Automation in Production Systems and Management
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Lecture - 10
Automated Production System Framework

Quality improvement is your concern. There are many reasons for which you want to implement an automated system. One of the reasons is quality improvement, the quality of the process, quality of the product, quality of the system.

Suppose someone ask you to implement an automated system, can you just whether tell me what is your quality of the automated system? Quality improvement is an important issue and we should understand the related to quality improvement what sort of principles you have to follow.

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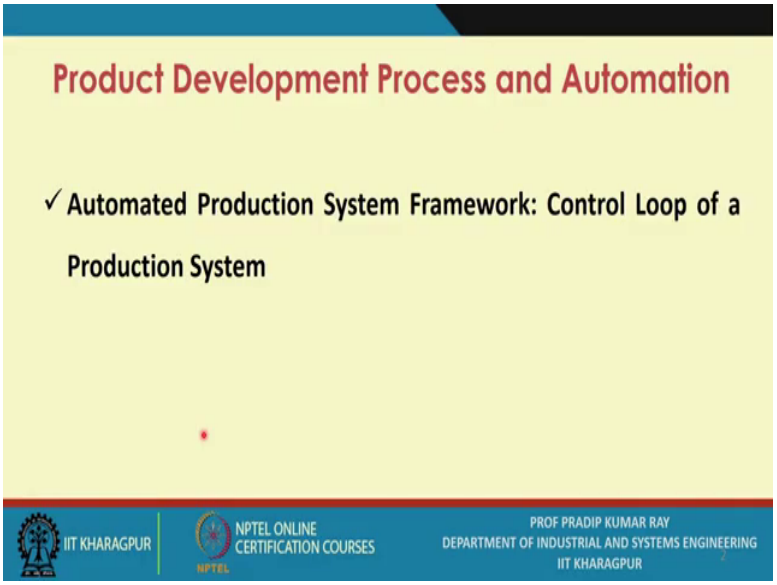

During this lecture session, our main concern is the automated production system framework, we will discuss one particular control loop of a typical production system.

All these elements we will identify and then once this framework is known, you start thinking of designing the automated system. But prior to designing an automated system you need to consider certain principles related to quality improvement.

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Let me first discuss the quality improvement principles, Since the time application of quality control and improvement tools and techniques in organizations started formally in the beginning of the 20th century, 1910, 1908, 1915, 1920.

The concepts of quality control have evolved into a comprehensive one, focusing on few important aspects that have become highly relevant in product development in recent times. Initially it was inspection-based quality control. Quality control means you go for inspection.

And you create one particular job inspector. Though the workers know how to create the product, it was assumed that the workers just cannot inspect the quality of the product. That is why another group is formed and that group is referred to as the inspection. What is the basic philosophy in installing such system?

The basic philosophy is production at any cost and it is most unlikely that when you go for producing large number of units, against a particular product or against a particular part in

discrete part manufacturing system, it is most likely that some amount of the output or units may become defective.

These defectives worker should not concentrate on producing and the inspector should be able to identify the defectives products or defective units or defective parts as quickly as possible. They will be the in charge of carrying out the inspection activities and that is why they are referred to as the inspection inspectors.

Now, later on we started emphasizing what are the activities which are value-adding? The processing activities, the kinds of work the workmen do, are all value-adding. Whereas, the inspection activity is not a value adding activity. Can you do away with inspection if you can?

From the inspection during 40s we move to quality control; that means online real-time control and when you refer to quality control system, we say that each and every unit is to be inspected and you have to do it right first time every time and quality is job number one. Ultimately from a process when you get the output with almost all units in the output defect-free and all are acceptable. Yes, there will be certain units which may be defective and you have to check whether some reworking is possible.

And if reworking is not possible, that particular part should be taken as a scrap. Ultimately from quality control we move to quality assurance.

These activities you carry out are related to improvement quality or performance in products and processes and systematic implementation of a new design for a product through continuously controlling process quality.

First you become concerned about the quality of the design. The design is certified to be a very good one, then as per the design, you start producing you start manufacturing. Then you check that whether the manufacturing system is able to the produce a particular product as per its design specifications. If it can be done then it is referred to as the quality of conformance.

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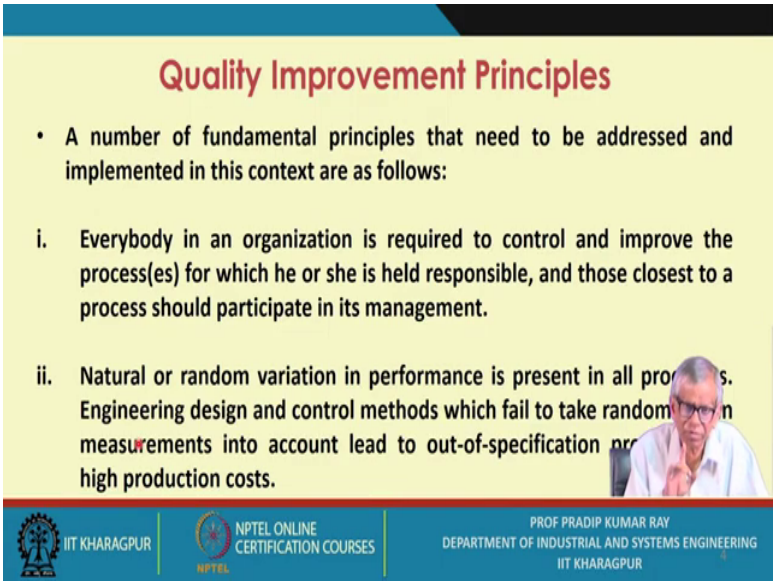

A number of fundamental principles that need to be addressed and implemented are given. These principles are fundamental or the basic. Everybody in an organization is required to control and improve the processes for which he or she is held responsible and those closest to a process should participate in its management.

Natural or the random variation in performance is present because always there will be common causes in the system, you cannot eliminate all such causes. It becomes a part of the system. These are referred to as the natural and because of presence the chance causes or the common causes, there could be natural or random variation in the performance.

Engineering design and control methods which fail to take randomness in measurements into account lead to out of specification products and high production cost, but there is one technique called as Taguchi method for quality improvement.

If you use a Taguchi method for quality improvement these problems can be tackled. Once this problem is tackled ultimately the quality reaches a level which is referred to as the robust; the product becomes robust.

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What is the robust product or the robust system or the robust process? The performance of the product performance, of the process performance, of the system is guaranteed, even if there is a presence of uncontrollable noise factors.

You have to ensure that the effect of uncontrollable noise factors on the performance of a product or the performance of a process or performance of a system like FMS, like an automated system is minimum.

These conditions we have to consider and then only you go for implementing an automated system. Because usually what happens as the automated system is designed based on the state of the technology, majority of the cases the investment is very high. Once it starts working, make sure that there could be the changes in the external system, but it has to be run all the time as per its requirement. All organizations must give top priority to fulfillment of customer requirements ultimately.

Whether it is an external customer or the internal customer and in today's market customers demand highly reliable and the low-cost quality product; that means, you are getting product from an automated system, make sure that it is a low cost.

You must have monitored the production cost with respect to a particular automated system. Use of the state-of-the-art technology may not result in increased market share for the product.

Before the new quality product is sold to the customers, experimentation of product performance under different conditions is a must. When we go for prototype testing is for a new product and hence experimental design is a valid and most sought after tool in the process of product development .

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Use of statistical process control ensures prevention of occurrence of defects and defectives in process.

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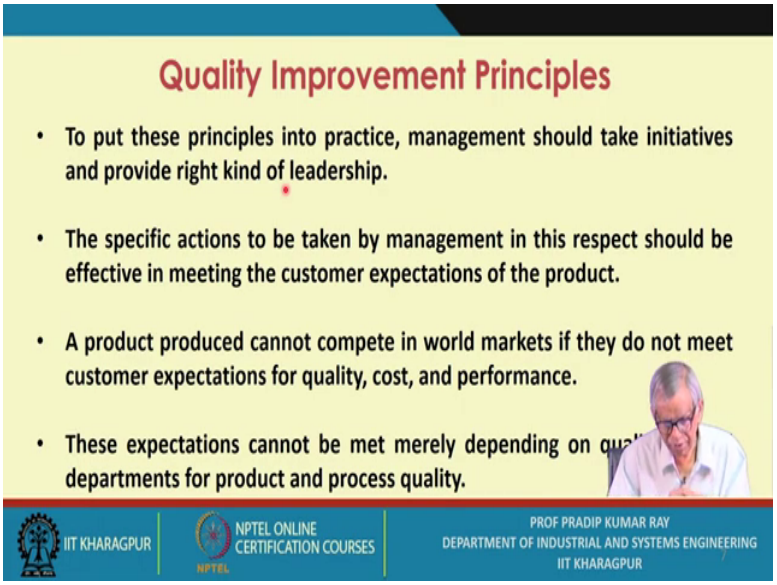

To put these principles into practice, management should take initiatives and provide right kind of leadership. The specific actions to be taken by management in this respect should be effective in meeting the customer expectations of the product. You must ensure that is the quality of performance.

Whether it comes out from the manual system or from an automated system it does not matter; ultimately this product will be put to use and with the performance of the product, whether the customer or the end user are becoming satisfied or not, that is the most important.

Particularly when the production system becomes automated, you have to make sure that there must be quality assurance system, even without inspecting a particular unit you say yes the next 100 units we are going to produce or even say 10000 units we are going to produce.

You do not need to measure the quality characteristics of each and every unit, the quality is assured. But beyond 10000 units or 100 units we really do not know what will be the quality level. The assurance must be given from the quality control till you reach quality assurance system. Whenever we install an automated system, it is assumed that there is quality assurance.

A product produced cannot compete in world markets or the international market if they do not meet customer expectation for quality, cost and performance. These are all interrelated;

quality cost and performance usually what you used to believe that if the quality improves the cost also will increase and we used to believe that there is a direct relationship.

There are multiple instances where you find that the quality of the product or the quality of the system is increasing, but the cost is not increasing. In fact, the cost remains constant or even the cost is decreasing-inverse relationship. Such manufacturing system may be referred to as the world class manufacturing systems. They have this relationship between quality and cost.

The performance has got seven criteria, where one criterion is a quality and other six criteria are cost and performance.

These expectations cannot be made merely depending on quality control departments for product and process quality.

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What are the main actions required for following the quality improvement principles in your production system? The first action is that the management must reevaluate the way in which the design products and processes.

Radically new and innovative ways of designing and developing a product. Whenever you start using the new and innovative technology or new and innovative design, they may be

referred to as the hallmark of any progressive management. The management must be empowered to provide leadership in the quality improvement effort in an automated system.

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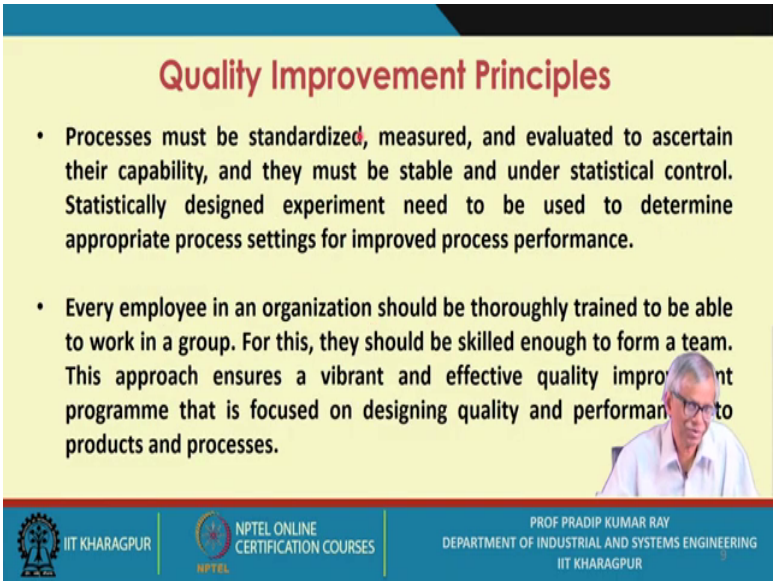

Processes must be standardized. That is another important condition to be made for creating an automated system and you must be able to measure the process and you must be able to evaluate the process performance to ascertain their capability and they must be stable and under statistical control.

Only a stable system can be made a controllable one. The stability in the system performance is to be guaranteed. Statistically designed experiment need to be used to determine appropriate process settings.

One of the important step in creating a process plan for a part or for a product is the optimal process settings. Every employee in an organization should be thoroughly trained to be able to work in a group.

If you use an automated system, it is most likely that you will be able to solve very complex problems. The complex problems are to be defined from several perspectives; that is why a group effort is needed, that is why the team is to be formed. They should be skilled enough to

form a team. This approach ensures a vibrant and effective quality improvement program that is focused on designing quality and performance into products and processes.

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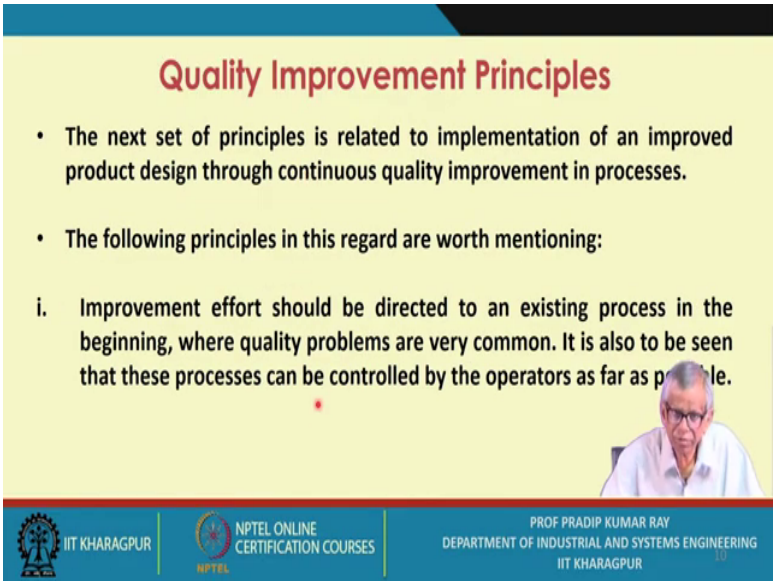

What are the next set of principles? First one is improvement effort should be directed when existing process. In the beginning you have to identify a particular process where quality problems are very common. It is also seen that these processes can be controlled by the operators as far as possible.

There are processes where the quality problems cannot be solved or the performance related problems cannot be solved unless those processes are made automated one.

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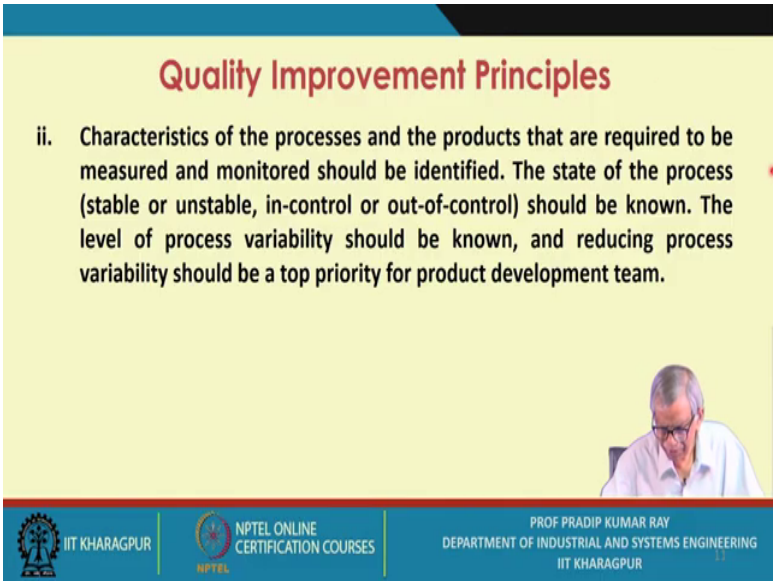

Characteristics of the processes and the products that are required to be measured and monitored should be identified. The state of the process (stable or unstable, in-control or out-of-control) should be known. The level of process variability should be known, and reducing process variability should be a top priority for product development team. If you want to create and automated system make sure that there is hardly any unit to unit variation.

Suppose the lot size is 10000. In one setup you can get 10000 units. Now you start measuring unit to unit variation and this variability is usually measured by the variance. The variance should be as minimum as possible and then you say, yes, the unit to unit variation is less and the product performance is guaranteed.

There will not be different levels of performance for different units. For the same product the level of process variability should be known. You must be able to measure whether it is a manual system or the automated system and reducing process variability should be a top priority for product development team.

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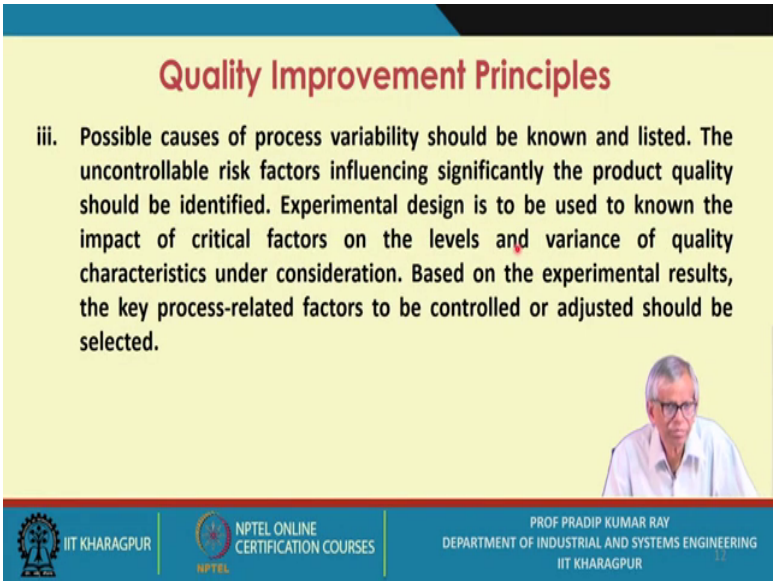

If you can reduce the variability then it is an example of the quality improvement. Normally the sigma of the process or the variability in the process performance depends on the kinds of design.

For the given process, the functioning of the internal components of the processes must be known for those who are linked and related to functioning of the internal components of the machine tool or the process. You need to determine the ideal process settings or the best possible and most appropriate process parameter values.

Possible causes of process variability should be known and listed. The uncontrollable risk factors influencing significantly the product quality should be identified. Experimental design is used to know the impact of critical factors on the levels and variance of quality characteristics.

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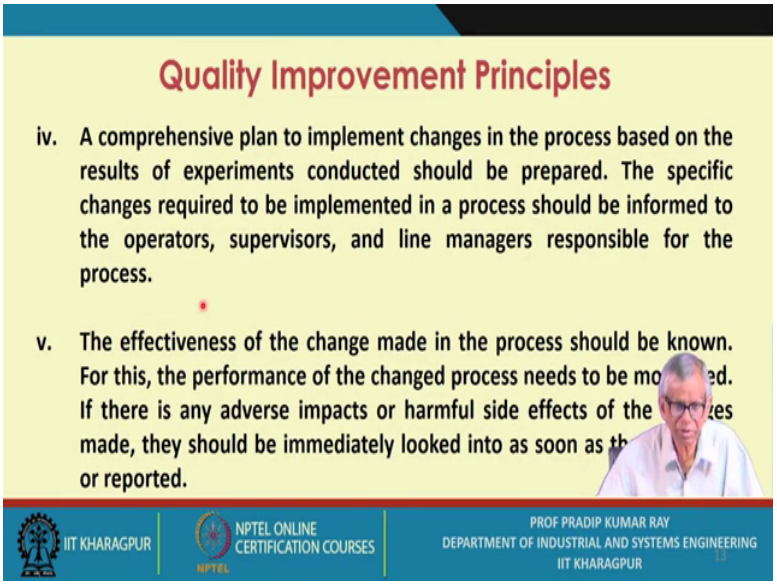
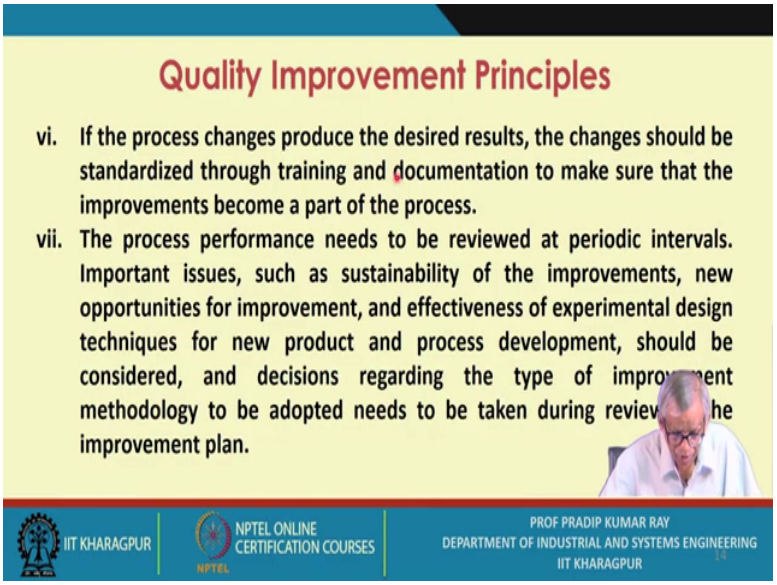


A comprehensive plan to implement changes in the process based on the results of experiments conducted should be prepared. The specific changes required to be implemented in a process should be informed to the operators, supervisors, and line managers responsible for the process.

The effectiveness of the change made in the process should be known. For this, the performance of the changed process needs to be monitored. If there is any adverse impacts or harmful side effects of the changes made, they should be immediately looked into as soon as they are seen or reported. (Refer Slide Time: 26:08)



If the process changes produce the desired results, the changes should be standardized through training and documentation to make sure that the improvements become a part of the process. The process performance needs to be reviewed at periodic intervals. Important issues, such as sustainability of the improvements, new opportunities for improvement, and effectiveness of experimental design techniques for new product and process development, should be considered, and decisions regarding the type of improvement methodology to be adopted needs to be taken during review of the improvement plan. The most important is that to what extent you can use the experimental design techniques for identifying the critical factors affecting the performance of a product or a system.

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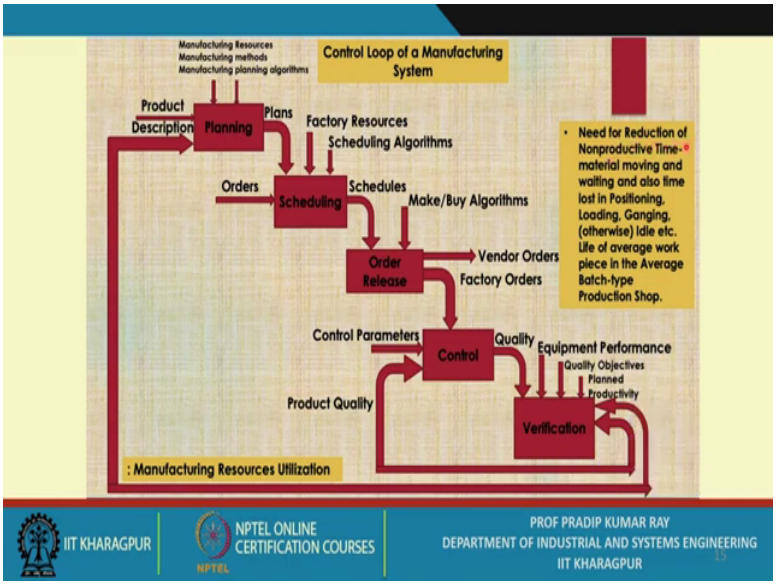

Now, before I the close the session, I need to discuss, the production control or the framework. If you look at this particular figure, we have identified the several activities need to carry out and how there are different functions we have identified and how they are interrelated.

Suppose you want to automate your production system. Instead of saying the flexible manufacturing system if you say, I want to have a flexible production system.

Production related activities and their interrelationships must be known. You start with the planning. What are the inputs? manufacturing resources, manufacturing methods must be known, manufacturing planning algorithms you need know and you need to the document entire process.

Then you create the plan. Once you get the plan then you consider the orders and you consider the factory resources, the scheduling algorithm and then you start scheduling the jobs and then you prepare and you take a decision called make or buy decisions. Given a part whether you will make it in the manufacturing system that you possess or it is to be procured from outside. This is referred to as the make or buy decision.

This is the order release; that is the activity you do; there could be vendor orders. The supplier orders and then the remaining orders are referred to as the factory orders. Now, when

these orders are executed then the we refer to the production system. For the production system what are the control parameters? Essentially when you look at your production system it is essentially a production control system.

Ultimately you get the quality of output. You need to verify with the quality, you need to verify the equipment performance, then the quality objectives, whether these objectives are getting fulfilled or not. Then the planned productivity you have; all these information or corresponding databases you have.

Once this verification is made, there is a closed loop over here, that is the product quality. These are all quality related aspects like how it is being performed, if there is some variation, control measures you have to take. This information you fit to the planning stage, along with the product description. How do you get this product description? You have a design of the product and along with the design of the product or the drawing of the product, you have the bill of materials.

If you look at all these bills of materials, you can prepare or you can document the product description. This is essentially the control loop. When you try any production system or production subsystem, you need to represent that subsystem with this control loop. And then you check that whether you need to reduce the non-productive time, material moving and waiting and also the time lost in positioning loading, ganging, idle.

The tool is engaged for a removal of metal with respect to the machining operations. The life of average work piece in the average batch type production system. Sometimes this is referred to as the flow time.

How long a particular part or the particular work part or the remaining within the system? It goes to the system, it comes over to the system, the difference between these two time periods is referred to as the flow time and this flow time should be a controllable parameter and it should be as minimum as possible.

It is expected that, compared to a manual system in an automated system, the flow time is should be significantly reduced. The productivity or the performance system also is expected to be very high if you install or if you implement an automated system.