Management of Inventory Systems
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Lecture - 47
Theory of Constraints and Materials Management (Contd.)

So, during the last lecture sessions, we have the come across the several the terms and terminologies related to the theory of constraint particularly you know, it is a three important terms you must always remember.

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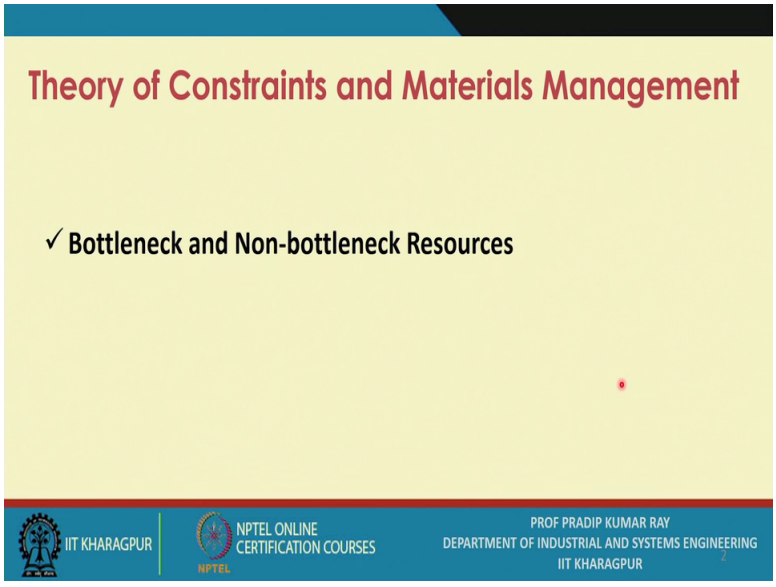

That is the first one is the throughput, we have defined, what is the throughput. The second one is inventory and the third one is the operating expenses. And we have the three important say the organizational performance measures the some. So, the first one is net profit and the second one is the return on investment and the third one is essentially you know amount of the cash flow and what do you try to do; that means, the organizational performance measures must be defined in terms of this, this three terms.

One is the throughput, the second one is the inventory and the third one is your operating expense. So, this is your starting point. Next, what you are going to discuss that is the bottleneck and non bottleneck resources, ok. So, we will proceed slow so, that your understanding will be appropriate and the later on when you take of many kinds of the modeling techniques. So, if you have you know the basic understanding, so the terms and

terminologies and which context to they relevant, then the understandings of the methodology will be, will be you know real also the appropriate.

Now, we have also defined what is what is a constraint and the constraints can be of two types; one is the external constraints, we have given several examples you try to find out the possible examples of external constraints that is your staring point and the second one is your internal constraints. So, there are many examples of internal constraints. So, some of these examples already we have given and what we have mention that the internal constraint is nothing but the bottleneck, ok. So, now, we are we are reaching level where you know we need to define what is a bottleneck and what is the non bottleneck with respect to a particular resource.

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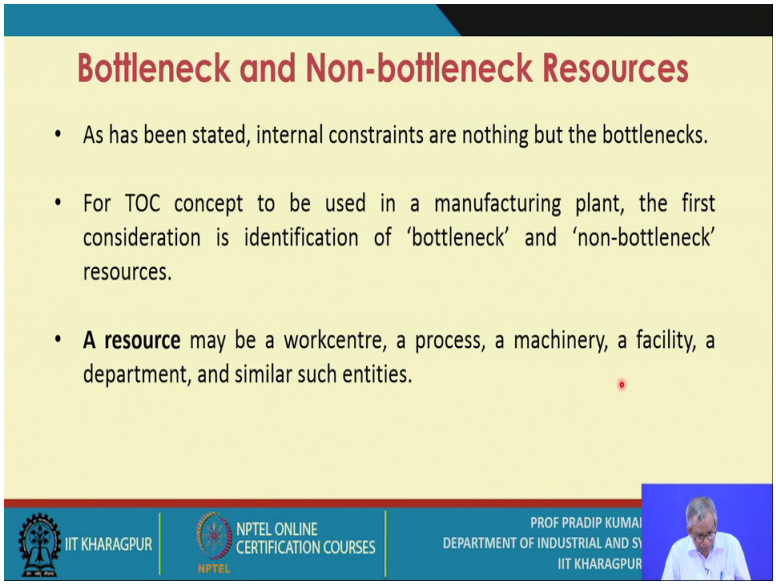

Now, as has been stated, in the in the last lecture sessions I have already pointed out the internal constraints are nothing but the bottlenecks, ok. So, that is point number 1. Now, for the TOC, your theory of constraints concept to be used in a manufacturing plant, usually you know just a point to be noted though we are saying that the TOC is a general methodology which can be applied for any type of organization.

But what will find that the most of the case studies related to TOC, they are essentially the case studies related to the manufacturing systems and more specifically, related to the jobs of kind of manufacturing system or the repetitive manufacturing or discrete part manufacturing systems. Or sometimes, they are referred to as batch protection system

and as I have already pointed out that the batch protection actually the consist of the 70, 70 to 80 percent of the total production system in the industrialized countries and so tools and techniques are mostly directed to ours, such tools and techniques are mostly directed or say used or the developed or the discrete part manufacturing system because these system is a most the complex one.

There are the numerous factors affecting it is performance and getting a perfect or acceptable ok, even satisficing solution for the scheduling problems, it is a real challenge. So, similarly the TOC is mostly applied for the discrete part or the manufacturing systems or the jobs of. Now for TOC concept, we used in a manufacturing plant the first consideration is identification of the bottleneck and non bottleneck resources.

So, the first you must know that what is a resource, once the resource is defined then you need to define what is a bottleneck resource and what is a non bottleneck resource. So, what is a resource? A resource may be a workcentre, a process, a machinery, a facility, a department and similar such entities; that means, in other words a resource is an entity where certain value addition is done; that means, there is some value addition. That means, suppose a raw materials is getting processed on in a in a particular so the machine tool on a particular machinery.

So, the input does a raw material. So, the rough stock, output has a part or the process part. So, this so, there is a value addition in terms of it is use in terms of it is in the shape and size. So, the value addition is there, has to be there. So, this is referred to as a resource. So, there are examples like sometimes referred to as a profit centers, sometimes they are referred to as a cost centers. So, the definition of resource is known to you.

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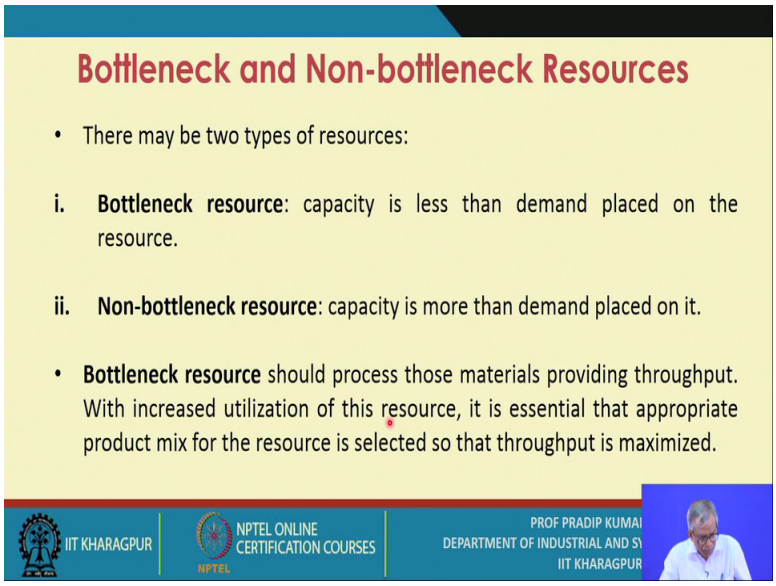

Next is there may be two types of resources. In this context, there may be you know the resource can be classified from several perspective some from where diff from several criteria. So, here our basic criterion is the constraint. So, in the context of you know identification and controlling the effect of constraints. So, there are two types of resources you should be aware of.

First one is bottleneck resource. What is a bottleneck resource? That means, in a bottleneck resource the capacity is less than the demand placed on the resource. for example, suppose a capacity of a particular say the machinery is say 1000 units it can produce of a given part per hour your per sheet. So, that is it is capacity in terms of say production rate or the number of the units in a particular say time period. So, that is the capacity.

Now, the demand could be so, suppose it is 1000 units per hour is per shift is it is capacity whereas, the demand could be 1500 units on that same resource, on the same machinery. So obviously, that capacity is less than the demand placed on the resource. So, you treat this resource as a bottleneck resource this is very simple definition. So obviously, if there is a bottleneck resource that could be non-bottleneck resource also. So, what is the non-bottleneck resource? That means, the capacity is more than the demand placed on it; that means, your capacity is 1000, but your demand is say 500 or

say 200. There are many such resources you may come across at a particular point in time in a in a manufacturing plant.

So, the first thing you need to you need to do; that means, out of n number of such resources we have defined, now how many are in the bottleneck category, how many are in a non-bottleneck category. So; obviously, the demand level must be known if the demand level is not known, then obviously, you cannot define what is the bottleneck and what is a non-bottleneck; now the bottleneck resource should process those materials providing throughput.

Now, our main goal is something you produce which you can sell and only when you sell, you can get the throughput. So, suppose you produce 1000 units and a particular point in time during of a period of time and you can just sell say 500 out of it. So obviously, your throughput is 500 whereas, the remaining 500 units you, it specifically is a waste ok. So, where should we should be as many as possible and logically it should be 0.

So, why do not you produce as per you know, why do not you produce in such a way that is it is converted into throughput. So, that is the main goal of TOC is it ok, you please make a note of this comment. So, what do you try to do; that means, the bottleneck resources because of it is capacity constraint is unable to produce; that means, there is a demand and if you produce more than your capacity as per the demand obviously, will be producing the throughput.

So, you have to think of where is an means of a so the improving the utilization sorry improving the performance of the bottleneck resource; that is point number 1, that is the first priority in any TOC exercise. Now with increased utilization of this resource, now utilizations you know that what is the definition of utilization, but here in under TOC concept, the utilization means that that means, the number of units which you produce out of say the total number required is it or the count total number say the given to be produced.

Now if we utilize it that means, suppose the 50 percent of the time you are utilizing, your the machine tool it means that whatever you produce say whatever this 50 percent you have produced this 50 percent of the time you are running a machine, whatever you are produced that you can sell that means, it is converting it is converted into the throughput.

So, with increased utilization of this resource, it is essential that appropriate product mix for the resource is selected. So, the throughput is maximized; that means, many a times what happens that because of inappropriate product mix, we are not getting the demand.

So, if you do not get you know adequate say the demand obviously, you know even if you produce you cannot sell and if you can say the change the product mix in such a way that the demand grows; obviously, you know you feel like producing as per the demand requirement is it as per the demand so, so that the condition of say two group production is met ok.

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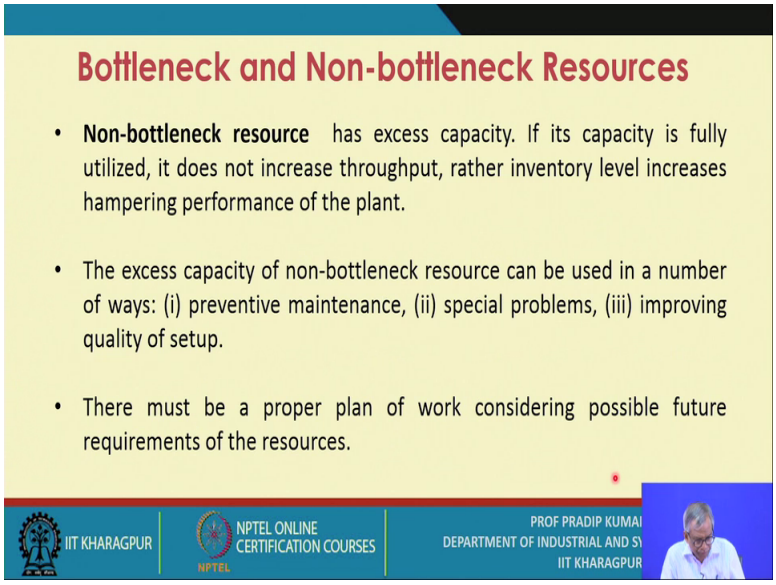

So, this is one second one when you talk about the non-bottleneck resource; that means, where the capacity is more than the demand. So, it has obviously, the excess capacity. This way we define whether a particular resources excess capacity or not, if it is capacity is fully utilized then what will happen? It does not increase throughput because you will be producing definitely, it is requirement is 500, it is capacity is one thousand now if you produce 1000; obviously, the 500 unit you cannot sell.

So, out of this 500, you cannot have throughput rather inventory level increases hampering performance of the plant; that means, the flow of materials in different forms a, the flow will not be smooth and the flow will be hampered; that means, the flow rate. So, it reflects essentially a bad inventory control systems and the bad production control. So, this is to be avoided. The excess capacity of non bottleneck resources, now the

question is that you have the excess capacity. And the capacity is to be used capacity of excess capacity of the non-bottleneck resource. So, what are the ways? That means, you do not want that that the machine remains idle, that also you do not want. So, what is alternative? So, alternatives are the excess capacity of non-bottleneck resource can be used in a number of ways. So, these are the alternatives the first alternative is the preventive maintenance ok.

So, why do not you use is for the preventive maintenance for that particular the machine tool ah? So, the preventive maintenance is a must. If is there any special problems with this machine? Normally, this is the case each machine is a unique one and while you start using a particular machine. Suppose I am a worker or I am a supervisors or I am a manager ok, the line manager against a particular machine I know that what are the special problems.

So, when you get you know a say extra time ok. So, during this time, what do you try to do you try to look into the special problems with respect to may be with respect to the design of that particular say the workcentre or say it is work holding devices, there could be some problems automated storage and retrieval systems ok. So, there are the different kinds of problems always you may come across with respect to a particular workcentre.

So, why do not you utilize the excess time for that purpose? And the last option could be the improving quality or quality of set up. So, this is an important issue like you know when you refer to the throughput time of a particular manufacturing plant. So, the total throughput time so, one of the important the element in the total throughput time in the setup and as we have mentioned that the setup is essentially a non value adding activity. So, why do not you try to reduce it. So, always you try to improve the try to improve the quality of setup and if you can improve the quality of setup, what happens the setup time gets reduced and the setup cost also gets decreased.

So, there must be a proper plan of work considering possible future requirements of the resources. So, this is an important point; that means possible feature requirements of the resources. So, you must have say a particular work plan or today may be it is less loaded, but in course of time. So, you must you know information of say the future requirements and accordingly you have to make a plan like. So, if you find that for a given non bottleneck resource in future it is expected that the this may become a bottleneck

resource. So, what you try to do right at this point in time, you look after it is preventive maintenance. You know the approaches all these methods whether improvement is possible the special problems, will look into and you try to improve the quality of setup ok.

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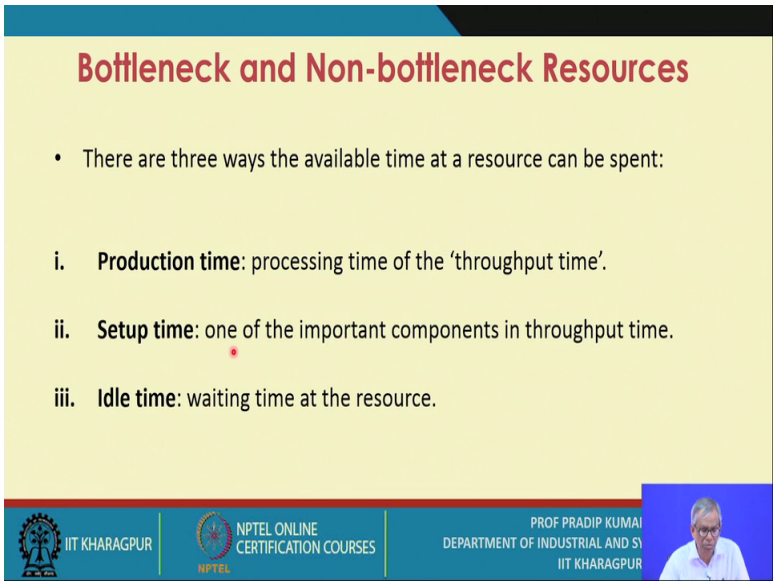

So, this is the context. Now, there are three ways the available time at a resource can be spent ok. It is in general any resource that any machine tool or the box center the three different ways you it can be used. The first one is it is used for the production purpose. So, that is quite natural. So, this is referred to as the production time. So, it has it is production time processing time of the of the throughput time, processing time of the throughput time you know the throughput time consist of 4 time elements. The first one is a setup, next one is a processing, third one is a transport transfer and the fourth one is a waiting time or the queuing time.

So, the processing time essentially the production time you refer to it is it is nothing but the processing time. The second one is the setup time I have already elaborated one of the important components in throughput time and the third one is obviously, the idle time due to many reasons. There could be idleness or the idle time waiting time at the resource, is it ok.

There could be many reasons like the machine is machine is ok, but it is waiting for the material that is why the machine is idle or the material is there, the person is there but the

machine is not in working condition machine is under breakdown ok. Or the machine is in running condition, the materials are there the person is there but you cannot run the machine because the cutting tool has there is no cutting tool, appropriate cutting tool available. So, there could be many reasons that why a particular resource remains idle.

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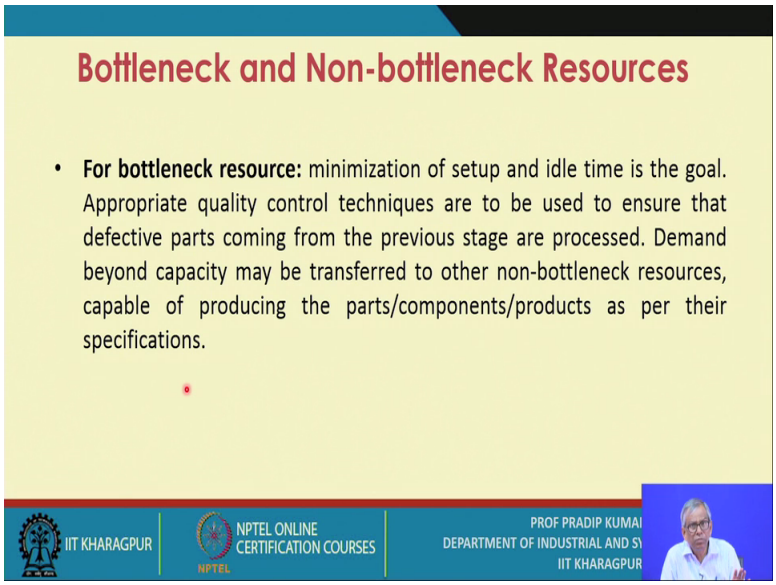

So, you must have thorough idea that means, resource wise you must have these information. You cannot generalize it as I have been telling, you that when you try to implement the TOC; that means, it is to be implemented at the soft floor at the plant level; that means, it is a practical problem or a particular situations you come across that means, essentially a data based modeling. So, the against each resource the possible reasons of it is idleness must be recorded and must be known in specific terms. For the bottleneck resource, how to the improve it is utilization already it is constraint.

So, what are the ways and mains with which you can improve it is throughput production. So, the minimization of setup and idle time is the goal, here you focus. In many a time when you refer to the case studies, you will find that the practitioners they find there is a lot of opportunities for setup reduction setup time reduction and if the setup time is substantially reduced. So, the time which you which you get which you which you get that extra time, which is it can be utilized as the production time.

Appropriate quality control techniques are to be used to ensure that the defective parts coming from the previous stage are processed, are prevented. That means, you do not

allow the defective parts to come to a you know a bottleneck resource because unnecessarily this defective part you cannot use and the production time will get lost. So, you will be losing on throughput. So, this there must be a check of a check of for the quality of the incoming (Refer Time: 21:47) materials as well as the process parts of the semi processed parts to this particular say the bottleneck resource for each bottleneck resource.

So, you must have a mechanism to control say the quality of the incoming materials, incoming parts to a bottleneck resource. Demand beyond capacity may be transferred to other non bottleneck resources. So, these options, this alternative also you can think of you can try. Capable of producing the parts of the components products as per their specifications; obviously, that particular say the non bottleneck resource whether it has got the right kind of capability or not, process capability that you have to check, that you have to verify then only it is considered as an alternative.

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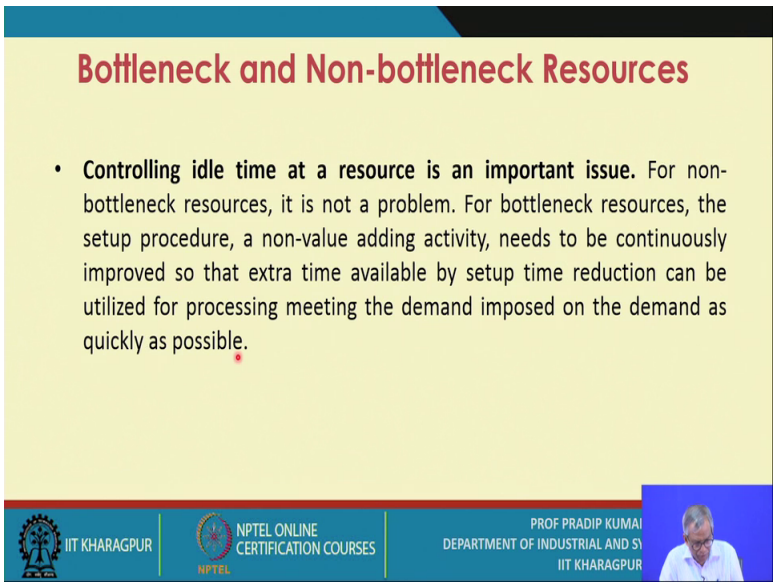

Now, controlling the idle time at a resource is an important issue. For non-bottleneck resources, it is not a problem. For bottleneck resource is the setup procedure a non value adding activity this point I have already mentioned needs to be continuously improved so that extra time available by setup time reduction can be utilized for processing, meeting the demand imposed on the demand as imposed on the demand as quickly as possible, is it ok. So, what is important is that as we are pointed out that on sometimes know the GIT

based approach also you can use, like one of the important goals of GIT is that is the batch size of 1 and you can achieve this condition only when the setup becomes 0; that means, the minimum one negligible.

So obviously, you know if you have already implemented the GIT based approaches; so, and if you focus on these particular aspect, so the technique is not the systems of controlling the setup or minimizing the setup time that is also known. And only thing is, if it is a if you can develop the generic approach why do not you apply this generic approach in respect of particular resource. Like say, if you can implement single meet exchange of this technique SMID techniques as a generic approach. So, I do not you implement it for say the Bottleneck resource.

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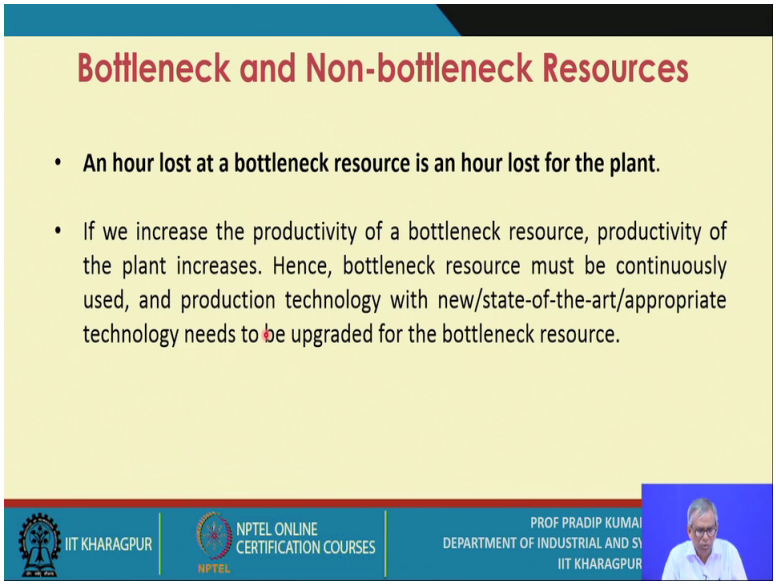

So, such approaches you should be aware of and specifically which can say control the setup time because the more time is required for production and if you produce more, you will produce more throughput. Now we say, an hour lost on a bottleneck resource is an hour lost for the plant because essentially the bottleneck is essentially the controlling the systems output not the Non-Bottleneck.

So, if you increase the productivity of a bottleneck resource, this point you just make a note. Productivity of the plant increases hence bottleneck resource must be continuously used and production technology with new state of the art, appropriate technology needs to be upgraded for the bottleneck resource, is it ok.

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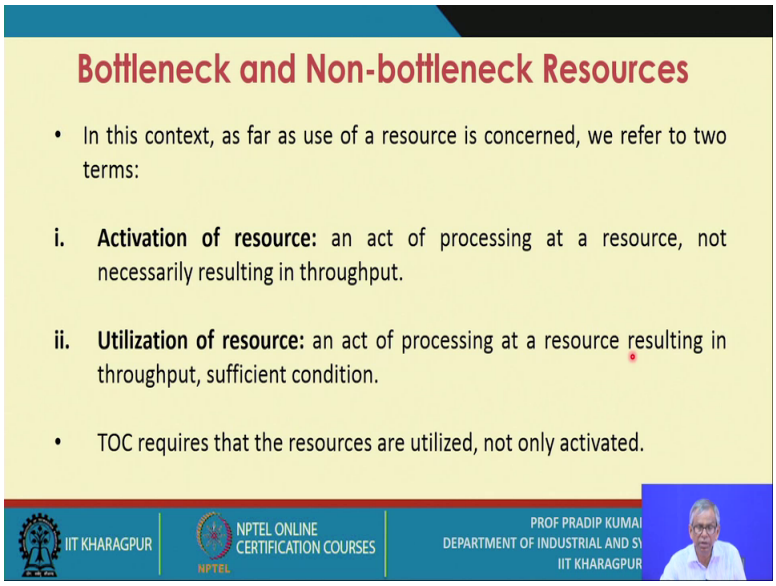

So, usually you know what is important is that means, the initiative like technology upgradation as to start from say the bottleneck resource ok. So, this is an advantage if you apply the TOC technique. The in this context you know the certain the terms which are highly relevant in the TOC methodology; you must be able to define. Now, when you start using a particular resource, now you come across two specific condition. One condition is activation of resource. So, what is activation? An act of processing at a resource it is very clear not necessarily resulting in throughput you just process it, but you are not sure that whether this produced quantity can be sold or not ok.

So, this is called activation. So, the necessary condition is activation. But the most important thing is can you have a condition called utilization of resource? So, what is utilization of resource an act of processing at a resource resulting in throughput that is the sufficient condition. So, this is the necessary condition and this is the sufficient conditions. So, for implementing TOC, what you need to do? You need to meet say the sufficient condition; TOC requires that the resources are utilized not only activated. Thus producing to capacity for all types of resources may lead to high level of inventory.

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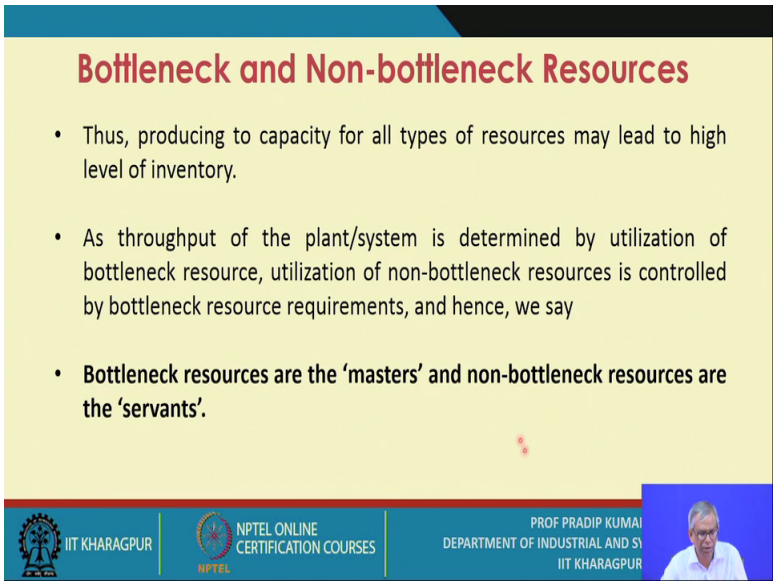

As throughput of the plant system is determined by utilizations of the Bottleneck resource. Utilizations of non bottleneck resources is controlled by bottleneck resource ok. That means, as for the requirement of the bottleneck resources why do not you use the non-bottleneck resource. So, this the linking has to be there and hence we say that the bottleneck resources are the masters. It is basic essentially, the this resource is guiding actually or the controlling the activity or the production of the Non-Bottleneck resource.

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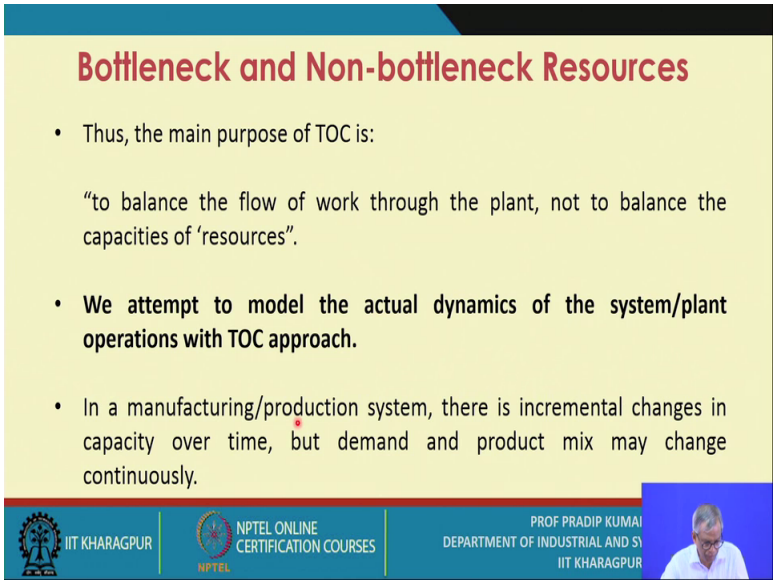

So, the bottleneck resources are the masters and the non-bottleneck resources are the servants. Thus, the main purpose of TOC is to balance the flow of work through the plant not to balance the capacities of resources ok. So, whenever you talk about the balancing of the flow; that means, we are referring to a dynamic system where whereas, when you try to talk about the balancing the capacity, you are not necessarily you are referring to a dynamic systems.

Essentially, you are referring to a static system. We attempt to model the actual dynamics of the system plant operation with TOC approaches. So, in a manufacturing or production system, there is incremental changes in capacity over time but the demand and product mix may change continuously.

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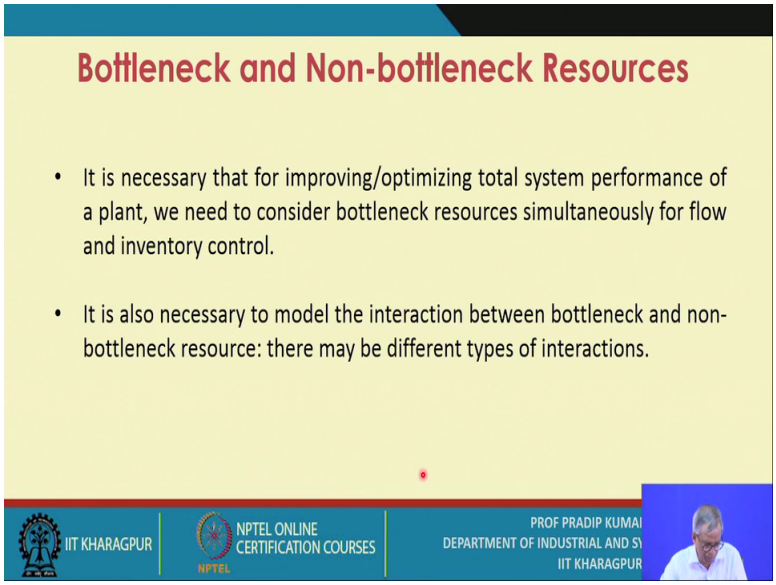

It is necessary that for improving optimizing total system performance of a plant we need to consider the bottleneck resources simultaneously for flow and inventory control. This point we have been elaborating all the time. It is also necessary to model the interaction between bottleneck and non-bottleneck resources.

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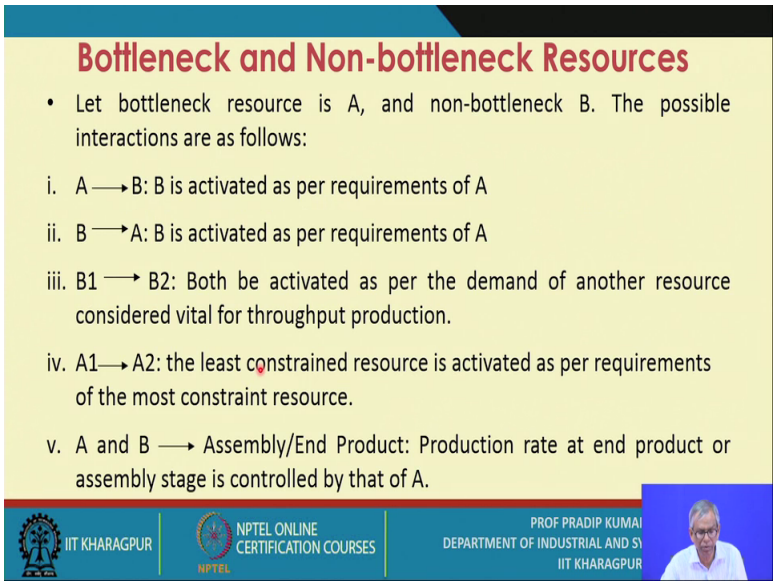

So, there may be different types of interactions. So, this is your starting point; identification of the bottleneck resource, identification of the non-bottleneck resource and then what could be the possible relationships between this two. So, suppose in capital A is bottleneck resource and capital B non-bottleneck resource. So, A is effecting B, B is activated as per the requirements of A. Now B is related to A; that means, B is activated as per the requirements of A, A is the masters, A is the controller.

This is the non-bottleneck resources is related to another non bottleneck resource. Both that both are act both be activated as per the demand of another resource considered vital for the throughput production. So, this point is to be noted. A 1 is activating a 2; that means, the linking A 1 with A 2. The least constrained resource between A 1 and A 2 is activated as per requirements of the most constraint resource, is it ok.

And A and B, both A is a constrained resource the bottleneck resource and B is a non-bottleneck resource, both are actually linked with assembly or end product production rate at end product or assembly stage is controlled by that of A not B. So, everywhere what do you find the basically the bottleneck resource must control must control the production rate or the schedules of say the other kinds of resources in the system. So, here we conclude. And in the next sessions, will go for say discussing other aspects of the theory of constraints.

Thank you.