**Management of Inventory Systems**
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**Lecture - 48**
**Theory of Constraints and Materials Management (Contd.)**

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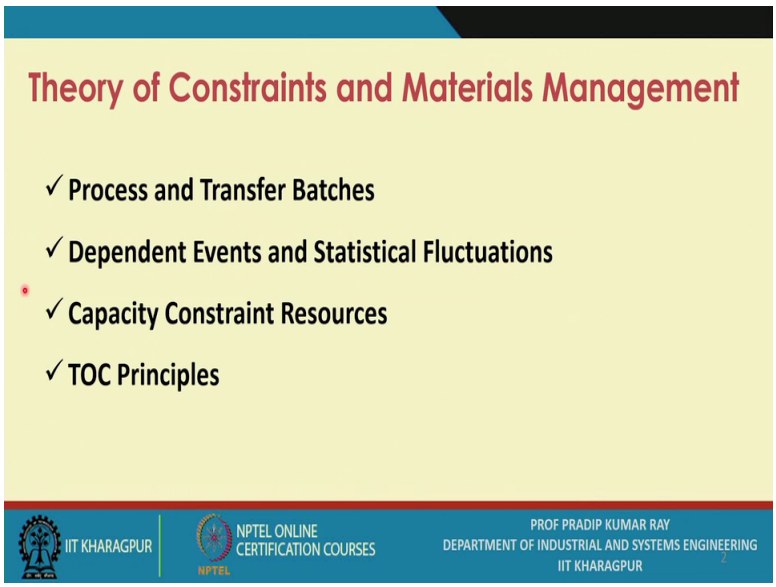


During this session the third lecture session, now will continue our the discussions on theory of constraints. We have already discussed some basics of the Theory of Constraints methodology and slowly you are understanding that what are the basic focus, what is the basic objective of implementing theory of constraint say the methodology in a in a manufacturing system.

So, you have come to know what is actually you know the bottleneck resource, what is a non-bottleneck resource, how can you establish the relationship between the bottleneck and the non-bottleneck resources, and how to link them with the other aspects of the production systems. Now here during these lecture sessions some other the concepts we are going to discuss related to TOC.

The first one is the process and transfer batches; everyone we are all aware of you know the batch size as you as it is produced in a particular box centre or a resource and so, this is referred to as the process batch size ok. And determination of batch size there could be several approaches there are several you know the formally you can use so, you are all

aware of; and so, but here we are also we are defining another term related to batch formation and that is referred to as the transfer batches. And so, the process and transfer batches they definitions and why do you go for such differentiation for in respect of TOC so, that point will be will be discussing in details.

Then you know we face a problem like say always it is a dynamic situation; that means, the determining of the actual requirement at a particular stage say it is a real problem and one the main reason could be that the dependency between the different stages. So, the modeling of dependencies is not that easy, and that is why many a time you go for online real time control system so, day today monitoring, hour to hour monitoring is alternative. So, the dependent demands events it should be considered specifically as well as the statistical fluctuations; that means, the demand is changing say and at a very a you know a lot of variability in the demand.

So, while you make a robust systems a control systems so, that is your goal through the TOC so, how to the take care of the statistical fluctuations. Then the third important issues we are going to discuss, that is the capacity constraint resource. So, what are how do you define capacity constraint resource and why do you the define it, why you try to identify it, and one point you just make a note that is this entire the exercise of TOC the starts from identification of the capacity constraint resource in short CCRs.

So, among say the resources you need to know the what are the capacity constraint resource, and then only if you your definition is clear and well defined and then only it becomes easier for you to initiate say the actions are initial. So, initiate steps for implementing TOC methodology. And then towards the end when we have sufficient knowledge about or you have developed the concepts what is written actually with respect to the TOC, then you should be aware of what are the specific the TOC principles you must be able to follow.

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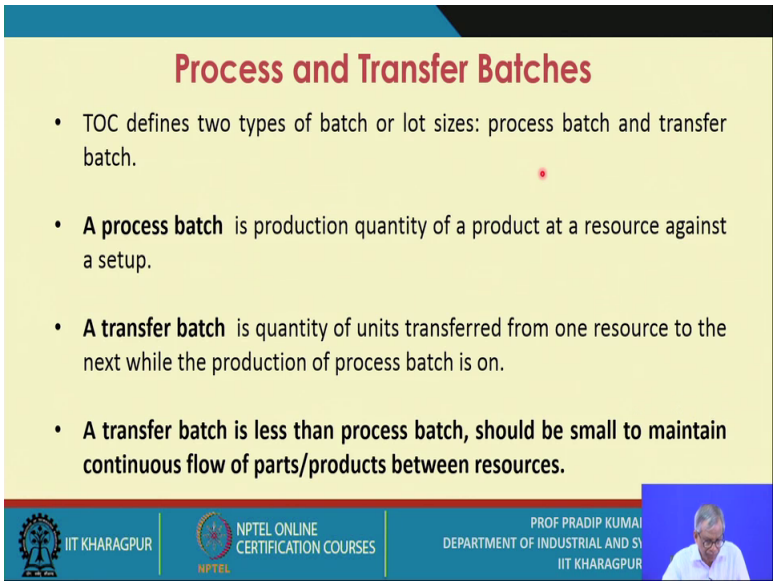


Now, the TOC defines two types of batch or the lot sizes, this term is already you are familiar with the lot size like production lot size or say the purchase lot size process batch and transfer batch. So, what is a process batch? Now a process batch is a production quantity of a product at a resource against setup, we have already discussed that against the setup you have you determine the you know the production quantity say 500 against one setup. So, if you from, so if 500 units are produced what you need to do; that means, you need to set it up once again is it ok.

So, that you can maintain the quality of the units within a particular batch. So, this is the basic the principle you follow. So, against setup the batch size is known or a particular process, and that is why it is referred to as a process batch. So, process batch determination is a must first; next one is the process batch can be split into the several transfer batches; that means, a transfer batch is a quantity of units transferred from one resource to the next, while the production of process batch is on. So, what does it mean in plain and simple terms it means that suppose you produce 500 units in 4 hours. So, and so, one approach could be that first you produce the 400 units in 1 hour, say in 500 units in 4 hours and then once the 500 units are produced so you send this 500 units in one short to the next stage so, that is this approach.

So, obviously, the flow is disturbed; that means, during the time you are producing this 500 units at your process, the next stage which is dependent on you. So, it is waiting for

this; that means, the 4 hours you it may not get any the units to be to be processed. So, the flow is transferred and there will be discontinuity in the flow. So, in order to avoid that what you try to do? That means, suppose the 500 units you produced in 4 hours, so, on an average 125 units it produce per hour.

So, as soon as 1 hour is over so you have with you 125 units. So, why do not you send it to the next stage? So, this is referred to as so, the transfer batch. And if you can if you can reduce the transfer batch size; obviously, you know the continuity will be continuity of the follow will be more smooth is it between the work stations or between the stages or between the processes. So, this is the basic idea behind the splitting of the process batch into several transfer batches.

So, transfer batch is the quantity of units transferred from one resource to the next while the production of the process batch is on is it ok. A transfer batch is less than the process batch, is it should be substantially less than the process batch if you can do that. If the your system permits it, then you will find that you your the entire material flow becomes a much smoother and this transfer batch could be small as small as possible to maintain continuous flow of parts on products between resources.

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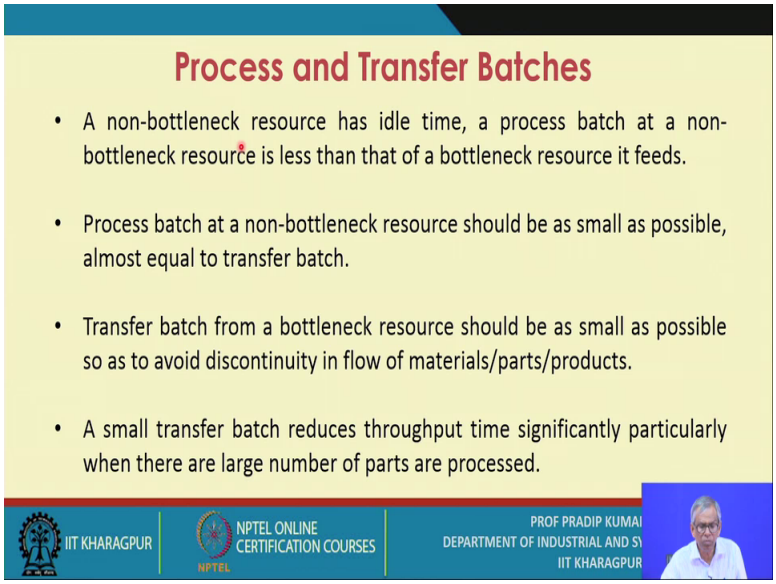


A non-bottleneck resource has idle time because its capacity is more; a process batch at a non-bottleneck resource is less than that of a bottleneck resource it feeds is obvious. So, just you go through the statement, I you find you know the logic is very clear is it

because you activate the non-bottleneck resource as per you know the requirement of the bottleneck at a particular point in time. That means, the both the quantity as well as the timing you should mention is it the timing of production as well as the quantity of production.

So, these are the two important aspects you need to look into when you try to describe the relationship between a non-bottleneck resource and a bottleneck resource. Now the process batch at a non-bottleneck resource should be as small as possible almost equal to transfer batch is it ok. So, means you know the flow of material from say the non-bottlenecks say should be as restricted as possible is it and absolutely it should match the requirements of the bottleneck resource with which it is linked and when you say its matching; that means, matching with respect to the quantity and matching with respect to the timing.

So, please your note down this two points; that means, whenever we talk about say the TOC based scheduling, this is essentially we referring to scheduling two important aspects you must look into, one is the quantity matching with respect to the quantity and matching with respect to the timing. The transfer batch from a bottleneck resource should be as small as possible so, as to avoid discontinuity in flow of materials, parts, products.

A small transfer batch reduces throughput time significantly particularly when there are large number of parts processed. It means that you know what happens if you maintain the continuity so; obviously, if you try to maintain the continuity; that means, you do not need to wait for processing; that means, waiting time will be less. And similarly you know the transfer; that means, the transferring the batch. So, here essentially you need many a time you need appropriate material handling systems and the advantage is if your the transfer batch the transfer batch size is less now even the you know the manual material handling is possible, and plus even if you use you know say the pit or say you know like say the you know the powered industrial truck.

So, the smaller size the pits you can use for transferring say the lot; that means, the transfer batch from one unit to another from one resource to another is it ok. So, in the process what happens that the proportion of the non-value adding activity is reduced whereas, proportion of value adding activity is increased. So, it throughput time is significantly reduced if you apply this concept ok.

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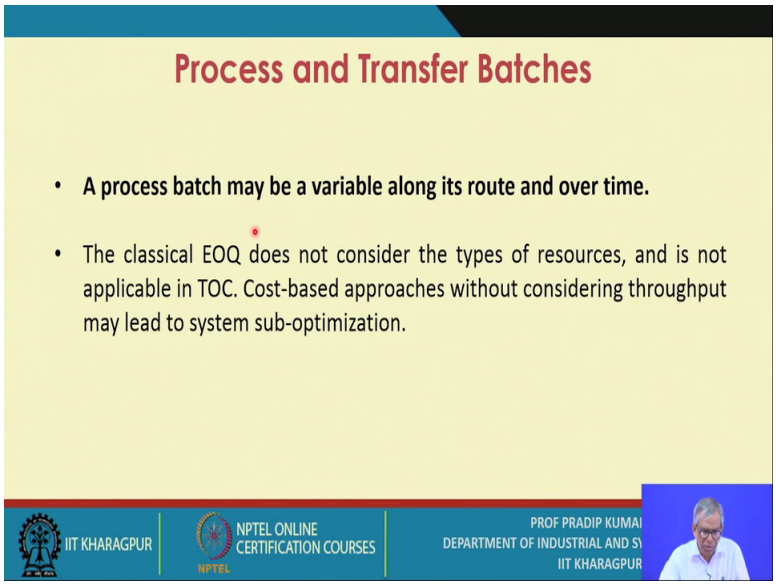


So, a process batch may be a variable along its route and over time. So, this is when you consider a number of say inter connected the production stages or the processes in a manufacturing systems. So, obviously, the process there will be a variable the process batch from say the process a to b it could be 25; from b to c it could be 20 from c to d it could be 50 ok. So, it is a variable along its route and over timing is it ok; that means, in the same say the between a and b so, the first hour the process batch could be 50 and the next hour the process batch could be 75, the third hour it could be 60 and so on ok.

So, this is the meaning of this particular say the statement; that means a process batch may be a variable along its route and over time. If the classical EOQ you know actually what is the classical EOQ formula. So, the classical economic order quantity does not consider the types of resources. This is a severe limitation this is an one limitation of say EOQ as if EOQ is applicable for all kinds of resources and is not applicable in TOC just make a note a of this particular comment. Cost based approaches without considering throughput may lead to system sub optimization.

So, this is another say the important statement; that means, the definitely the cost based approach is applicable, but you have to go beyond the cost based approach. So, that the other kinds of benefits also you get, particularly when you talk about a complex systems say the scheduling for a very complex systems, repetitive manufacturing, discrete part manufacturing, and dealing with 100s and 1000s of parts ok. So, this a very complex

situations and you come across several types of constraints. So, what they are found the practitioners that that TOC has high level of applicability for such cases ok. And what is most important is as per the systems theory, we say that the sub systems optimization the sum of sub system optimization does not necessarily mean that that you will you will be getting a total systems optimization ok.

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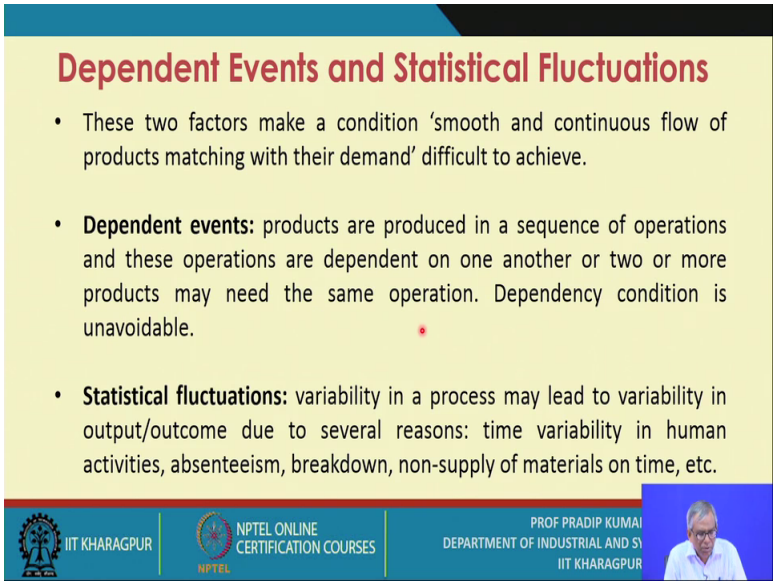


So, this is so, it talks about so, it is a. So, it is systems theory is applied in TOC, now there is a two aspects dependent events and statistical fluctuation. So, let me just explain it the concept is very simple, this two factors make a condition smooth and continuous flow of products matching with their demand difficult to achieve. So, you have just one specific objective in TOC, what is that objective? Smooth and continuous flow of products matching with their demand this is your say your main goal or the main objective.

Now this objective may not be able to achieve fully if you do not have sufficient control on these two aspects. So, the first aspect is dependent events. So, what is it? Products are produced in a sequence of operations and these operations are dependent on one another like when you refer to a process plant or a particular product; obviously, there is a sequence of operations. So, this is; that means, there is a dependency between the operations; or two or more products may need the same operation ok. So, this is also so, it is also referred to as a dependency condition.

So, the dependency condition is unavoidable you cannot avoid. Then the study is the next important aspect to be considered that is the statistical fluctuations. Variability in a process may lead to variability in output or outcome due to several reasons ok. So, variability study is a important study not only in quality ok, but also for say the in production control systems when you study production control systems or when you study the inventory control systems.

So, the variability is important aspect and the time variability in human activities. So, this will have an effect, absenteeism, breakdown non supply of materials on time etcetera. So, these are the factors actually it creates sorry it its leads to its and it is the create variability in output and outcome ok.

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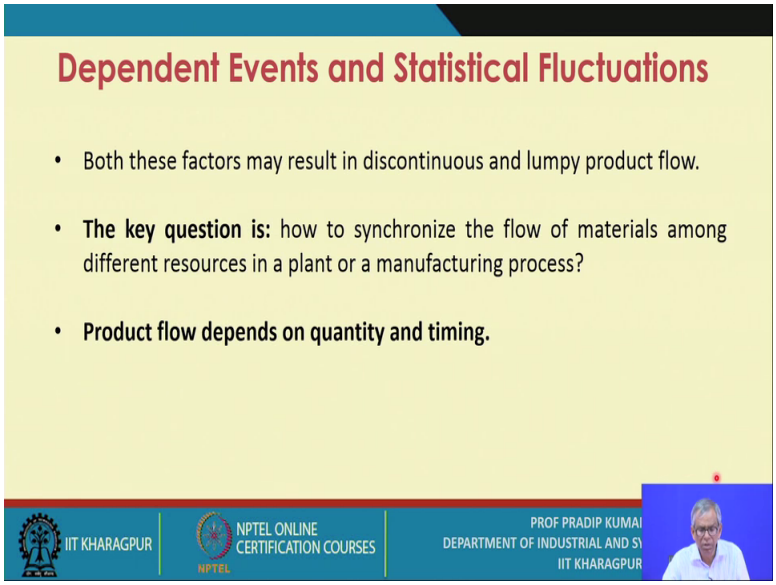


So, you can identify several such factors when you study a particular system, when you start collecting data; obviously, will come to know when a specific situation, what are the specific factors resulting or say the leading to or the effecting or say the variability in the system. So, creating variability in the, you know the systems outcome or the systems output. Both this factors may result in discontinuous and lumpy product flow I have given a few examples.

The key question is how to synchronize the flow of materials among different resources in a plant or a manufacturing process. That means, the condition of synchronization a

synchronous manufacturing systems we have to create, where you get a continuous flow and smooth flow of materials. So, the product flow depends on quantity and timing.

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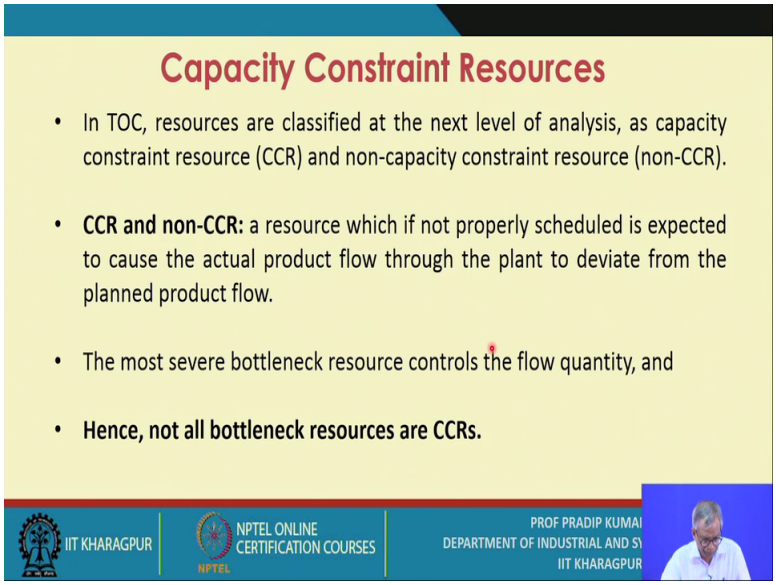


In TOC resources are classified at the next level of analysis as capacity constraint resource. First you have defined resource, you know what is a constraint, now you go to we are going to define a two kinds of resource one is a capacity constraint resource and the second one is the non-capacity constraint resource.

So, what is CCR and what is non CCR? A resource which if not properly scheduled is expected to cause the actual product flow through the plant to deviate from the planned product flow. That means, when you have to make a plan so, there must be a planned product flow that is your starting point. Now due to several reasons the a planned the product flow may change. So, what is a CCR? The CCR is very sensitive resource; that means if you cannot properly schedule this kind of resource, immediately there will be an effect on the planned product flow negative effect usually on the planned product flow.

So, you need to identify this resource and usually not only one resource, but a number of resources may be of this type and this resources are referred to as a CCR resource. The most severe bottleneck resource controls the flow quantity and hence not all bottleneck resources are CCRs ok.

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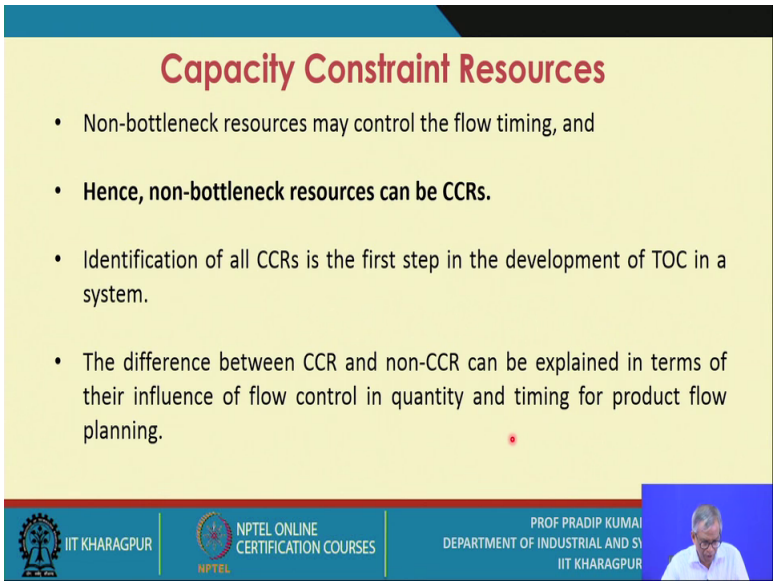


Non bottleneck resources may control the flow timing, and hence non-bottleneck resources can also be the CCRs is it there are two aspects the timing and the quantity ok.

Identification of all CCRs is the first step in the development of TOC in a system. So, you have come to know what is the first step; that means, you must be able to define the CCR and the next step is you need to identify, you need to identify those CCRs in a particular plant, and then you start working on the TOC methodology. The difference between CCR and non CCR can be explained in terms of their influence of flow control; that means material flow control within a plant in quantity and timing for product flow planning.

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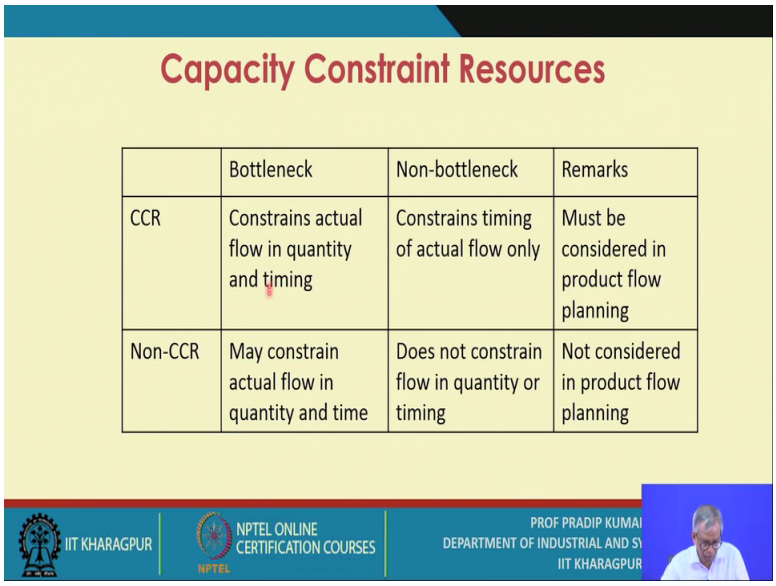


So, this is the relationship the resources could be CCR, resources could be non CCR. Now, the resources could be bottleneck or resources could be non-bottleneck. If it is CCR and if it is bottleneck, then the constraints actual flow in quantity and timing ok; that means, the constraints are affecting the actual flow in quantity and timing both. Whereas, here the constraints are affecting the timing of actual flow only not the quantity and this CCRs whether it is bottleneck or non-bottleneck must be considered in product flow planning. So, essentially the toes TOC exercise is nothing, but an exercise on product flow planning.

But if it is a non CCR, then it may constraint actual flow in quantity and timing and if it is a non-bottleneck resource and as well as the non CCR, then it does not constraint flow in quantity of timing. So, what is your decision? The decision is that non CCR may not be considered in product flow planning whether it is the bottleneck or whether it is a non-bottleneck. So, my advice is you study this table intently and later on when you get few the practical examples this will be made more clear.

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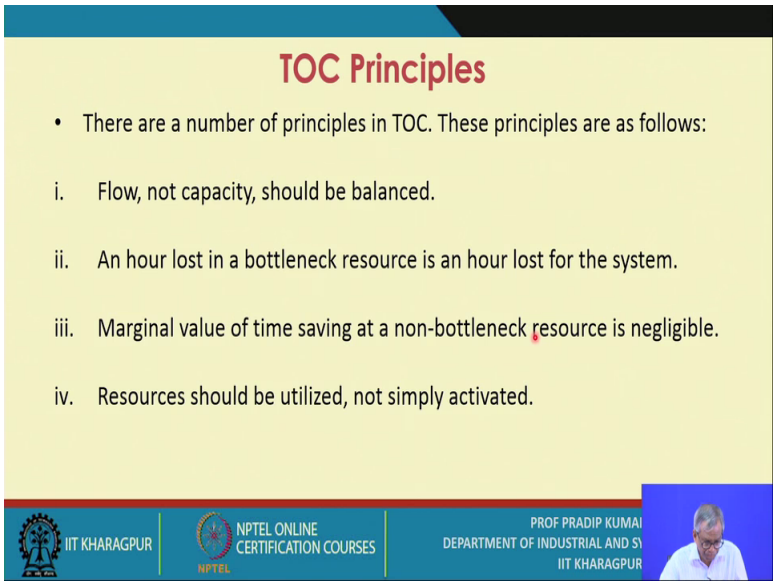


So, there are now before we conclude the sessions, I will just tell you that what are the TOC principles ok. So, by this time you know by you have come you have come across or you have come to know, you have become familiar with several terms and terminology the concepts and issues related to the theory of constraints. And right now when you have come to know this terms and terminologies related to TOC as well as the concepts and issues related to TOC; obviously, you can relate this concepts with definitely the product flow planning and as well as the inventory control systems and in general to the materials management materials management say the function of any organizations.

So, what we say that the theory of constraints is closely linked with the material materials management systems of any organization. Now what are the principles? The let me just highlight a few important principles and. So, the first principle is the flow not capacity should be balanced. Now whenever you talk about the scheduling systems of a production plant or the manufacturing plant, now what we are saying that you create the sibling system in such a way that a the flow of materials within the system is control, you do not bother about the capacity, your first priority should be maintaining appropriate flow a matching with the demand.

Suppose you are you are maintaining a flow, but this flow; that means, the quantity and timing of the flow of materials is not matching with the demand or it is not matching

with the demand all the time. So, it is all likelihood, it will be producing non throughput. So, our you know the basic constraint is that whatever you do, whatever may be the flow pattern to what extent you are able to produce as per produce throughput. So, that is your primary objective of creating a TOC based systems or theory of constraint based systems.

So; obviously, the even if you go for capacity balancing and you know the capacity is changed over a period of time; you cannot change the capacity of a resource continuously so it is a inflexible. So, that is why you know the capacity you create definitely, but the more importantly to what extent your taking other types of controlling systems so, that you know you produce as per the demand at any point in time this is your goal. And as we have pointed out with respect to an the inventory control systems, there is basically the entire exercise should be should be boiled down to a matching systems say a perfect matching systems between supply and demand.

Now, the supply is essentially you get the supply out of the production system. Definitely the production systems or the kinds of technology you use the depends on the capacity of the resource definitely. But still when the capacity remains constraint the technology becomes constant, now what you need to do in order to meet the demand for the all the time periods you need to constantly the monitor the performance of the material the or the or the monitor the condition of the material flow all through; that means, over time considerly. And that systems you must have and there must be you know you your system your scheduling systems much capture the you know the dynamic system or the dynamic the production system.

So, that is why the flow essentially is indicating of the dynamics of the systems and not the capacity should be balanced ok, so this is point number 1. The next important principle is I have already mentioned that is an hour lost in a bottleneck resource is an hour lost for the system, which is not true. This statement suppose if you lose 1 hour in say in an in a non-bottleneck resource, it does not mean that you are you are losing 1 hour for the system. So, that is why the bottleneck resource should be the controlled should be controlled and as far as possible the utilization of the bottleneck resource, should be guaranteed should be assured.

Marginal value of time saving at a non-bottleneck resource is negligible there is no point ok. So, if you have you suppose you do not bother about say whether the resource is bottleneck or non-bottleneck, and your you know the time saving scheme or by you know by applying several the relevant tools and techniques suppose you start implementing or any kind of resource. So, it may so, happen that the effort you put for the non-bottleneck resource for time saving right it may not have any effect on the systems performance improvement.

So, the marginal value of time saving at a non-bottleneck resource is negligible, and the fourth principle is resources should be utilized not simply activated. There is an necessary condition, but more importantly you must be able to utilize the resource is it ok That means, utilization means that the amount which you can sell and out of this sell you can get the revenue; that means, you can generate the throughput you can make money.

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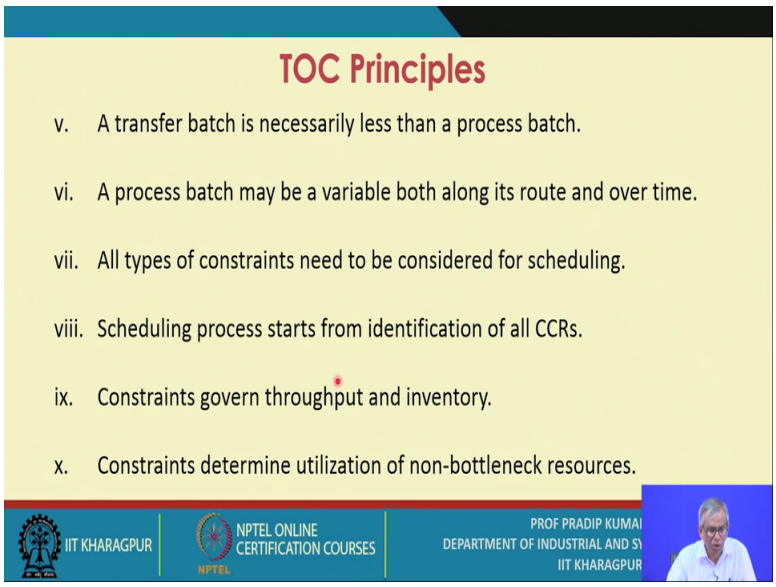


The fifth principle is a transfer batch is necessarily less than a process batch I have already elaborated. Sixth one is a process batch may be a variable both along its route and over time, this point also we have elaborated over the difference stages only. So, over the route it may be it is a variable; that means, there is a change in the that could be a change in the process batch size, and over time also between the two stages.

Then the next principle is all types of constraints need to be considered for scheduling is it all type of constraint that is why we have emphasized on the classification of the constraints. Scheduling process starts from identification of all CCRs Capacity Constraint Resource. So, please you know you refer to its definition and out of the resources, which one is which set or which one is the CCR. So, why do not you start modeling the scheduling system, after you identify all the CCRs so that is one of the principles you must follow.

The next one is the constraints govern throughput and inventory. So, we have defined throughput we have also defined inventory, and the last principle is the constraints determine utilizations of non-bottleneck resources.

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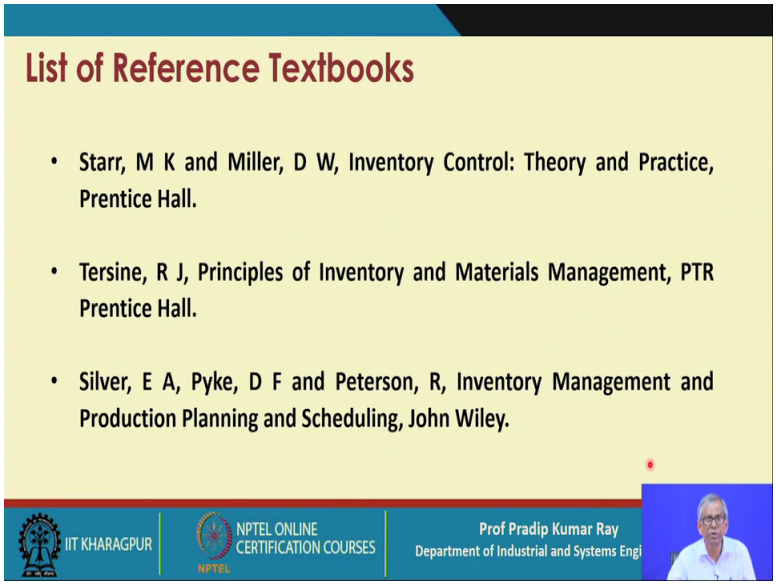


So, these are the 10 principles we have identified and. So, this is the third lecture session on theory of constraints, and by this time we have come to know that what are the basic concepts in theory of constraints, what actually you are supposed to do and with this knowledge once you know this set of principles the.

So, will be we are we are going to discuss the scheduling the TOC based scheduling approaches in the next 2 lecture sessions, and we will find that when you discuss this scheduling the TOC based scheduling, will find that as far as possible you know you need to do the follow all these principles is it ok. And if you cannot for certain reasons

obviously, you know this TOC methodology is treated as a continual improvement technique.

So, at the next step; that means, there could be a first approximation, and then may be you are not able to the follow all the 10 principles, and at the next stage of development as a part of continual improvement definitely you try to so, the follow all other principles. So, this process continues so that is why it is treated as the TOC based methodology is treated as a continual improvement say the approach. Thank you.