Automation in Production Systems and Management
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Flexible Manufacturing Systems - II
Lecture - 44
Fixture and Pallet Selection Problems: Numerical Examples

During this lecture session we are referring to FMS working, and in the last lecture sessions, we have referred to the tool allocation policies. Four types of the tool allocation policies we have referred to.

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During this lecture session, I will be the referring to another important aspect and that is Fixture and Pallet Selection Problems. We will take up one or two numerical examples related to fixture and pallet selection problem.

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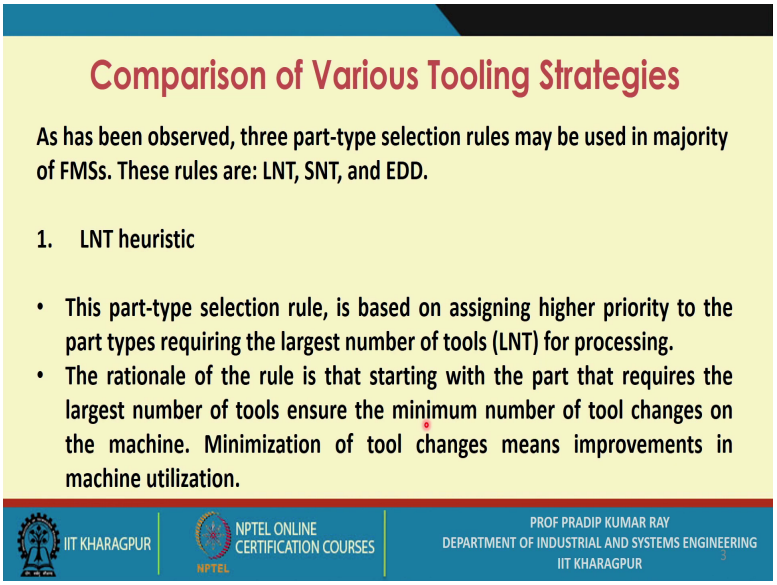

Before you start processing the work part, you should be aware of the kinds of problems you may be facing while you carry work part fixturing as well as a palletizing. You also must know that how many pallets you require, given a particular demand in terms of the number of parts to be processed per unit of time.

Let me again discuss LNT, SNT and EDD rules or the heuristics for part type selection. These are rules you may use in majority of FMS.

If you follow one particular rule, your performance will be the best one. Let me just go through once again LNT rule; that means you will the select a particular part for which the number of parts or number of cutting tools you require for its processing is maximum. This part type selection rule is based on assigning higher priority to the part types requiring the largest number of tools.

The rationale of using this rule is that starting with the part that requires the largest number of tools. The major advantage is that it ensures the minimum number of tool changes in the machine. The tool changeover time is essentially non-value adding activity. It is unavoidable, but make sure that the tool changeover time should be as minimum as possible.

If you can automate the tool changeover process; then substantial reduction in the tool change over time is possible. Minimization of tool changes means improvements in the machine

utilization. If you remember that related to FMS performance, there are many performance measures.

One such the performance measure is the FMS utilization. Within FMS utilization, you also must be bothering about the robot utilization; because if you utilization is poor, that means yes, the robot operations are perfect.

But then again if it is not cost-effective, it will seriously affecting the production cost. Whatever may be your manufacturing system with FMS or without FMS, whether it is a semi-automated or fully automated systems, make sure that it is cost effective.

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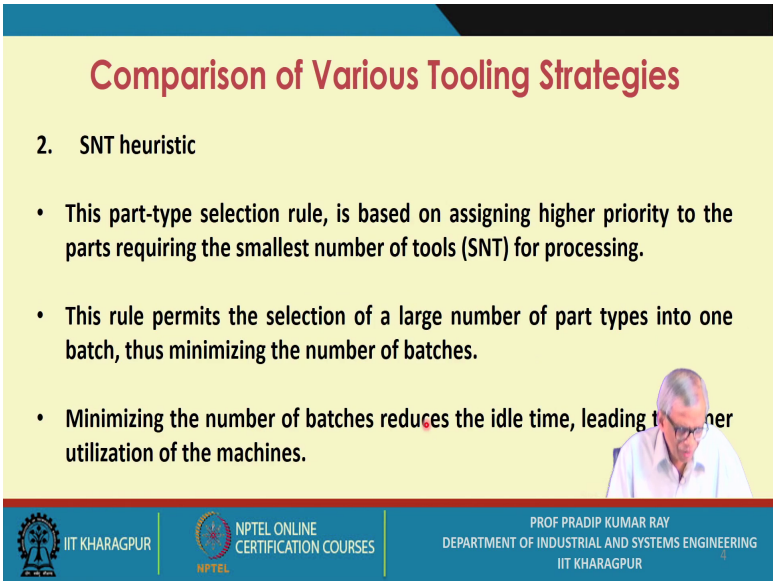

Alternatively, you can go for SNT rule. This part type selection rule is based on assigning higher priority to the parts requiring the smallest number of tools for processing. Normally, out of many parts you are dealing with, it is assumed that if you need for processing a part just one tool, you may assume it to be a simple part. But for processing another part, suppose you require some five different types of cutting tools; you may assume that the part feature is not that simple. It is a complex shape, that could be your assumption. This rule permits the selection of a large number of part types into one batch.

The majority of the parts in a part population requires minimum number of cutting tools. The minimum number of cutting tool becomes the basis of your part selection.

You expect that in a particular batch, greater number of parts you can include. You will be dealing with minimum number of batches for the same population size.

Minimizing the number of batches reduces the idle time, leading to higher utilizations of the machines; the changeover time will also be reduced. Less number of batches you will be dealing with.

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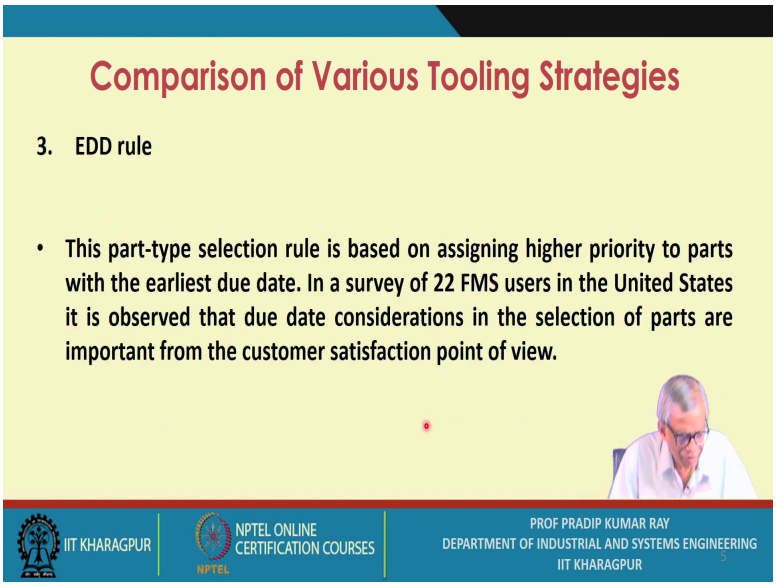

Alternatively, many manufacturing systems may be following the EDD rule. This part type selection rule is based on assignment of higher priority to parts with the earliest due date.

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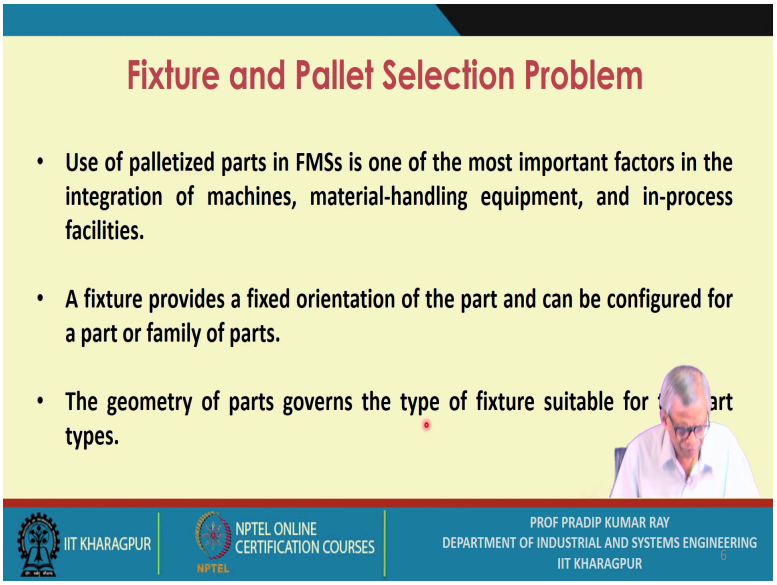

With respect to the performance measures and with respect to the priority rules; if you want to assess the performance of each tooling strategies or tooling policies, you need to go for a simulation system; you must have prior knowledge of how many the machining centers you will be dealing with.

Let us talk about fixture and pallet selection problem. Use of palletized parts in FMS is one of the most important factors in the integration of machines, material handling equipment, and in process facilities.

FMS is basically an automated system. Prior to an automated system, make sure that your level of integration is the highest order. For ensuring this acceptable level of integration, there are many kinds of physical subsystems you need to design and you need to use.

One such system is the palletization. First the parts with the fixtures, part and fixture with the pallets and then you have one entity. This entity you create in such a way that there are certain rules followed, such that certain conditions are followed. There could be error build up.

If you lose control on the error buildup, it may so happen that with the FMS you produce the parts; but when you check its quality you will find that these parts are basically out of

tolerance. This is treated as a waste and as FMS is a sophisticated system, this just cannot be allowed.

At each step you have to check whether there is a possibility of making error or not and to what extent this error ultimately affecting the quality of the part. A fixture provides a fixed orientation of the part, that way if the fixture is defined and can be configured for a part or family of parts, it is like a you propose a general-purpose fixture, the composite one. It is not only designed for one part, but you can use that same fixture for a number of parts. There are several examples of such for flexible fixture.

The geometry of parts governs the type of fixture suitable for the part types; it could be prismatic parts or cylindrical parts. In general, for the prismatic part, one type of fixture you design and for cylindrical parts, another type of fixture you have to design.

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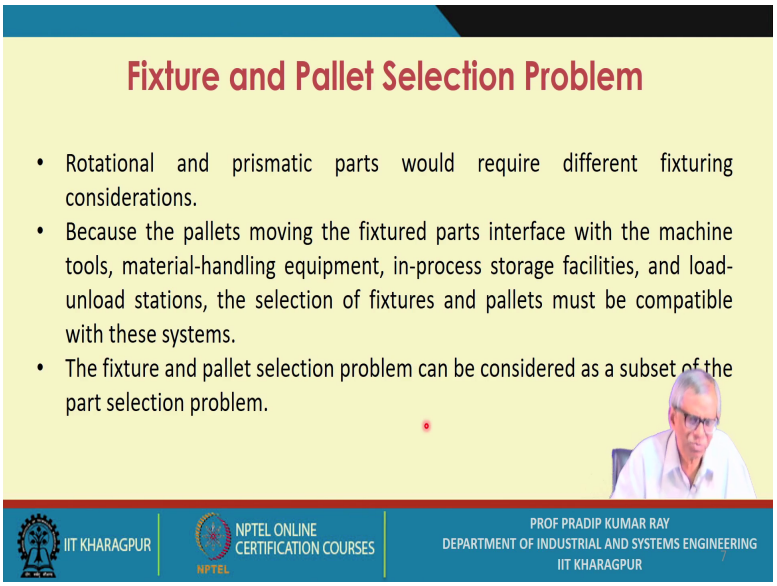

The rotational and prismatic parts would require different fixturing considerations because the pallets moving the fixtures. Fixture parts interface with the machine tools, material handling equipment, in process storage facilities.

First you get the part and then as the subassembly is formed with the part and fixtures with the palette, one unit is formed. This is to be transferred to a particular machining center.

The material handling system you have to use and then in the machine tool, which particular machine tool it goes that also to be specified, which kind of the material handling system you are going to use are also to be specified and whether you need the temporary storage or not, that is also to be decided.

What sort of an automated storage and retrieval systems you have? Load-unload stations. The selection of fixtures and pallet must be compatible with these systems. The fixtures and pallet selection problem can be considered as a subset of the part selection problem.

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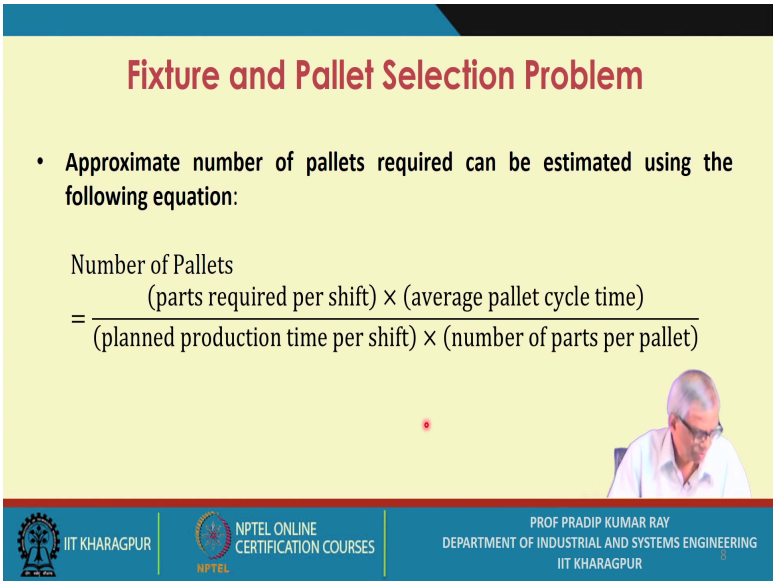

Here, we assume initially that the problem is a deterministic one; the values are given and the values are the problem under certainty. You need to determine the number of pallets. We propose this formula to determine the number of pallets.

Given a set of parts and given a set of cutting tools, you are given the machine tool or the NC machining center, you are given the material handling system, it could be a robot or AGVs or by any other systems, material handling systems; these are all given and there is appropriate selection of material handling equipment.

You have automated storage and retrieval system; this is also working. Now, to meet the demand in terms of the number of parts to be processed in a given time period or the planning

horizon, say one hour, one shift and all, how many pallets you need to use? We say that the relevant information is made available and the problem is under certainty.

What is the information you need? First one is the parts required per shift you specify; average pallet cycle time. The part enters the system and several kinds of operations are carried out. Once all the operations are carried out, this part leaves the system.

The time when the part leaves the system and the time when it enters the system; the difference between these two the timings is referred to as the pallet cycle time. Planned production time per shift, say 8 hours duration.

Suppose, you have created an automated system of 8 hours duration; you create the system in such a way that entire 8 hours, 8*60 = 480 minutes; this entire time period is spent on production.

Whenever you install an FMS system, make sure that it becomes a continuous working system; that means what kind of the maintenance systems you have, the preventive maintenance of the systems you have to install and the breakdown is not permitted at all.

It should be continuously working; then only it becomes cost-effective and ultimately the company's profitability will be at the maximum level. The planned production time you have to decide and waiting time, which is considered to be non value adding, are not permissible. Number of parts per pallet.

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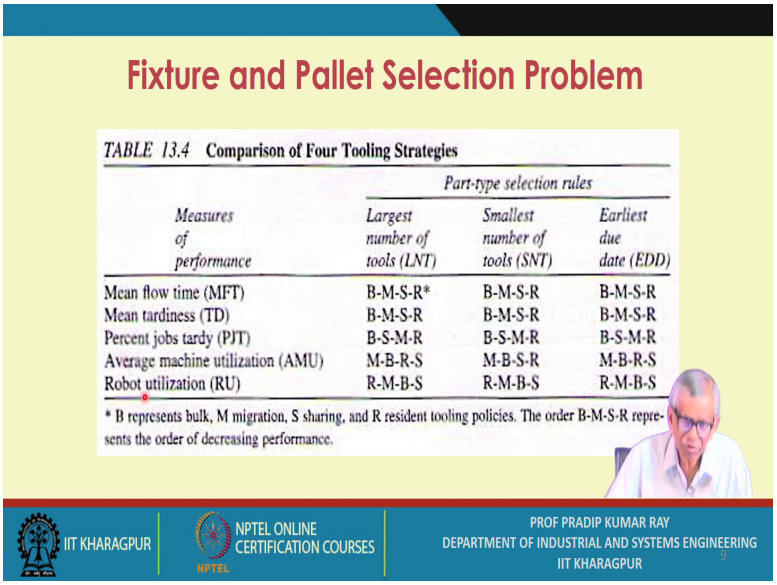

This information you will get.

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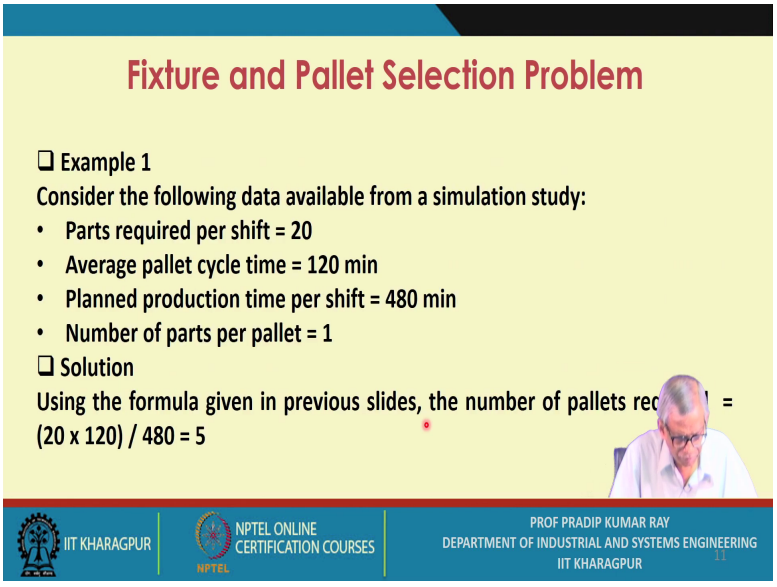

This is one example I have taken up related to the number of pallets. Consider the following data available from a simulation study. Parts required per shift is 20.

Average pallet cycle time 120 minute, that means the 2 hours. Planned production time per shift 8 hours, 480 minutes; that means it is continuously working and number of parts per pallet is 1.

It depends on design of the pallet, how many parts it can hold. You apply that formula.

(20 x 120) / 480 = 5

Whenever you have installed an FMS and you are working on FMS, the first condition you should ensure that, at least for 1 year or the 6 months your system remains stable,

You are utilizing your FMS to the fullest extent possible. The maximum utilization you have to ensure. It is a kind of quantity assurance system. These are the preconditions before you go for installing or implementing an FMS.

Initially you start with conventional machining and then you start implementing NC technology, the system is becoming disciplined under-control. In the next stage, you change your manufacturing system's layout to a cellular manufacturing system.

As soon as you start implementing Group Technology principles, the next level the control system becoming more accurate and better and it will have a direct impact on the performance of the system or the quality assurance systems.

In the last stage you opt for the CMS. So, you go one step further. It is expected that before you implement FMS, you have already implemented the CMS. Many factors are directly affecting the performance of the system, they are under control.

There could be certain assignable causes; but you are sure that those assignable causes will be identified as quickly as possible, because when you install automated system, there is one important aspect called traceability.

If you quickly can trace the problem, advantage is very quickly you will also come to know the assignable causes without having any type-I error, you will be able to identify the causes and you also will be able to remove these causes.

This sort of condition you must have in the system before you talk about performance of FMS. FMS may not be the compatible with the existing production system.

In another context, this is referred to as the creating environment.

As far as fixture and pallet selection problem is concerned, these are five performance measures we have identified for an FMS.

First one is the mean flow time; second one is the mean tardiness, the percentage jobs tardy, it is called basically the late jobs; that means actual time you have taken and your due date. Positive lateness is referred to as the tardiness.

How many parts tardy at this point in time? Average machine utilization and robot utilization.

In the context of scheduling essentially scheduling, the selection rules are referred to as the priority rules.

First one is LNT, alternatively you can go for SNT, and alternatively you can go for EDD priority rule. Now, you have four types of tool allocation policies.

Suppose you opt for LNT and you want to maximize the performance in terms of mean flow time; that means mean flow time should be as minimum as possible. First priority will be B and if you cannot do this one; then the next alternative is M as far as tooling policies are concerned. And if suppose M is not feasible, you have to go for the third one.

Within FMS, we are discussing several factors. But FMS is a part of the total system; many other factors, which you get from other systems may affect directly or indirectly and those factors you need to consider when you take a decision.

The different alternatives are given and then you check that when you opt for a particular tooling policy, which the combinations you will be referring to, LNT versus the mean flow time or SNT versus average machine utilization.

And then you check what is your first priority, what is your second priority, what is your third, and what is the last or fourth one as far as the selection of the tooling policy is concerned.

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