Operations Management
Dr. Inderdeep Singh
Department of Mechanical & Industrial Engineering
Indian Institute of Technology, Roorkee

Lecture - 27
Process planning

[FL] friends, welcome to session 27 in the course on Operations Management, we are currently in the sixth week of our discussion and today is the second session in production planning and control. In our last five weeks, I think I will just like to have a brief review we have covered the basic aspects of operations management, we have covered product design and development, we have covered demand or sales forecasting, we have covered plant location and we have covered plant layout.

So, discussion regarding five weeks is over and currently we are into the sixth week of our discussion. And we have two and a half hours dedicated for production planning and control; why am I emphasizing on two and a half hours is, because this topic production planning and control is usually taught as a full fledged UG program or UG course in most of the college and universities.

So, we may not be able to cover everything related to production planning and control, but certainly we will try to address few important tools or techniques; which are important when we are studying this important topic. So, we will be considering two, three important points like the process planning, then we will be covering the aggregate production planning and finally, the capacity planning. Because basically the task is the planning task only in operations management and the execution then will be followed at the control stage.

So, we may not be focusing too much on the control part, but we will be focusing much more on the planning part. So, from the planning point of view; PPC has got certain advantages and certain limitations. And we will start our discussion today with the advantages and limitations of PPC, then followed by the basic aspect of process planning.

And finally, we will see that an example where we can calculate the number of machines based on the data that is available with us; that is how many number of products we have

to produce? What is the machine capability? And depending upon these parameters; how many number of machines will be required to meet the demand?

So, basically that will fall under the process planning because now we have to see that how the raw material will enter into the company? Then we have to see that which machines will be used to operate this raw material? And at what rate these machine will be working? Who are the people who will be responsible for working on these machine? How much time will be required in each machine? What will be the delay for; maybe what will be the work in process during the overall operation or the overall maybe product cycle?

Then all these parameters we have to take into account while we are making our planning activity or when we are doing our planning activity for a particular batch of products. So, we have to take into account the time we have to take into account, the man we have to take into account, the machine.

So, all these things have to be managed; in brief all the production resources have to be managed in such a way that our optimal utilization is ensured and we are able to achieve the four important objectives of operations management. That is again I am reiterating, again I am re emphasizing the four words again; the quality, quantity, time as well as the competitive cost. So, we have to ensure that our production is of right quality, in right quantity, we are able to produce at the right time that is the delivery date which has been fixed and finally, the production must ensure that the competitive cost is also achieved.

So, production planning and control as we have seen in the previous session is focused on the planning of our production; in such a way that we are able to manage, we are able to make best possible utilization of the resources that we have at our disposal. And with this background; let us now try to see that if we are able to do the PPC activity; that is the Production Planning and Control activity successfully, what are the advantages that we can derive?

And if we are not able to do the PPC or what are the limitations of the PPC? Where PPC will not be much helpful to us? So, let us start today's discussion with the advantages and limitations of PPC.

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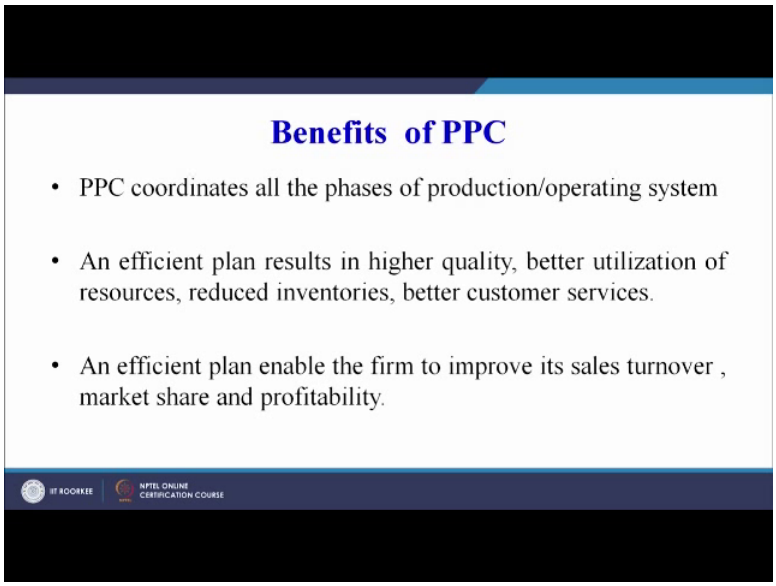

So, on your screen you can see the benefits of PPC. So, production planning and control coordinates all the phases of the production system. Now all the phases means that the management activity will ensure that from the start of the procurement of raw material, to the final dispatch of the finished goods; all operations or all maybe we can say activities, jobs, events will be in the overall focus area of production planning and control.

So, PPC department will ensure the smooth operations; a continuous operations so that the due date of delivery is met in the most efficient manner. An efficient plan results in higher quality, which is one of the objectives of operations management. Better utilization of resources; as I have already highlighted that the main objective is to ensure the optimal utilization of resources. Reduced inventories; so we do not want to block our money by keep a very large sized inventory, we would like to keep a inventory which is maybe there is a new concept or just in time.

So, when the product or when the part is required; we must get that part. So, an inventory must be; maybe as less as possible working process must be less, better customer services. So, basically if we are able to do our production planning and control activity in the most efficient and effective manner; we will get better quality, better utilization of resources, reduced inventories and better customer services. An efficient plan enables the firm to improve the sales turnover, market share and profitability.

So, if we take a similar example of our life only; we get suppose 100 rupees salary in a month. And suppose out of the 100 rupees; we are able to judiciously spend on our requirements, on our family requirements. So, we are use making use of the resource that is the money that is available with us; in the most cost effective manner, we will definitely be able to save some money for the future also.

So, the best utilization of the resources will always help the organization to be more profitable; to be more maybe the sales turnover will increase. Similar is the case of the organizations; so, if the resourced are optimally utilized, the man power is optimally utilized, the machines are utilized to the maximum possible extent; then in those cases the overall sales turnover will increase, the profitability of the company will also increase; overall we can say the economic well being, the economic health of the organization will increase or improve; if we are able to make judicious, optimal, efficient and effective use of the resources available at our disposal.

So, the PPC activity in general or maybe in specific and the operations management in general ensures that whatever resources are available with us; we are able to make use of these resources, in the best possible manner or we must use the tools and techniques available with us to ensure the best possible utilization of the resources. But many times, we are not able to make best possible utilization of the resources; because of poor planning and because of maybe the lack of knowledge related to the tools and techniques available with us.

So, the PPC function is based on certain assumptions or forecast of customers demand, plant capacity, availability of materials etcetera.

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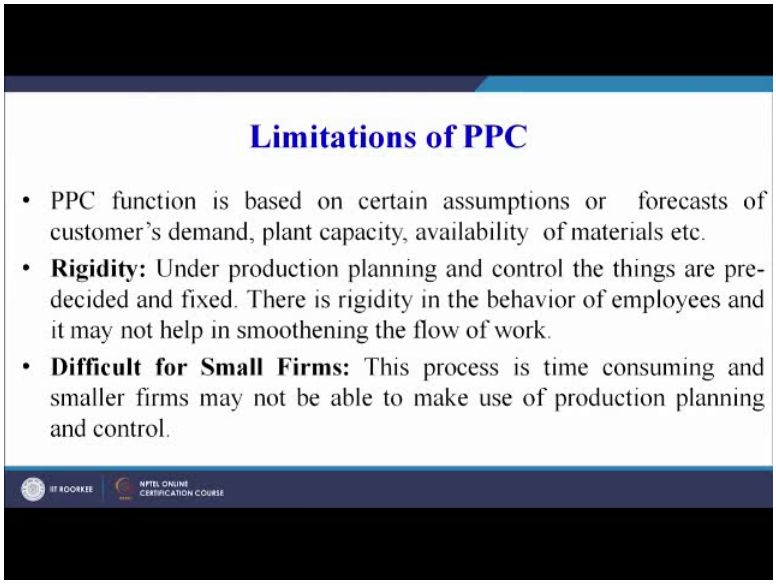

So, whatever we are planning; we are planning based on something, based on some input data. For example, we have already had a discussion for one week on sales forecasting. So, why do we do sales or demand forecasting? To get an idea that what is the demand of the or what is going to be the demand of the product in the next year? So, or in the next two years. Based on that; we do the calculations and we try to plan our production. So, our production is planned based on certain data, which is a forecasted data; which may not be correct.

So, the plant capacity we make a assumption that we will see in an example today; that we have a plant capacity to produce maybe 10000 products per month, using all the 100 machines available with us. But if we see that all 100 may not be working; some may be under maintenance, some may be under breakdown. So, that is also we are planning based on the plant capacity or the overall plant capacity, but that capacity may not be available to us; during the complete month or during a week in a month.

So, therefore, the PPC is based on certain assumptions and therefore, sometimes it tend to be very rigid. So, rigidity is one problem related to the product planning and control because most of the time whatever we have planned; the manpower, the skilled people working for the organization would love to stick to those plans and to achieve those targets. But many a time, there will be some unforeseen circumstances, some unforeseen events in the manufacturing facility which may disturb the plans that we have made.

And therefore, some kind of dynamism or some dynamic planning is required which sometimes is not done by the organizations. And therefore, there are problems related to the delivery dates; problems related to the number of products that we have produced or we want to produce. So, there are issues related to the volume of production, there are issues related to the due delivery dates or the postponement of the due delivery dates.

So, because of the rigidity also there is an issue and then the PPC activity requires certain skills, certain know, how certain formulas. So, there maybe sometimes situation where small companies may be operated by individuals; may not have the requisite skills to implement or to use the tools and techniques of production planning and control.

So, basically these are the three major limitations I must say that are inherent in production planning and control activity. The first one is the assumptions that we make in terms of demand, in terms of available plant capacity, in terms of availability of materials rigidity. Because once the plans have been made, the companies love to stick to those plans and many times; some dynamic planning may also be required based on the specific requirements and then it is difficult for small firms sometimes to implement the PPC.

Now, process planning we are going to cover today.

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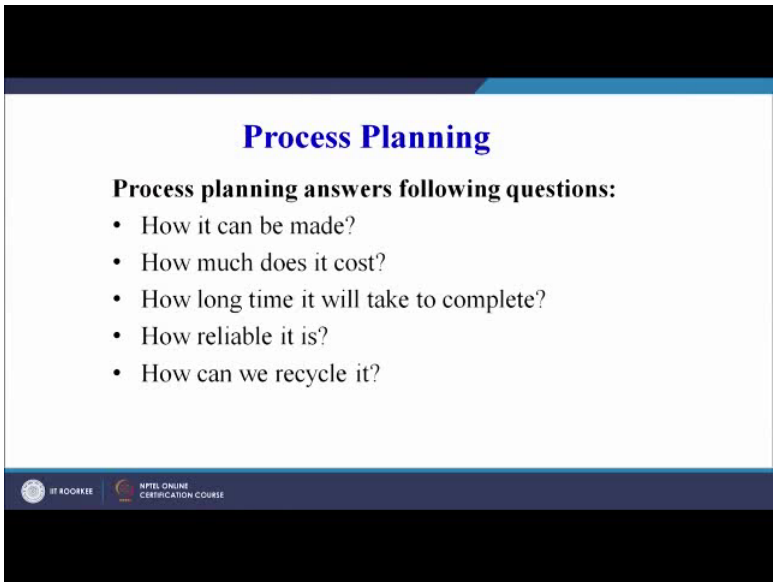

Process planning answers the following questions; let us read the questions first. How it can be made? It means the product. How the product can be made? How much it will cost? How long time it will take to complete? So, time is also coming; process is also coming how it can be made? Then how reliable it is? How can we recycle? So, there can be number of further questions that may be answered by our process planning department or process planning results.

So, basically the process planning will focus on the first two, three points that are mentioned here that; how it can be made? Now how it can be made does not refer here to the actual manufacturing process that; suppose we are doing casting. So, for casting how the solidification will take place? And how the mold has to be made? What type of pattern will be used for making this casting? No, it is focussing on the steps that will be required, the sequence of operations that will be required to complete the product or to complete the batch of products.

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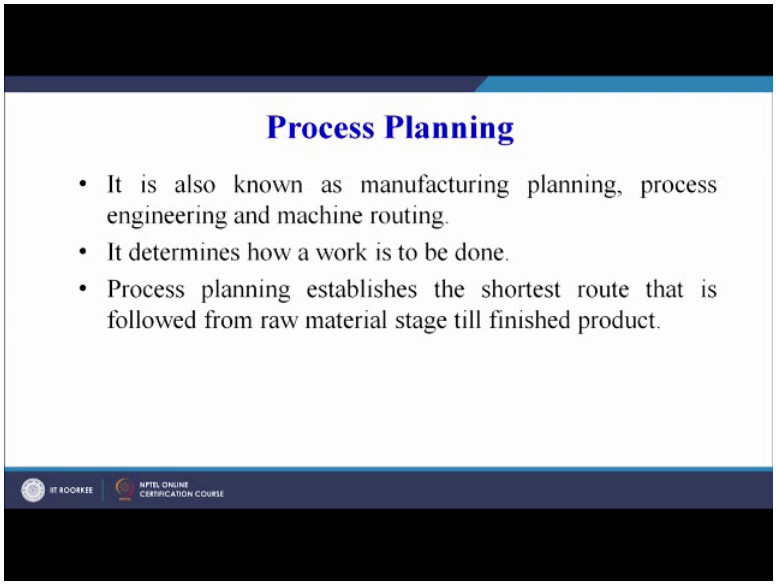

Now, it is known as the manufacturing planning, process engineering and machine routing; so, people may call it with different names. So, basically requiring a complete process, it may have 4 operations, 5 operations. So, depending upon the process we will define what is going to be the sequence? Which are machines that are going to be used? Who are the people who are going to work on those machines?

So, maybe we will plan the complete process; it determines how the work is to be done. So, that is important thing that has to be listed down; as we have seen in functions of production planning and control, there was one diagram which we have seen in the previous session; if you remember. We have seen that there are important steps or important functions of production planning and control, there is a preplanning activity which involves layout planning of the factory; which we have already covered in week 5. So, it requires sales forecasting; it required product development

So, first you have preplanning and then in the planning; you do 4 resources or 4 M's. So, Man, Material, Machine, Money that four resources that we take into account and then finally, we decide on the routing, as scheduling, estimation, dispatching, expediting evaluation. So, these are all functions of production planning and control; so, here also we will see how the work is to be done. Now from how point of view; we will see that what is the route of machines that is going to be followed? As we will estimate the time required for each machine to work on the product, then we will decide the number of people required to work on individual products.

So, all that is being decided during the process planning stage only; so, process planning establishes the shortest route that is followed from the raw material to the finished product. So, shortest route means that the sequence of operations that we are deciding for a particular product needs to be the best possible sequence to get the product.

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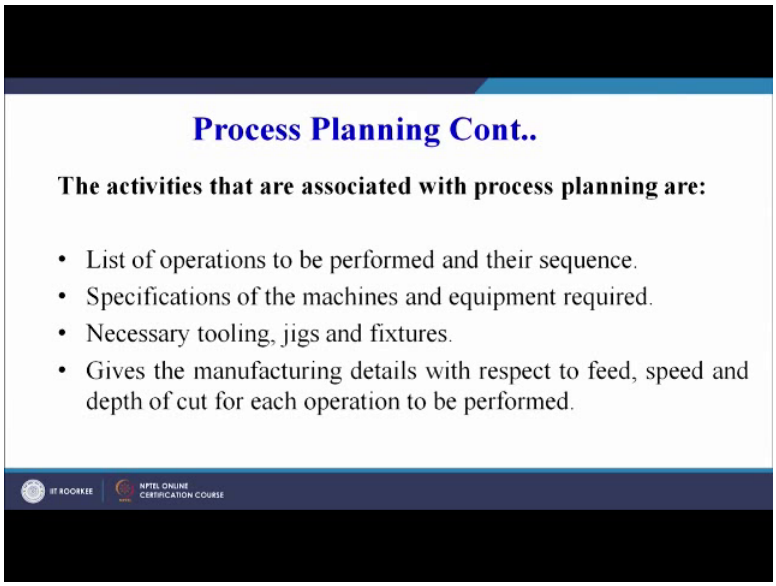

Now the activities that are associated with process planning are like how we can do our process planning? First we have to list the operations to be performed and then we have to decide on their sequence. Let us take an example of making a metallic pulley; now suppose you want to make a metallic pulley by casting process; what is required?

First step I think will be we have to make a pattern. So, first we require to have a drawing of that metallic pulley then we have to develop or maybe design a pattern giving all the pattern allowances. We will make a wooden pattern then we take this pattern to the foundry shop, we will make a mould; then in the mould we will melt the metal pour the metal into the mould and finally, we will break the mould and get our metallic pulley

So, this is the sequence that has to be followed for making a metallic pulley using the casting process. So, this is we have to list the sequence of operations, we have to list the operations first and then we have to establish the sequence that is required to get our product. So, specifications of the machine and equipment required we must know; now we must know that if we have to melt the metal, which type of furnace do we have? We have to melt maybe 5 kg's of metal, then we must see that whatever furnaces that are available with us; which one is suitable for melting 5 kg of metal?

So, the machine specifications, equipment required that also is required for process planning activity. The necessary tooling, jigs and fixtures required; suppose we have to make a sand mould; what are the tools required? Moulding box may be required, then ramming tool will be required; there will be number of tools required for making a mould.

So, all that is also needs to be listed down' gives the manufacturing details with respect to feed, speed, depth of cut for operation to be performed. So, the last maybe point is related to suppose we have to do the machining activity. So, for machining three important parameters are there; the cutting speed, the feed rate and the depth of cut. So, that also needs to be specified; suppose the machining operation has to be done after doing the casting operation.

So, we are doing sand casting; for finishing, we may require to do a machining operation also. So, for machining we may have to specify these three operating parameters like cutting, speed feed and depth of cut. So, basically we can see that process planning does not only require the management knowledge; process panning also requires the

engineering knowledge also. Because we need to identify that how the product will be converted into the or how the raw material will be converted into the product or how the product will be processed though the various sequence of operations.

So, it requires both type of knowledge; it requires engineering knowledge also, it requires managerial knowledge also. Now what are the factors affecting the process planning?

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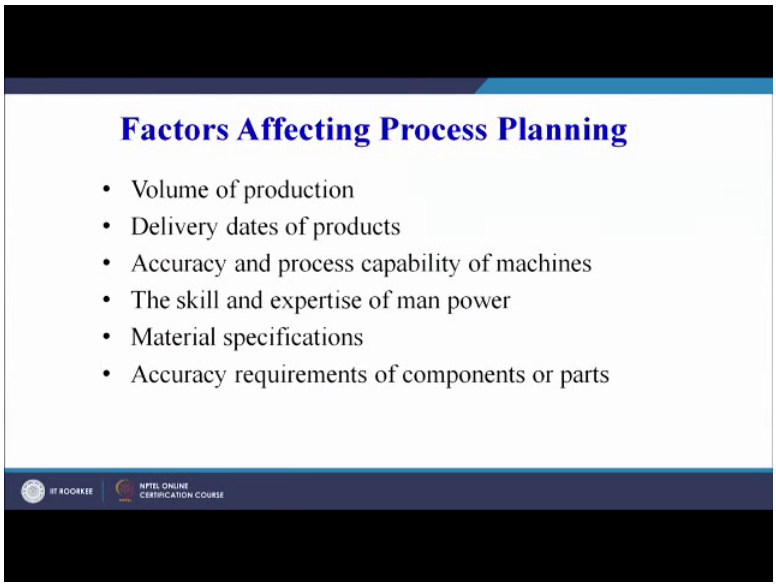

Now, we have seen that how we can use the information available with us for making our process plan. In the previous slide, we have taken an example also that what are the inputs required? So, this information must be available with us; if we have to make a process plan.

Now once we are in the process of making a process plan, we need to consider number of factors. Now what are these factors? Now these factors are the volume of production; volume of production may be in terms of number of products that we are planning to produce in a particular week or in a particular month or in a particular quarter or in a particular year.

So, first thing is the volume of production that will affect our process planning; then the delivery dates of the products, definitely will affect we have to schedule our operations in such a way that we are able to meet the targets. Then accuracy and process capability

of machines that is also very very important to ensure the quality of the final product. The skill and expertise of the manpower is also very very important, material; that is the raw material specifications must be known to us. Because once we know the material, we can very easily select the processes that can be used for that particular material.

Accuracy requirements of components or parts; that is the accuracy; or the specification or the quality specifications of the product, so basically we need to understand that what we want to make? What are the design specifications of that product? What are the quality specifications of that product? That is one thing related to the product that we must know, then related to the machine we must know what is the machine capability? How much quality that machine can deliver? How much volume of production that machine can deliver? What is the maybe preventive maintenance requirement? What are annual maintenance requirement?

So, all details related to the machine also we must know and prior to that; what is the raw material? Whether it is steel or it is aluminium or it is a plastic or it is maybe some advanced material or advanced alloy. So, related to the material also we must have all the information. So, I have I think taken a reverse route; we can take a other route also that starting from the material, we must know all details related to the material; why?

Because suppose we are going to make a metallic pulley, if we are going to make it with aluminium; we need to use a temperature for melting aluminium, which is going to be different from melting of steel. So, first we must know what is the material that we are going to use? Then the processes; for each process we must know what is the capability? How much quality the process can deliver? What is the volume of production the process can deliver?

So, everything related to the process and in many cases; there will be sequence of processes or sequence of operations that have to be done on a particular product or on a particular raw material. So, we must know the capability of each and every machine and finally, what are the quality standards of the product that we must know? So, broadly starting from raw material; the process and the product all these three; all details must be available with us and specifically from process point of view; what are the number of operations; sequence of operations and at each operation what are the details there in; all that information is required when we are going to make a process plan.

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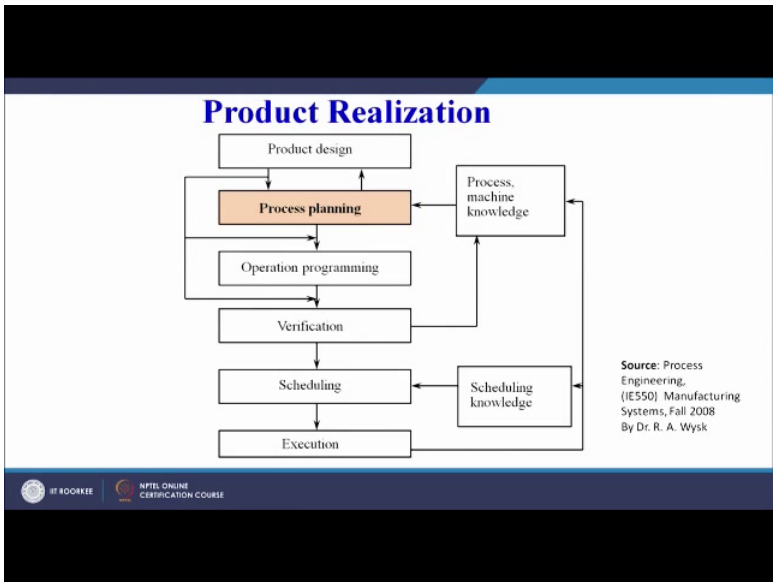

Now, this is product realization; the source is also given process engineering. So, by Doctor. R. A Wysk; so product realization very quickly we will go through this. So, the first thing on your screen you can see; there is a product design. So, once we have a design the material for the product is also finalized. So, we know that the product is going to be made by this material, this is going to be the shape, this is going to be the tolerances, this is going to be the surface finish required.

So, once we know what is to be made? We have the product detailed design specifications, we will go to the process planning and this is what we are discussing today. And once we have done the process planning, we will go to the operation programming where we will maybe; checking will be done at the verification stage. In operation programming, we will make a complete process plan and we will execute maybe the process plan. Then we will verify scheduling, execution and whatever feedback is there; will go back to the process machine knowledge into the process planning. So, maybe this is a representative diagram for product realization that once where product design is ready, then the process planning is an important step in the overall product realization.

So, that is very very important; so, we must remember that when process planning has to be done? So, after product design is ready; we know what is the number of products

required or sales forecasting is done; then we will go for process planning and rest things will follow.

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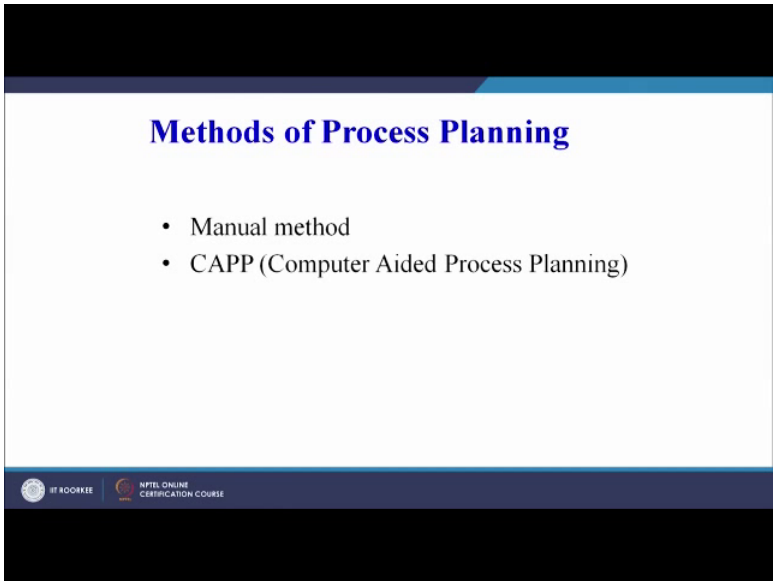

Now very important methods of process planning; now, there are two methods; manual method of process planning and computer aided process planning.

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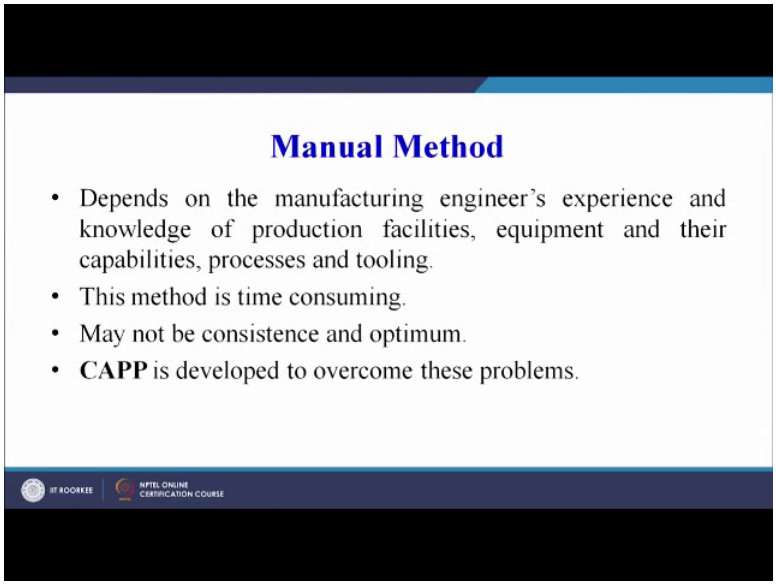

So, quickly we will see; in manual method it depends on the manufacturing engineers experience and knowledge of production facilities, equipment and their capabilities, processes and tooling; I think all this we have already covered. A person or an engineer;

who is going to make a process plan must know about all the processes, about the capabilities of the various processes; he must know the sequence of operations required for a particular product, he must know what are the tools, jigs, fixtures, equipment available? And how they can be utilized for making a particular product?

So, the complete knowledge about the manufacturing facility must be there with the person, who is going to make a process plan. So, this method is usually time consuming method becausethere are a few changes which are beyond the control of the manufacturing engineer. There are certain events which are beyond the control and therefore, maybe to make a effective process plan; sometimes becomes difficult and then there are certain a maybe exigencies to which a factory has to or organization has to respond. And then some of the plans may get disturbed or may not be able to achieve the desired results.

So, this method usually is a time consuming method again and again; you have to change the process plans, then may not be consistent and optimum. So, we are sure because of the dynamic changes happening and if suppose a company is making 5 batches of product and all the due delivery dates are fixed. All of a sudden you get a new order which has to be done and there is a maybe time contract agreement with one of the customers and you are getting lot of profit out of it.

So, you will see that how I can adjust the other 5 batches; so, that this particular batch can may also be put in and we are able to get the profit that we are envisaging that is possible with adjusting the sixth batch products also. So, this sixth batch may be economically lucrative to us, but will disturb the process plans of the other five batches, which may not be a good decision to take.

But many times seeing the economic benefit of the sixth batch; we are maybe tempted to take a decision that let us take this also and we will try to manipulate the other process plans to make this happen or the make the sixth batch also possible. So, that is basically requiring; therefore, it makes it a time consuming process, then you have to adjust everything and if we say that no the sixth batch will not be possible for us, we will focus on our process plans for these five batches of products only, I think there will there must not be a problem.

But may not our; this thing manual process planning may not be consistent and optimum. So, that is also one of the limitations of the manual method; so therefore, there is a new technique which is not new I must say; text is available and in books we can find that topics related to computer aided process planning.

So, these days we are using computers, we are using information technology for developing the process plans based on the capabilities that we have. And there are softwares that can be developed for making use of the plant facilities in the best and the most optimal manner. So, keeping the time paucity into maybe consideration; we are not discussing computer aided process planning here.

But if the time permits in our subsequent discussions, we will see that we can cover this computer aided process planning in slightly more detail. But I think, I have been able to highlight the problems associated with the manual process planning. Because so, many things have to be taken care of and human intelligence and decision making also has got a limitation. And therefore, we make use of computers in our decision making process.

Now, let us take a very small example of machine requirements.

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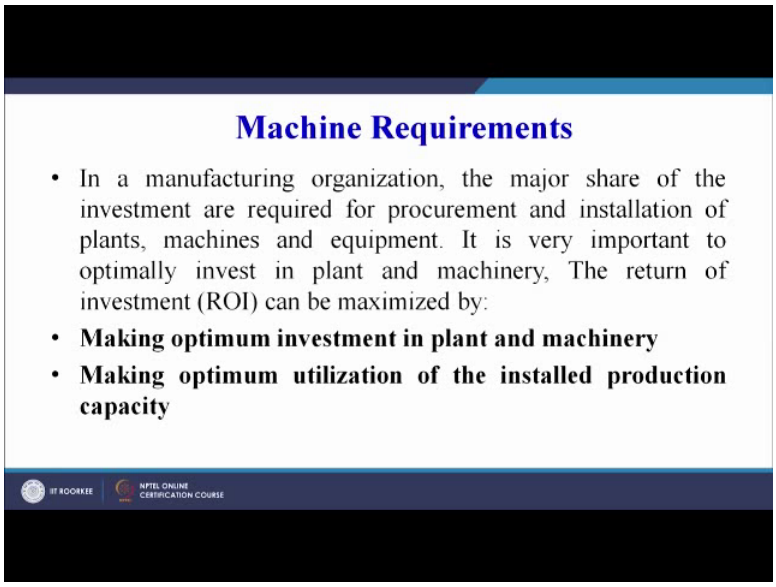

Like when we are doing the process planning; we may have to take a decision that how many machines will be required for achieving our target? So, in a manufacturing organization, the major share of the investments are required for procurement and

installation of plants machines and equipment. It is very important to optimally invest in plant and machinery; the return on investment can be maximized by making optimum investment in plant and machinery, as well as making optimal utilization of the installed production capacity.

So, this is related to one aspect of our resources that are available at our disposal; that is the machine.

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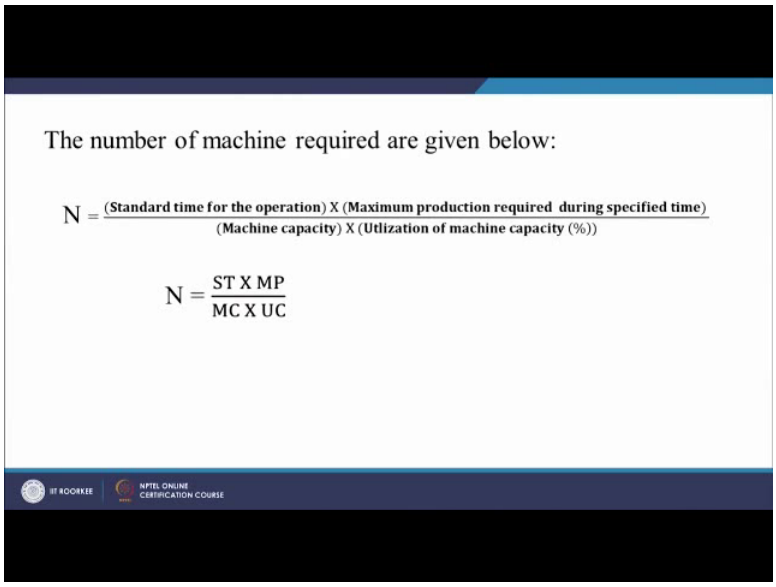

Now, the number of machines required for a given problem or for a given situation can be easily calculated as; so, N is representing our number of machines. So, we can calculate it, we can have standard time for the operation; that we can very easily find out in our subject on time and motion study or motion and time study.

So, in motion and time study we can calculate the standard time for the operation; then we require the maximum production required during the specified time. We must know the machine capability or machine capacity that is also known. Then utilization of machine capacity; so, many times machine capacity we may not be able to utilize 100 percent; so, we have 90 percent, 80 percent utilization of machine capacity.

So, the four unknowns here; if we know these unknowns, very easily we can calculate the number of machines required for a particular situation. And this is one aspect only of

the overall process plan or the development of a process plan; just I am trying to take one example that what type of calculations we do when we make a process plan?

Now, let us take an very simple example.

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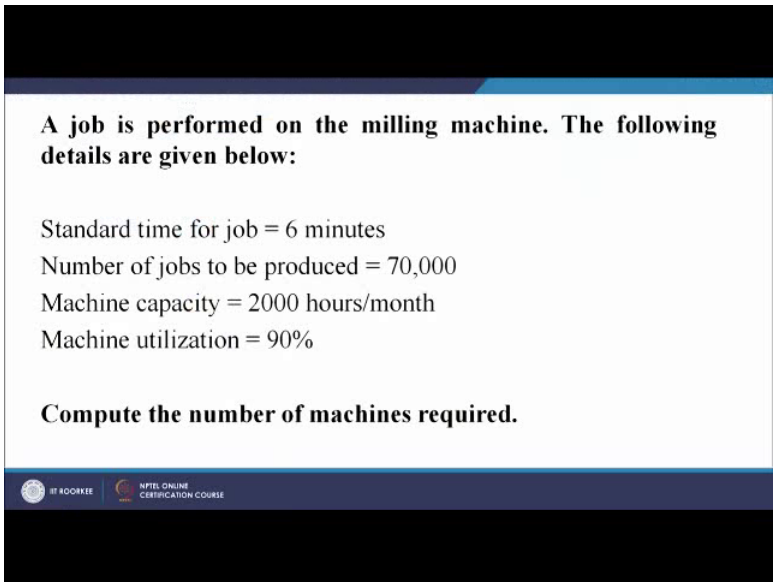

A job is performed on a milling machines which is a common machine in any machine shop. The following details are given standard time for a job; so, suppose we are making a pocket in a maybe; we can say a square pocket in a block of steel. So, square pocket has to be cut; standard time for cutting this square pocket is 6 minutes. If data is given that for cutting one square pocket, you require 6 minute; number of jobs.

So, we have to do 70000 such pockets we have to cut in steel block, machine capability is 2000 per month. So, we can make use of a milling machine and a milling machine has a capability or capacity to work 2000 hours in a month and machine utilization is 90 percent. So, 2000 hours is the maximum capacity, but we can make use of the 90 percent of this only.

So, now we have to calculate that how many machines will be required to achieve this target of 70000 square pockets in a steel block? And for each square pocket, we require 6 minutes. So, very easily standard time is given 6 minutes.

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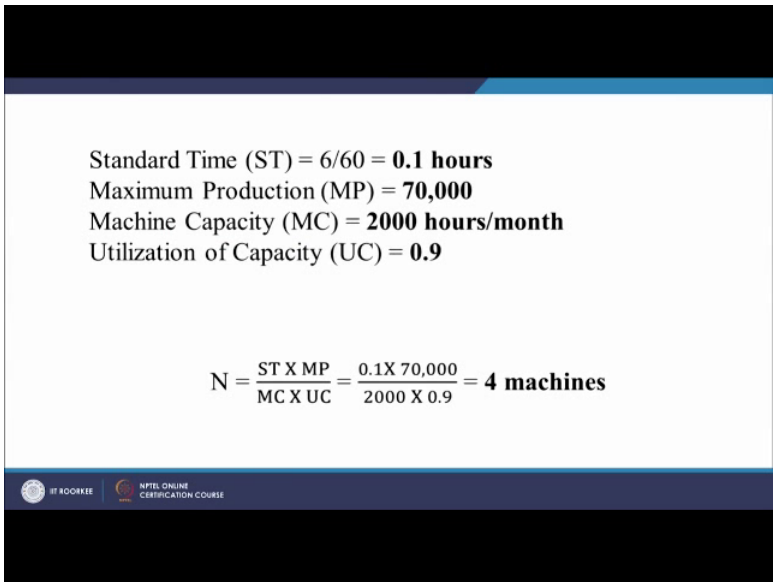

So, we can convert it to hours because the other data is available in hours. Maximum production required is 70000, machine capacity is 2000 hours per month and utilization is 90 percent; so, we get is to 0.9. So, very easily we can calculate what is the number of machines required?

So, by using the formula which was given in the previous slide; where we can calculate, we can see the standard time is multiplied by the maximum production required and divided by the machine capability into the utilization of capacity. So, we can get 4 machines are required to achieve a target of 70000 products; each product requiring 6 minutes of standard time. So, in this way we can very easily make our process plan that in order that all unknowns are known here now; so, we know that 70000 products are to be made and what is the machine capability? What is percentage utilization of machine capability? And what is the total number of products required? Now based on this information, we can calculate the number of machines required.

Similarly, we can calculate the number of people required also. And in this case; simple case only one type of product is being made on one type of machine only. So, we can calculate the number of machines, but you can see that is there is a product which require 10 different operations; on three different types of machines. So, you can yourself imagine the complexity involved in developing a process plan; in such a case or for such

a maybe difficult situation. So, therefore, we are using a computer aided process planning technique for making the process plan nowadays.

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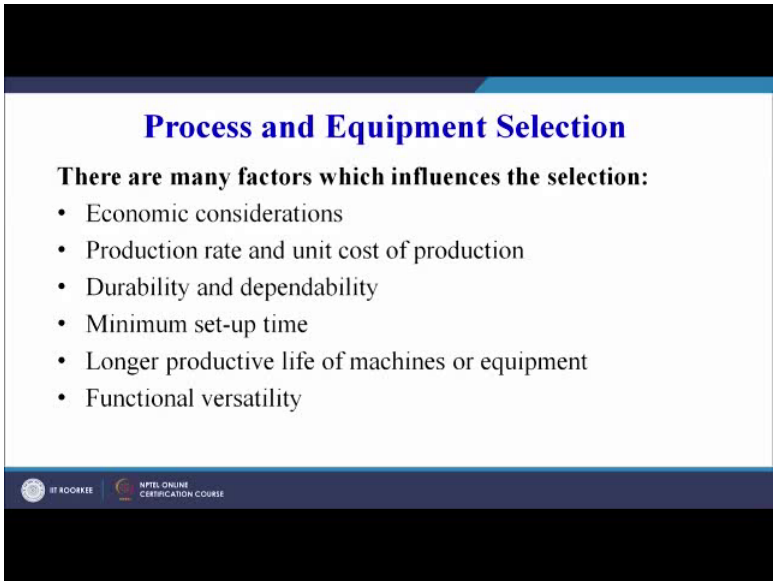

So, last slide that I want to cover in this session is the process and equipment selection. Because when we are doing process planning, we definitely would love to select our process and equipment judiciously so that we are able to meet our overall objectives. So, there are many factors which influences the selection; some of them are listed here. So, first is economic considerations, production rate and unit cost of production; durability and dependability, minimum setup time longer, productive life of machines or equipment, functional versatility or maybe the versatility of the equipment and the machines.

So, basically when we are trying to make a judicious selection of our process and equipment; these are the parameters that we need to take into account. And if we are able to ensure all these things; their setup time is less, the cost effective production is being ensured, machine capability is being utilized to its fullest, we are able to meet the delivery dates or the due targets. So, then our overall process plan; we can say is a successful process plan based on all these factors.

So, with this I conclude today's session; in next session we will cover two important topics in our remaining sessions. In the next session, we will cover the aggregate

production planning and in the remaining two sessions; our focus will be on capacity planning. So, with this I conclude today's session.

Thank you.