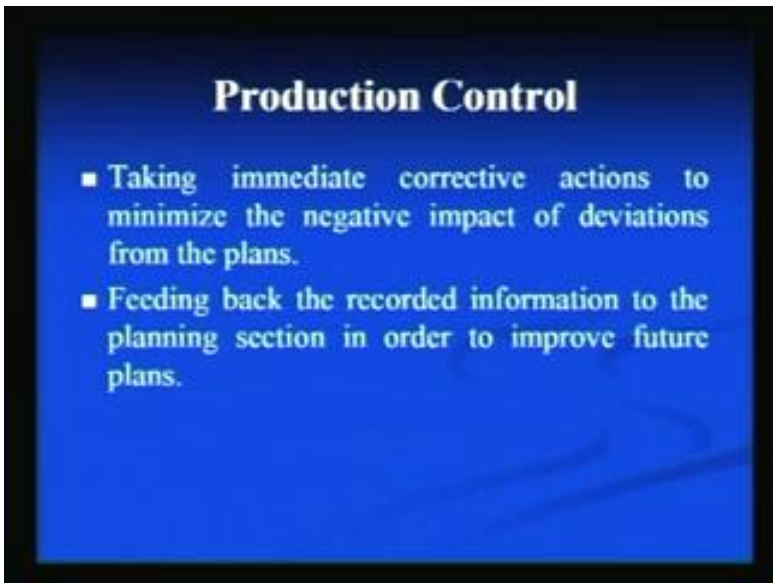

Another important function is taking immediate corrective actions to minimize the negative impact of deviations from the plans, when we talk about this correct these corrective actions, here objective is that dissatisfaction to the workers to the customers, minimization of the failure rate minimization of the machine breakdown etcetera. So, basically here by taking corrective action, we have to minimize the negative impact of those deviations on the performance of the manufacturing system as I hold.

Another important function is feeding back the recorded information to the planning section in order to improve future plans, because planning section basically as we have discussed earlier, use past data for the plans for preparing the production plans. So, this data as I said may come from the record books, it may come from the shop floor it may come from the market from the customer.

So, basically when we feedback recorded information to the planning section, this information help them in preparing good process, good production plans in future. Now, I will talk about the control systems which are commonly used in the manufacturing organizations, one of them is the open loop system with no control.

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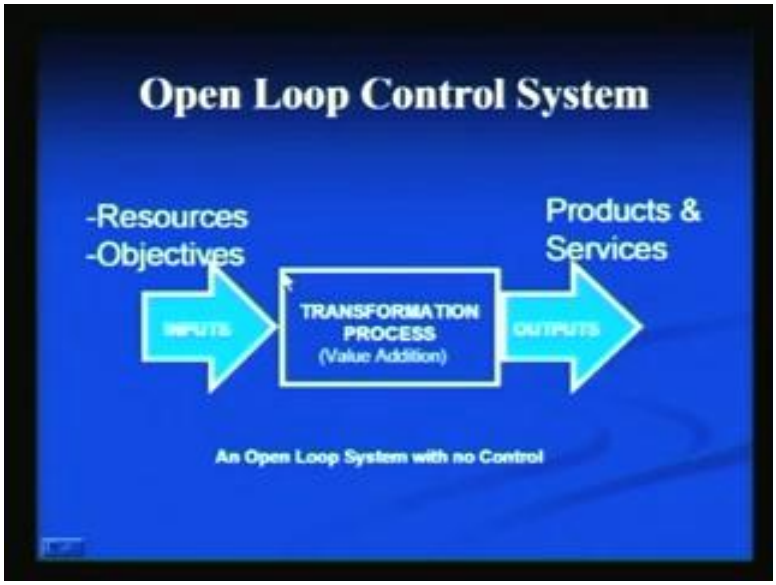

Here, we see that this block which represent, basically the Transformation Process, transformation process is basically a sort of value addition process where certain values are added to the inputs. Inputs are in the form of material, manpower, machines and equipments etcetera to give a sort of output which is valuable in the market and that output maybe in the form of products and services, so by selling these products and services, company make the profits to run their operations.

So, here in this open control system open loop control system we see that, there is no feedback channel, so we start from one side and finish on the other side, so if there is any deviation from the plans, then there is no mechanism to measure that and there is no mechanism to take some corrective actions. So, this is the main disadvantage of this type of control system, but this is simple to operate in small scale industries or those organizations which are less complex which has only few facilities on the shop floor, another type of control system which we use is close loop system with control function.

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Here these three blocks are same, on one side we have the inputs that is in the form of the resources and objectives, second block basic represents again the transformation process here, certain values are added to the raw materials and third block is the output that, represent the product chains versus deliverables to the market or to the customers. Now, here in between transformation process and output, we have another function that is performed by the control system and it is the measure of monitoring of the progress of the system.

So, if here we measure progress or output of the system with the planned output, then we will be in a position to find the deviations and these deviations are basically reported back to the planning section for taking some corrective actions. So, if deviations are large and we are moving away from the plans, then some corrective actions here are required, for example say if we are lagging behind our schedule, then in that case some rescheduling may be required at this stage.

If for example, say we are producing defective parts regularly, then we have to find the causes of those defective parts, and accordingly we have to take some corrective actions. We may be getting some defective materials as inputs or some other processes are producing the defective parts, so we have to identify the causes of the deviations and then some corrective actions accordingly.

So, this type of system is effective in controlling the quality of the products, this system is effective in meeting the due dates and delivery schedules of the organization, but at the

same time this system is difficult to implement, because here we have to incorporate this feedback channel in our system a reporting system in our, in our organization. Now, I will come to the production control which is second part of production planning control function.

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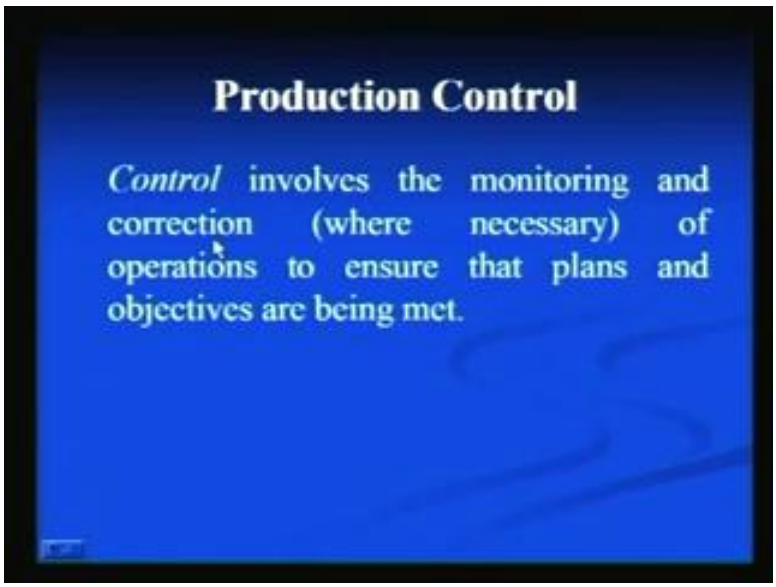

Here control involves the monitoring and correction, where necessary of operations to ensure that plans, and objectives are made as we have seen earlier in the block diagrams of production control system that some measure some monitoring is required to find the deviations from the plans. And, some corrective actions are required to remove those deviations from the system, so this basically summarize the objective of that block diagram.

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There may be different forms of production control like quality control means, when we measure performance of our system, then we may check the quality of the output and then accordingly, we may take some corrective actions. Sometime we may control the stock or work in process in the organization, so if work in process exceeds the predefined limits, then there are some problems on the shop floor.

Some of the operations may not be working properly, so that is why there is a built up of the raw material or semi finished products on the shop floor, so we have to take some corrective action. Production control may also cover schedules or processing etcetera; that means, if we are lagging behind our schedule, in that case we have to take again some corrective action some rescheduling is required, so deviation may be found in the form of lateness delays etcetera.

Another type of control may be the cost control; that means, we have to control our cost, so basically when we prepare our plans we estimate the cost of our end product and that, costing takes in to account the working process defective pieces produced any wastage scrap etcetera. So, if for example say work in process is increasing number of defective parts produced are large in that case the cost of the end product may increasing.

So, and, then there may be a deviation from the estimated value, so in that case we have to control the cost of the product and some corrective actions may be taken if cost is increasing continuously. Another important control factor is the people and labor

productivity, so basically we have to maximize the utilization of the labor or the workforce available in the organization.

So, we have to control their productivity if for example, say workers are working only for two hours in a shift that means, productivity of that organization is very low, so accordingly we have to take some corrective action, so that productive of the workers can be improved and there by the cost of the product can be reduced. Now, I will talk about the functions of production planning and control together.

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There are several important functions which are performed by the management under this heading, one of them is product planning, this product planning function covers several issues which are very important for the survival of the organization in the market place. One of them is product engineering, product design and development, functional and technological considerations and quality considerations.

When we go for product planning, first and most important thing is to get feedback from the customers through market survey, marketed search or sometime from the consultants who are in this particular type of business. So, when we get feedback of the customer, then we come to know about their requirements both in terms of functional requirements, technological requirements and quality requirements.

By knowing those requirements, we should cover these requirements in to a conceptual design of the product, once that conceptual design is accepted by the management, then that conceptual design is converted into a part drawing that, we call as sometime product

design and development exercise. Once that product design is prepared next stage in product planning is to go for functional and technological analysis of the product.

In that case, first of all we have to go for the functional analysis, in functional analysis we have to identify those functions which are must for that particular product and these functions are defined as primary functions. Another set of functions which is important sometime for the product is the secondary functions which add some values to the primary functions. And, third set of functions which must be satisfied sometime or the tertiary product, tertiary functions which basically help the ((Refer Time: 21:10)) secondary functions and primary functions.

For example say in case of a television set, good quality picture and sound are the primary functions, secondary functions may be number of channels etcetera and tertiary functions may be shape and size of the television set, its look styling texture etcetera. Similarly, we have to go for the technological consideration; that means, we try to we should try to use advanced technology in our products.

For that purpose say in case of again television sets, LG uses golden eye technology and they try to advertise their product with the help of technology, so we should try to take in to account the technological requirements of the customer at the same time. And third is the quality consideration; that means, the product which is offered to the customers that should be a quality product it should, it should not have any defect and it should work properly as long as customer desire.

So, these are the three important considerations while we go for product planning, please remember that in this particular function we only try to make a product design which can satisfy our customers requirement which can satisfy market requirements and which can compete in the market. Second important function of production planning and control is forecast planning, in this we have to cover the quantity forecast and demand pattern forecast issues.

When we talk about quantity forecast, we have to find the numbers in which the product can be sold in the market that means, we have to determine the volumes that can be observed by the market. While determining these volumes we have to take in to account, the sale of similar products available in the market may be offered by your competitor, we have to take in to account the existing customer base of the organization and we have to take in to account, the future trends in that particular market.

So, all these things can be used, all these factors can be used for quantity forecast and there are several techniques which are available for that purpose like regression analysis, simple average method, simple moving average method, exponential smoothening method or sometime Delphi technique can also be used for that purpose. Another important issue that we cover in this function is the demand pattern forecast, along with the numbers or volume we also have to determine what will be the pattern of the demand in near future.

For example, say trend may be increasing demand another trend may be decreasing demand another may be the stable demand or there may be some seasonal variations like in case of cold drinks and ice creams. So, we have to identify the pattern of the demand of that product, because that will help us in capacitive planning that will help us in determining the number of equipments and facilities we need for the manufacture of the that product.

And, at the same time that will also affect the scheduling of our resources, so this function is very, very important for the organizations who are sometime entering for the first time in that market. And the data which we use for forecast planning either may come from the market research or it may come from the sale figure of the similar type of products in the market or sometime it may come from the consultants.

When we go for say forecast planning, it must be kept in mind that the data which we use for sales forecasting that data must be accurate, because accuracy of that data will determine the accuracy of our forecast. Another important function of production planning and control is process planning.

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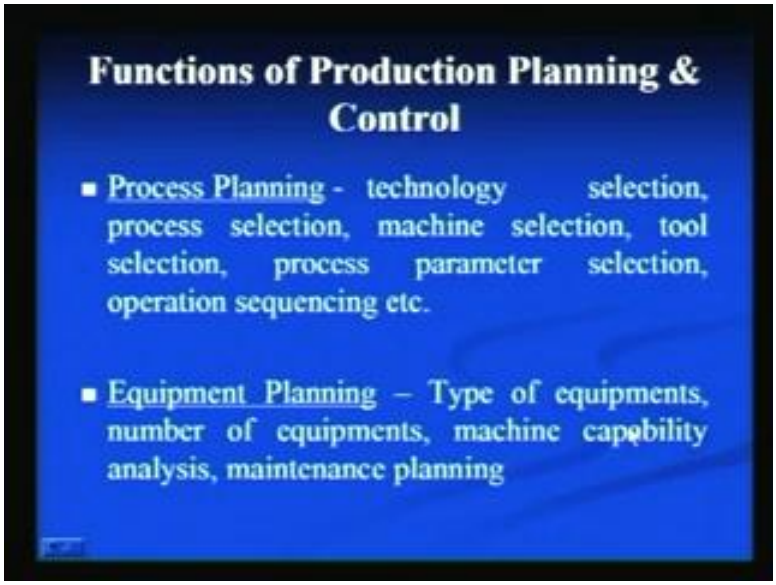

Process planning is basically a function where we try to convert design specifications which are laid down in the part drawings by the product designer in to the manufacturing instructions. Manufacturing Instructions are in the form of the machines equipments, operations, cutting tools, process parameters, processing sequence etcetera, which are used to convert raw material from its initial stage to the finished or the final stage as per the drawing or part designing specification.

The issues which are covered in process planning are technology selection means, what type of technology should be used to convert that, raw materials in to a finished product. Technology may be for example, say casting processes, machining processes, welding processes etcetera, depending on the nature of the product, type of the product, size of the product and shape of the product.

Then, we have to identify the processes in that particular domain for example, say if the we use machining process or machining technology, then there may be a number of machining operations which can be used for that purpose. For example the turning operation can be used for cylindrical parts, milling operation can be used for prismatic parts, drilling operation can be used to produce holes and boring operations can be used to give desired accuracy to that hole.

So, depending on again the type of the product, the configuration of the product and the requirements of the surfaces, we have to identify suitable machining or suitable processes. When we go for the selection of the processes, we always have to go for

process capability analysis what we mean by process capability analysis, we mean that the requirements of the product should be match with the capabilities of the process and, then proper selection should be made.

So, here we have to first identify the capabilities of all the processes available in the organization, and then we have to compare those capabilities one by one with the product requirements and one of them should be selected. Along with the technological capabilities as we cover in, in process capability we also have to look for the economy of the operation, the process which we select that must be economical.

So, we have to consider economy aspects, we have to consider technological aspects while selecting the processes appropriate processes for that product, another important issue to be covered in process planning is the machine selection; that means, we have to select appropriate machines for the processes which we have already identified. See one operation can be performed on several machine a turning operation that can be performed on several lathe machines which are available in the organization, but here, we have to identify which of the machines is selected for the performance of that particular operation.

So, here again when we go for machine selection, we have to look for the machine capability we have to go for we have to look for the process capability and we have to look for the product requirements. Product requirements maybe in the form of size of the product maximum dimensions for example, say the requirements for the process may be in the form of the accuracy requirement.

Say for example, we have to create a surface which is accurate which gives us good surface finish; that means we have to select a precision lathe for the operation turning operation, which we have selected in process selection module. So, here basically again we have to identify the appropriate machines to perform the operations or process selected earlier on the product.

Here, when we go for machine selection along with the machine capability data we have to consider the operating cost or working cost of the machine, because some of the machines are very expensive and naturally the cost of operating those machines per hour is very high. So, naturally if that type of machine or that sort of machine is not required by the product under consideration by the process under consideration, there is no point in using that machine.

So, economy of operation or the machine should also be taken in to account while selecting the appropriate machine, another important issue that can be covered in machine selection is the location of the machines on the shop floor. Because, if machines are locate at distant places from one another, in that case the cost of material handling or the distances traveled by the material from one machine to another machine will be very high.

So, when we go for machine selection at that time, plant layout or the physical location of various machines should also be taken in to account, another important issue to be covered in process planning is the cutting tool, selection tool basically is used to generate the required geometry on the part profile. So, basically when we cover, when we select tool for the execution of an operation or a process, then we have to see the compatibility between the machine selected earlier and the tool we are intending to use.

We have to find the compatibility between the tool and the process which we have identified earlier, and at the same time we have to see the issues like tool life number of tool changes over the part manufacturing and also issues cost of the tool availability of the tool etcetera should be taken in to account.

Because, every tool change over will add some nonproductive time to the manufacturing lead time and that, will increase the overall cost of the product, so basically when we go for process planning, we should try to use a tool which can which is available on the machine under consideration and which can be used without any change over. Another important aspect to be covered in process planning is process parameter selection.

Here, process parameter selection for example, say in case of machining operation maybe cutting speed feed and depth of cut, while as in case of welding operation this may be the current voltage etcetera of the process. So, we have to select appropriate machining parameters or process parameter for the implementation or for the execution of the process which we have identified earlier.

Now, when we go for process parameter selection, there are several approaches which are used and one of them is the data base approach; that means, we try to use some machinability data handbooks and we try to retrieve some of the data from those books to arrive at suitable machining parameter process parameter.

Another approach is the optimization approach, here we try to make a mathematical model of the process itself, and then by applying some constraints and by defining a objective function, we try to determine the optimal set of machining parameters. So, but one thing which we should keep in mind while selecting the appropriate machining parameter process parameter is that, the process parameters which we identified here they should be available on the machine tool which we select.

For example, say a process parameter cutting speed is for example, say 500 rpm, but that speed is for example, is not available on the machine selected. So, that parameter cannot be implemented, so that is why the process parameter selection should take also in to account the type of machine which we have selected the process parameter range available on that machine, the cutting tool which we have selected.

For example, say if cutting tool is high speed steel tool for that tool we cannot go for very high cutting speed, so all these factors are taken in to account while selecting the appropriate process parameter and same way, we have to sequence the operations which we have already identified. As we know that for the manufacturing of any product, several operations are required to be performed and when we go for the manufacturing of that product, it is important to determine the sequence in which, those operation should be performed.

So, operation sequencing is always important, while determining the operation sequence of for a product we should keep in mind that total number of tool change over should be minimum, total number of machine change over should be minimum. So, that the known productive time which is added because of the machine change over, because of the tool change over should be minimum.

So this, the all these things all, all these aspects are taken in to account while going for operation sequencing in process planning, so process planning is very important aspect of production planning and control and this is basically a sort of we can say interfacing between design and manufacturing. Because, once that part design is available to the process planner, process planner will study that design to generate suitable manufacturing instruction.

And, then those instructions will be passed on to the product manufacturing engineer, and manufacturing engineer will try to implement those instructions as such but sometime it may be possible that some of the machines may be out of order, some of the

tools may not be available in the organization. So, in that case manufacturing engineer may refer back that process plan to the process planner for some modification some editing, so this is basically a very important function in production planning and control.

Another important function that is perform under production planning and control is equipment planning, in this function we have to determine first the type of equipments; that means the type of machines and other accessories which we need to run our operations. While determining the type of equipments we have to take in to account, the requirements of the market and the customers.

For example, say if customers need very high quality product, then accordingly we have to identify or we have to select precision machines and equipments which can give us those qualities. Another important thing is the rate of production that is required to satisfy certain demand of the product that means, if demand is very high, so we have to identify those machines which can give us that rate of production to meet those demands.

And accordingly, we have to take all these decisions in to account while determining the type of equipment and machines which are required. Another important thing, which we have to cover is number of equipment; that means, quantity of the machines of each type, this is again determined by taking in to account the requirements of the market that is in the form of Sales volume.

If demand is very high, naturally the equipments number of equipments in the plant should be very large, so that we can meet the demand by producing that many number of units in the plant. At the same time, when we go for the determination of number of equipment we have to look at one constraint that is the capital available for that purpose, so if money is not available the finances are not available, in that case we have restrict to a limited number of equipments in the plant.

Another important thing in equipment planning is machine capability analysis, machine capability analysis is again I said earlier is basically a sort of matching between the requirements and the capabilities of the machine. When we know the requirements of the market requirements of the customers in terms of quality, cost, surface finish, texture shape and size, then we have to go for machine capability analysis to identify the right type of machines.

Along with the number of machines type of machines we have to go for maintenance planning of the machines also, because when we go for maintenance planning, we have to prepare the preventive maintenance as schedule, we have to look for the time to failure mean time to failure etcetera. So, that most of the equipments are in ready state in the system and their downtime is minimum, another important function in production planning and control is materials planning.

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In material planning there are several issues which we have to cover, first is selection of material and their specification, while determining the specifications of the material we have to take in to account the technological requirements of the product. For example, say if you need very high strength product, then the specification should also be high if you need good surface finish on the product, then the material which we select should be able to give us that surface finish.

If we need a sort of texture on the product, then the material which we select should be able to give us that texture, so material and specifications are mainly governed by the product requirements by its technological requirements, quality requirements and sometime the cost requirement. Because, sometime we can the cost of product is kept low in that case the material selected should be low cost material.

Similarly, we have to go for the selection or identification of material volumes this is again governed by the demand of that product in the market. If demand is very high rate of demand is very high in that case we need large volumes of the material. Same case of

a steel plants, we know that we need raw material that is iron ore in large quantities, because we know that demand of that product is very high in the market. So, accordingly material volumes are determined.

Another important issue to be covered in materials planning is economic lot sizing, economic lot sizing is basically a sort of thing where we try to take advantage of the discounts offered by the suppliers. We try to reduce transportation cost of our products of the material to the plant and we try to reduce the overall cost of inventory and accordingly we try to determine economic lot sizes.

To determine economic lot sizes we have to use some inventory management techniques like economic order quantity, economic production or quantity technique and some other techniques to determine economic lot sizes. Another is inventory planning; that means, we have to plan for the materials in such a way that the total cost of inventory or keeping that material in the plant is minimum, so this issue will be covered in inventory planning. And, then store planning that means, if we are using a variety of the raw material spare parts or say finished products in the organization, then we have to keep all these materials and parts in our store.

So, basically so in that case store planning is very important you have to decide about the location of each and every part in the store. So, that it can be retrieved with no time in no time, so here store planning is important from that point of view. Another important function of production planning and control is loading, scheduling and sequencing, this is very important in to day to day today functioning of the organizations.

So, if you remember that third type of production planning was short term planning, here in that case we try to prepare our loading chart schedules and sequences according to the day today requirements of the organization. When we go for loading, scheduling and sequencing first and important thing is to differentiate between these three terms, loading is basically the assignment of the work to the equipments or resources, so in case in this case we have to prepare a load chart.

For example, say if five jobs are assigned to a machine to a worker, then these jobs are represented in the form of a load chart say five jobs are ABCDE, so we will prepare load char of that worker or that machine by assigning those jobs to that worker or machine. Scheduling is basically a time based loading, in loading we do not identify the start time

and finished time of the jobs, only thing we say that these are the five jobs which has to be completed by that worker or that equipment.

But in scheduling we try to determine the start time and finished time of each and every job on that machine and then finally the sequencing, sequencing is basically say on a particular machine there are five or six jobs, then what should be the sequence or the order in which those jobs should be processed. So, here some dispatching rule some priority rules can be taken in to account like first come first serve is the simples and one of the easiest tool to implement.

Shortest processing time may be another rule that can be used for that purpose, last in first out may be another rule that can be used for the sequencing of the jobs. So, we can say these three functions in production planning and control are very important for day today functioning of the operations, and here if you see machine loadings operations, scheduling and job sequencing are the three important activities which we have to do.

So, these things or three functions will determine the efficiency of the plant whether we are in a position to meet the delivery dates or not, whether we are able to maximize the utilization of the equipments or not, all these are basically covered by these three functions. Now, if you look at the definition of the production system as a whole.

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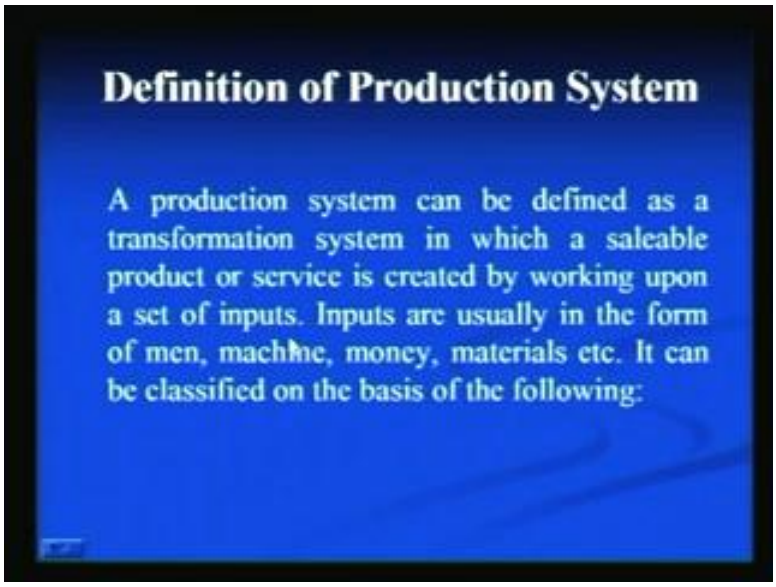

So, far we have discussed about production planning, production control and production planning and control and its functions, but now I will talk about the production system as a whole. Production system as I said before is nothing, but a transformation process here

certain values are added to the raw material to the inputs to get a saleable product of service. So, if you look at the definition of a production system, a production system can be defined as a transformation system in which a saleable product or service is created by working upon a set of inputs.

Inputs are usually in the form of man, machine, money, money materials etcetera and it can be classified on the basis of following a number of factors are used to classify a production system. As we if you will see the definition of a system, it is basically defined as a system which is made of several subsystems there are several subcomponents and each of these subcomponents are interrelated with each other.

So, output from one subsystem may go as input to the other subsystem of the overall system, so basically the performance of one system will affect the performance of the other systems and the overall performance of the system. So, in that way we can say a production system may have several subsystems, shop floor may be one subsystem planning may be another subsystem, inventory control may be third system, forecasting may be another subsystem. And, the overall performance of the production system will depend on the performance of these subsystems individually and these subsystems are interrelated with each other, if you look at the factors which help us in classifying the production system.

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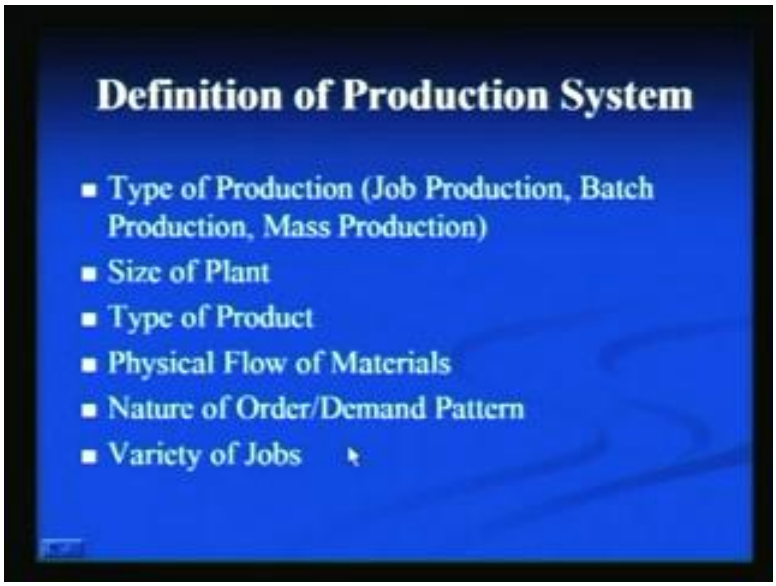

First of them is type of production, here we classify our production system as job shop type production batch type of production system or mass type of production system I will

come to these productions type of production systems later on. And this is the mostly used classification system for this purpose, so mostly the systems are classified as job shop type, batch type or mass type of production system.

Another type of a classification is based on size of the plant, if the size of the plant say is very large say in case of petroleum industry, automobile industry, aircraft manufacturing industry we can say this type of system is very large or large in size. Another type of system may be very small in size for example, say printing press where we have a limited number of equipments and worker, so that is small plant and similarly we can see medium size plant.

So, depending on the size of plant also we can classify our production systems a large medium and small size plant, but this is not very common in manufacturing organizations. Another type of classification is based on type of product type of product manufactured by the company, for example say if type a product is sometime may be very simple sometime if may be very complex sometime it may be simple to manufacture sometime it may be very difficult to manufacture.

So, in case of aircraft where we need thousands of parts for the end product, so that product is itself very complex in natural, so that is one type of classification we can use complex type of production system. In another case as I again take the case of printing press where product is very simple, so there also we classify our systems on the basis of the type of product and accordingly the production planning and control system of the manufacturing organization will be affected.

For example, say if product size is very large naturally the production planning and control function of that system is very, very complex in nature. Another type of classification which we use is physical flow of materials, sometime flow of material may be fully automated sometime it may be semi automated sometime it may be manual, so depending on the type of material flow we can classify our manufacturing or production system.

Another is the nature of order and demand pattern sometime nature of demand pattern means if say for example, demand is stable in nature, then we can say that system will remain stable throughout the life cycle. If demand is not that stable it is fluctuating, then we can say this is sort of unstable type of production system, another type is another classification is based on the variety of job sometime we need to produce a variety of the

products for the customers, in case of automobiles, in case of consumer electronic item, sometime there is no need of any variety; for example say in petroleum products etcetera. So, that is one another basis of classification of the production systems, first of all now I will talk about the job shop type of production system.

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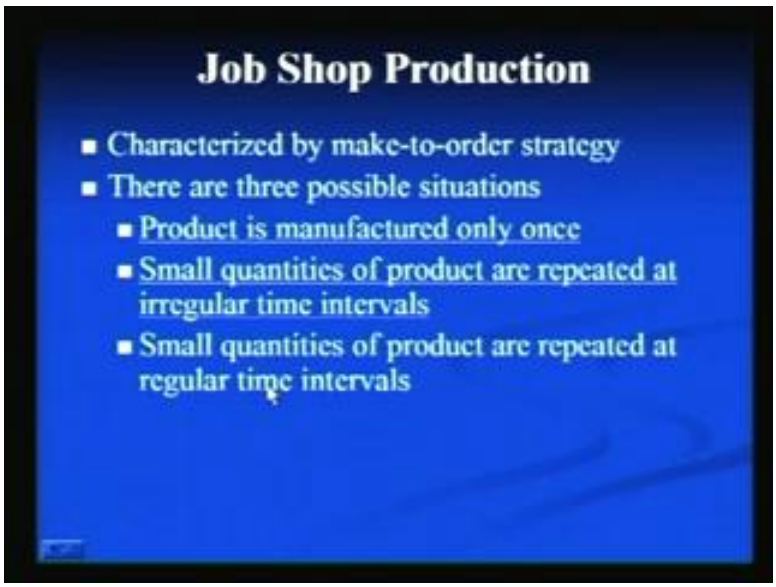

These systems are characterized by make to order strategy that means, we manufacture products only after getting the order from the customer, so we do not make any we do not keep these products in the organization as inventory, so there are not stock for the supplied to the customer. There are three possible situations in job shop type production environments, one is product is manufactured only once and that product is never repeated in future.

So, that is one of a kind of the product for example, say products manufactured by the produce, so many units of that product because demand is there in the market, so we can say this is the third kind of third type of situation in job shop type of production. But when we talk about job shop of type of production system we say first and two are most common; that means, product is manufactured only once and a small quantities of product are repeated at irregular time interval.

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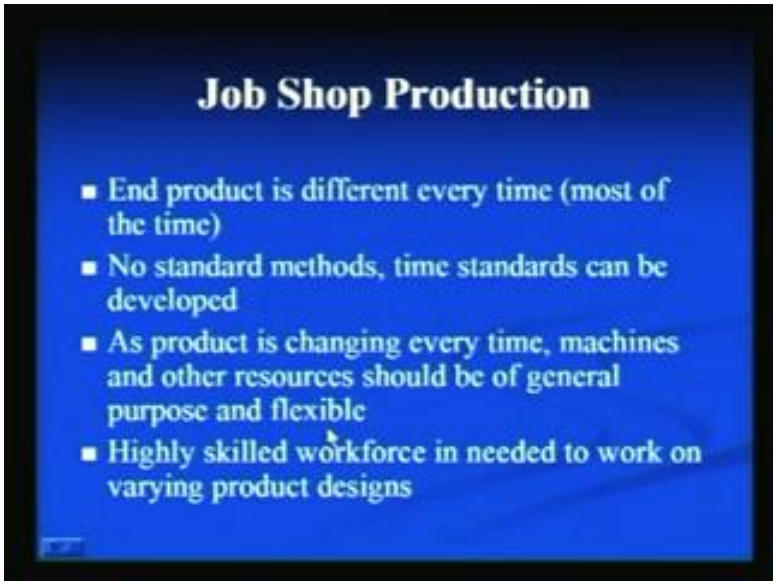

Another characteristic of job shop type production is that end product is differential every time or I should say most of the time that means, we never repeat the same product, so product is different every time, because here we use a strategy that we call as made to order, so as per the requirements of the customer. No standard methods time standards can be developed, because product is changing every time, so there is in fact no need to develop standard method time, standard etcetera to standardize the processes for manufacture of that product.

Another characteristic is as per product is changing ever time, machines and other resources should be of general purpose and flexible, because your product is changing that is why the requirements of the products are changing and accordingly the machines and equipments which you use in job shop type of production system they should be of general nature and they should be flexible in nature.

So, that they can be used for different type of materials, different type of jobs for different type of shapes and sizes, so the equipment should be of general purpose general or flexible in nature. Another characteristic of job shop type production system is that, we need to employ highly skilled work force reason is very simple, because we are changing our product very frequently.

Our product is changed ever time that is why there is a need to employ highly skilled workers who can work on different type of products, different type of situations and sometime we mean at different places. In case of ship building industry, because in that

case product is very large in size, so it cannot be manufactured in the plant, so you have to move your workforce your equipments etcetera to the product side itself, so the workforce which you employ in this type of environment they should be highly skilled.

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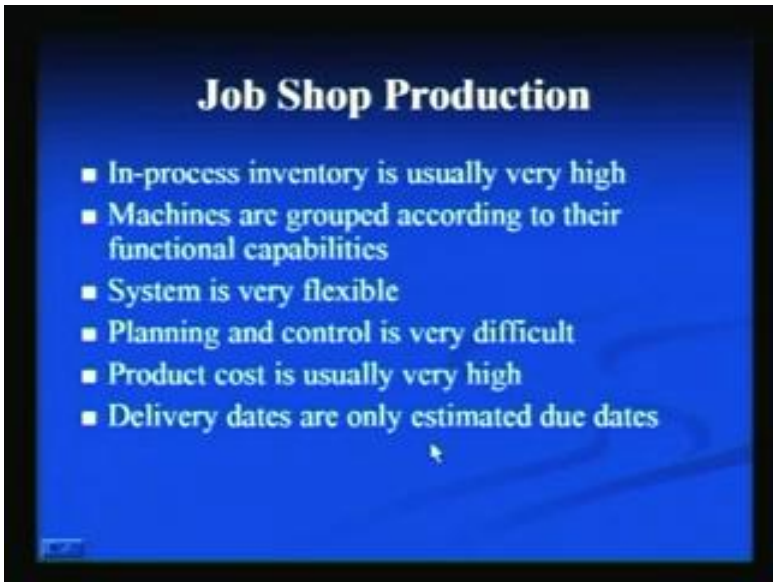

Another important characteristic of job shop type production is that in process inventory is usually very high in process inventory sometime we define as work in process, it is usually very high, because we do not plan for that product in advance as soon as the order comes we start making plan for that product. And usually what we try to do you try to make sure that no shortage of material occurs for in that company in future, so that is why normally the in process inventory or work in process is very high.

Another important characteristic machines are grouped according to their functional capabilities, because we use several general purpose machines in job shop type production system and these machines should be grouped as per their functions or functional capability. See all lathes may be grouped at one place, milling machines may be grouped at another place all welding equipments may be grouped at third place etcetera.

So, that product can move from one section to another section as per the requirement of the manufacturing operations and system is very flexible in nature reason is very simple, because your product is changing ever time you cannot make a production plan in advance. So, that is why you need to have a flexible system, so if there is any change in

the circumstances if there is any change in the raw material supply if there is any change on the shop floor immediately you can replan or reschedule your operations.

And, in such type of systems planning and control is very, very difficult reason is very simple, because everything is flexible in nature no certain plans are there no schedules are there that means, you have to go for very strict planning and control mechanism. So, you have to monitor your progress regularly you have to report all the deviations to the management and, then suitable corrective actions are re-planning must be done by the planning section.

Product cost is usually very high this is because of the highly skilled work workforce that is employed in the organization that is, because of the high work in process in the organization that is because of the nature of the planning and control system we use in the system. So, that is why the product is cost is usually very high that is why you can see the cost of a ship or aircraft is very, very high as an example.

And delivery dates are only estimated due dates, because all the system or all the activities are bit uncertain and system is very flexible, so the due dates cannot be the confirmed due date they are just the estimated due dates. And, we try to fix a due date on the basis of our estimate that this work or this product can be delivered on such date, but it is a normal practice that some delay is always there are always there.

So, sometime what will happen that we the customer and the manufacturer may sign a contract they can have a sort of penalty clause also that if product is not delivered by this date then some penalty will be imposed on the manufacturer side. So, all these things should be taken care of by the management while finalizing the due dates, another type of production system is batch production.

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If you look at the characteristics of batch production, a batch of identical articles are manufactured in such an environment, for example say printing of the textbook we manufacture hundred copies of the textbooks; that means, article is same only thing is that, it is manufactured in limited quantities. Another characteristic of this system is that demand is usually less than the rate of production, so basically when we produce a batch identical articles that means, we have to keep that batch in our store for sometimes.

So, there will be a built up of inventory of the finished products in this type of situation and again there are three possible situations in batch type production, one is batch is manufactured only once that is similar to the job shop type of production. And here, we classify this as made to order means once we get an order we manufacture the batch and supply the customer.

Another is batch is repeated at irregular time intervals that is again made to order means you do not make it to stock, so once you get an order you just complete that batch and deliver it to the customer. And, third is batch is repeated at regular time intervals means there is a continuous demand of that product in the market, only thing is that demand is less than the rate of production.

So, once you manufacture those unit those items and then keep them in the stock or inventory for say next five months or six months, once that inventory or that stock is finished than again you start manufacturing that batch. A good example of this situation is the printing of the textbook, you make hundred copies of a particular textbook and

then keep them in the store, so once those hundred or thousand copies are sold again, then again you repeat the same thing.

So, you reprint you get the reprint of the books, so this is the make to made to stock type of situation and here among all these three situation last two are the most common situations, because if batch is manufactured only once, then it is similar to the job shop type of manufacturing environment.

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Another import antibiotic characteristic of batch type production system is final product is usually standard or may belong to the same family, when we say it is a standard; that means, identical to the previous product that means, it is design is similar or we can say it may belong to the same family. So, family is same or basic design of the same of that product is same only few features or few functions may be change.

For example say manufacturing of the, you can say television sets, so you will manufacture a television set only thing is that, the design of outer periphery of the product may be different, but basic design or of the product basic unit will remain same. Another characteristic that, customer may be external or internal this is very important in case of batch production, your customer may be outsider means you have to supply that product to the external customer to the market or the internal means from one department to another department.

Say one department manufacture one sample as in case of automobile industry, engine assembly plant is their gear assembly plant is there, so they are basically the independent

units, but at the same time they are supplying those products to the other plants of the same organization. So, in that case your customer is internal, batch size is determined either by forecasting or by order size, these are the two techniques or two methods which we use in case of batch production.

Batch size is determined by the forecasting technique that is, only when your customer is external and by order size when your customer is internal and machines may be either general purpose or semi automated. General purpose because sometime your product may be of different type, but belonging to the same family, so some of the machines may be of general purpose.

But, most of the machines are semi automated in batch type of production environment reason is simple in case of semi automated machines. We can achieve higher rate of production we can stream line over manufacturing operations and we can try to simplify the production planning and control function.

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Another important characteristic of batch production system is machines are grouped as per their functions as we do in case of job shop type of production system, means lathe section milling section welding sections are created. A skilled labor is required, because they have to operate the semiautomatic machine they have to work on similar type of products, but of a different nature.

Less supervision is required in comparison of the job shop type of production environment and this type of environment is less flexible than the job shop type of

environment. Planning and control is less complex if we compare this with the job shop type of system, reason is very simple, because product is identical in nature. So the amount of planning and control which we need is less and due to this the same planning and control system can be used again and again for the similar type of products. Another type of system which we use is mass production system or classified mass production system.

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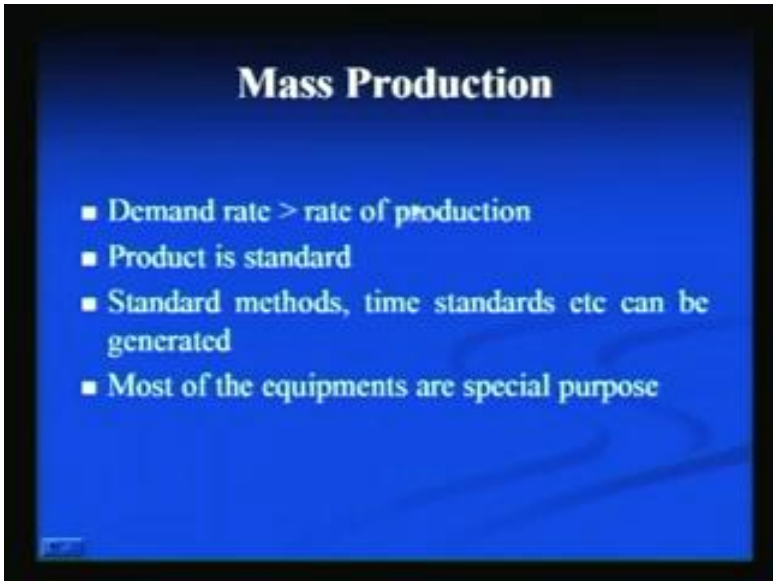

Here the characteristic of mass production systems are one of them is demand rate is greater than the rate of production that means, demand is always higher than the rate of production. So, companies have to adjust their operations in a manner as they can maximize their rate of production to satisfy the market demand, here product is always standard similar type of product is manufactured again and again for long time.

A standard method time standards etcetera can be generated, because you are making same product, so there is a need to develop a standard method there is a need to develop time standard, so you have to generate these in the organization. Most of the equipments are special purpose, because these equipments are designed for that product only to maximize the machine utilization to maximize the rate of production.

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Another important characteristic that it is capital intensive system and needs elaborated programming, reason is very simple because you want to use fully automated equipments and machine, so this is a capital intensive system it needs lot of investment. And, this needs elaborate programming in advance, because you have to see that the market can sustain that type of demand in future also, so here long term planning is very, very important for the organization.

Semi skilled labor or sometime even unskilled labor can be employed for supervision only because most of equipments are automated in nature, so there is a need of supervision only, because all the operations are carried out by the machines themselves. And, day to day planning and scheduling need not to be elaborate in mass production system, because it is planned once and then all operations are run automatically.

So, there is no need to plan and prepare schedules on day to day basis, so and this system is very, very rigid in nature means, if there is any change in the circumstance there is any change in the inputs or in the shop floor. Then it is very, very difficult to incorporate those changes in the plans for re-planning and rescheduling. So, we have learnt about the concepts of production planning, production control, control systems which are used in the production organizations we have learnt about the production planning and control as a whole.

We had discussed about the sub functions of production planning and control, we have also discussed about the methods or the approaches which we use for the classification of

manufacturing systems. We had talked about the job shop type of manufacturing environment, batch type manufacturing environment and mass type of manufacturing environment, we have discussed about their characteristics and a bit of comparison between them.

Thank you very much.