Automation in Production Systems and Management
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Flexible Manufacturing Systems (Part - I)
Lecture - 40
Numerical Examples

During the previous the four lecture sessions we have discussed the different types of the flexibility and their measures.

There could be many kinds of changes taking place and these changes are classified under two categories- internal changes and external changes.

During the 5th lecture session, I will be discussing a number of the problems in a manufacturing system where FMS you can recommend.

If you want to develop or install an FMS, a number of problems you have to deal with and those problems are to be formulated. Once a particular problem is formulated then you must get the solution and once you get the solution then the control measures or the improvement measures you can take.

At this point in time we are trying to focus on those types of problems in FMS.

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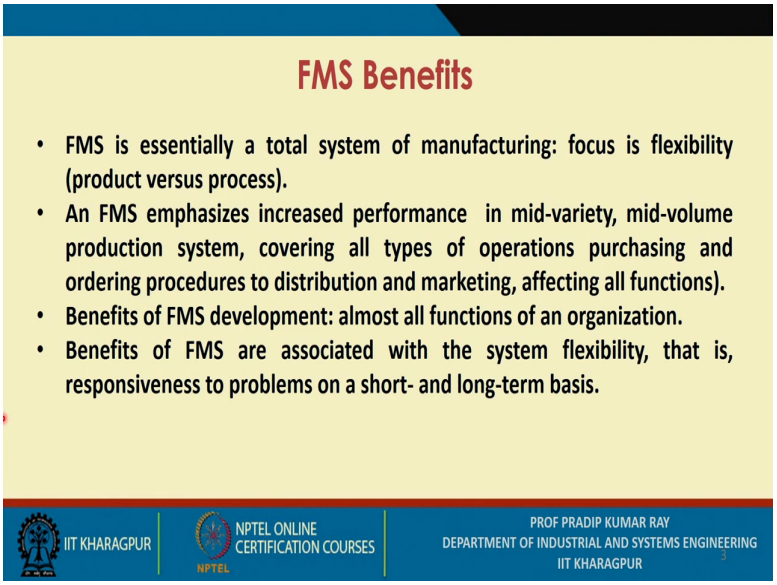

FMS can be of different types. It is not that all kinds of FMS will be able to solve all kinds of problems. Those prioritised problems are to be solved with an FMS. This is problem details totality.

You must know the benefits of an FMS. FMS is essentially a total system of manufacturing: focus is flexibility.

An FMS emphasises increased performance in mid–variety, mid-volume production system. The increased performance covering all types of operations purchasing and ordering procedures to distributions and marketing affecting all functions.

Not only the direct activities or the direct work, but indirect work supporting services, say, the availability of a particular tool, and the tool or the cutting tool is to be used and again, suppose one particular machine tool within FMS suddenly the breaks down, how quickly the maintenance system can respond?

There are different kinds of the manufacturing system we have. You can go for push type MRP-based system or alternatively you can go for JIT based systems. First you have to look into the characteristic features of your manufacturing system and how these characteristic features will help you in developing an FMS.

The benefits of FMS developments: almost all functions of an organization. There could be many functions. There could be marketing and market research; there could be specifications engineering; there could be process planning and control; there could be sales and distribution.

Once you install an FMS in your production system, you will find that almost all other functions and their performance will be affected, and usually the effect is positive.

While implement an FMS, make sure that all the necessary conditions for implementing or for developing FMS are satisfied. The benefits of FMS are associated with the system flexibility that is responsiveness to problems on a short term and long-term basis

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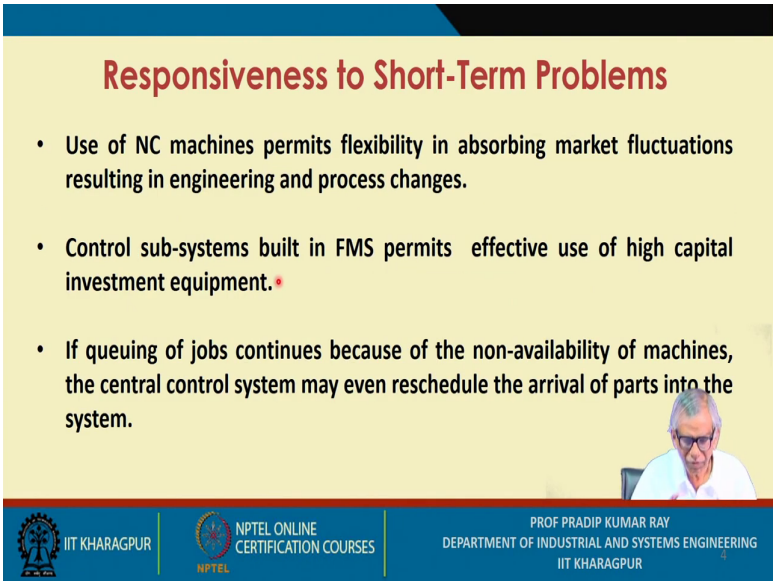

There could be short term problems. Every day almost you are getting certain problems or every month, every quarter. There could be the long-term problems also. So, how do you respond to these kinds of problems?

Certain important the aspects you must be aware of. One is the use of NC machine. The use of NC machine permits flexibility in absorbing market fluctuations. So, we will respond very quickly and effectively to the changes in the market demand.

Absorbing market fluctuations resulting in engineering and process changes. There is concept called product mix flexibility. If you install FMS, product mix flexibility or other kinds of flexibilities will be very effective and you can respond quickly.

As soon as the product mix changes, we have to come out with new process plans. Control subsystems built in FMS permits effective use of high capital investment equipment.

If your design of the control subsystem is very good then it will help in installing capital equipment in your FMS.

If queuing of jobs continues, waiting time is continuing. Why do you wait? Non-availability of machines, the work part is ready, but machine is not available.

Central control systems may even reschedule the arrival of parts into the system. As soon as one particular the part is released from the system for its subsequent processing in the system, it is already the assured that the machine is available otherwise that particular work part will not be released.

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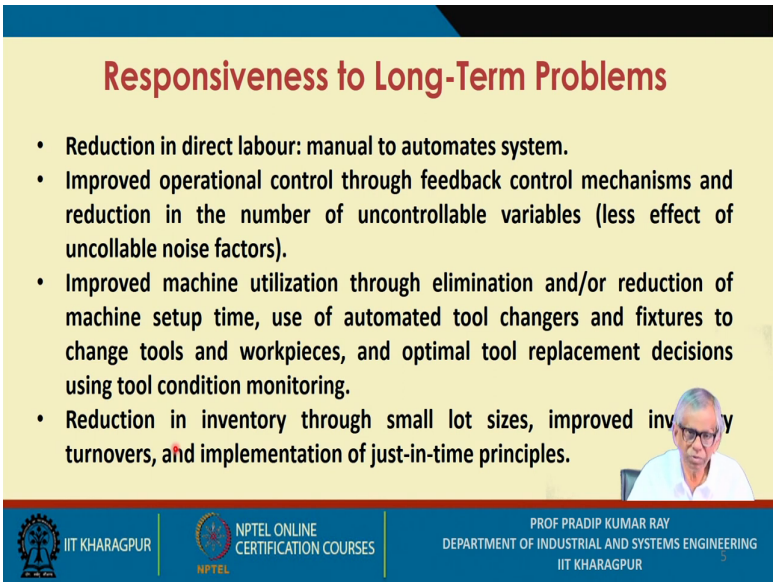

Once you refer to the long-term problems, the reduction in direct labour is a great advantage. You are moving from manual to automated system, what is required is that whether it is a feasible alternative or a desirable alternative or not.

Then you check what extent it is a feasible alternative and in order to make it feasible, what sort of changes in the design and manufacturing system you have to make. We will find that the direct labour reduction is a possibility.

Sometimes what happens in many manufacturing systems the direct labour may not be a significant proportion of the total product cost. Many a time that under what conditions you must go for an automated system? We will assume that right now because of some reasons we are continuing with manual, but the manual system is not desirable and that is why we have to make it an automated system.

Improved operational control through feedback control mechanisms, there will be feed forward systems as well as the feedback systems. Entire manufacturing system can be represented as a control system and there is a closed loop control.

Based on in the closed loop control, you have to create the automated system. What is the main advantage? Improved operational control through feedback control mechanisms and reduction in the number of uncontrollable variables or less effect of uncontrollable noise factors. This is one condition of making your manufacturing system a robust one.

Not only you make your product robust one, but also you have to make your process or the manufacturing system a robust one. But you have to wait, you have to design it properly and ultimately this is the major advantage in the long term, improved machine utilisations through elimination or reduction.

If complete elimination is not possible at least reduction of machine setup time. Many sorts of approaches you can use for reducing setup time like Single-Minute Exchange of Dies; SMED technique.

Use of automated tool changers. You have to do fixtures to change tools and work pieces, a composite fixture you can use. So, that type of fixture you have to design optimal tool replacement decisions using tool condition monitoring.

In the FMS, what could be the tooling strategies? There could be different types of tooling strategies. Reduction in inventory through small lot sizes, improved inventory turnovers and implementation of just-in-time principles.

Just-in-time principles means the zero defects like the zero setup then zero handling, zero inventory, lot size of 1 and almost no maintenance.

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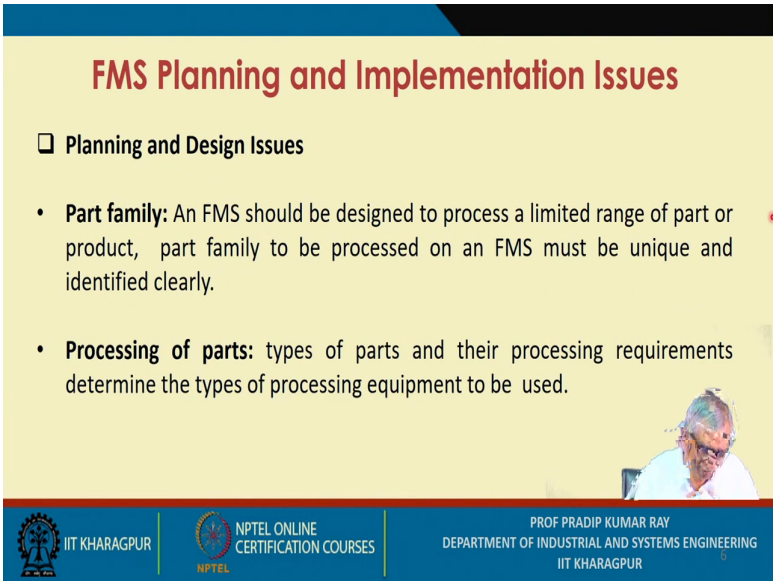

As far as the manufacturing system is concerned there could be two types of systems. One is the push type and alternatively if one can go the pull type. In today's context, you get erratic demand pattern for any product.

If you convert your push system to a pull system, you will be in a better position to respond to the changing demand patterns of your products. So, it is better that if you can convert the system; certain steps you have to take; convert the push type system to pull type.

What are the planning and implementation issues related to FMS?

The planning and design issues, first is the part family. The part family related problems we have to deal with and FMS should be designed to process a limited range of parts or product. Part family to be processed on an FMS must be unique and identified clearly.

You can define similarity coefficients.

The level of similarity or the similarity coefficient first you calculate and under a certain level, say the similarity coefficient up to 0.7, I will consider. But, if you consider the similarity coefficient up to say 0.3 or 0.2 then you need to include a greater number of parts;then again, the range of parts will be very high.

Processing of parts: type of parts and their processing requirements. How do you get these processing requirements? You refer to the process plan. This process plan actually depends on the kinds of processes you need to process a particular part, the design of the parts.

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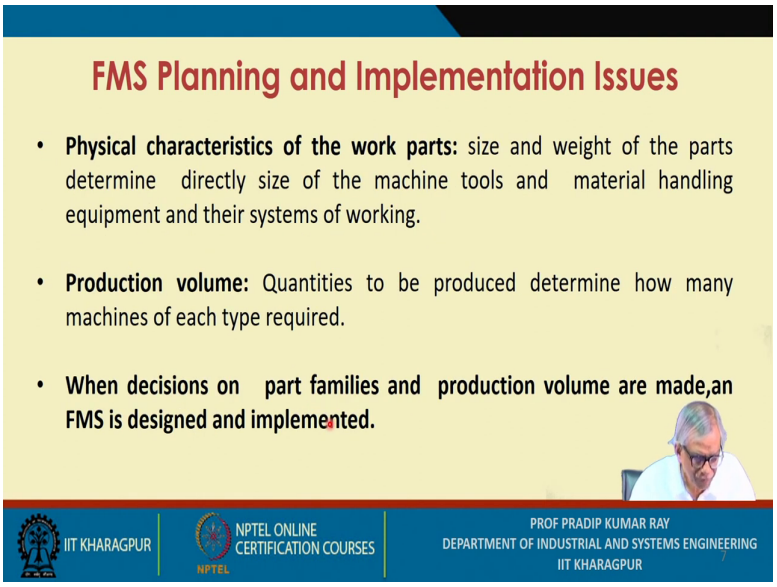

The physical characteristics of the work parts, physical characteristics like size, shape, weight of the parts. Determine directly the size of the machine tools. Suppose the size is very large; the raw materials weight is quite heavy, a specific machine tool you have to recommend.

As per the weight of the object, raw materials you have to select; the material handling systems. Any material handling systems you recommend, you must know its specifications. If you use AGVs or suppose you use a particular conveyor, the conveyor or the AGV is to be designed.

The capacity of the conveyor of the AGVs must be known and this capacity as well as performance dependent on the size and size and weight of the objects or the raw materials getting handled.

Now you have to select the raw materials with respect to its size and weight.

Production volume: quantities to be produced determine how many machines of each type required. Whether it is a specific type of machine, suppose one NC machining center.

Depending on the production volume, you need to decide whether one unit of a machine tool is sufficient or you have to add one more machine tool of the same type; identical machines.

Similar machine tool you can use provided that the specific operations are made available. When the decisions on part families and production volume are made, an FMS is designed and implemented.

First you convert your manufacturing system into a cellular manufacturing system and once you create your cellular manufacturing system then you try to develop an FMS.

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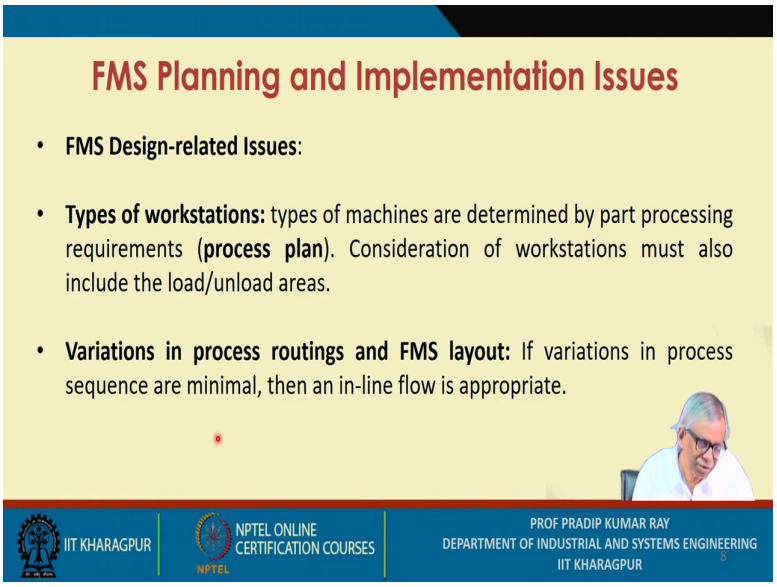

If you follow these stages, you will get the maximum benefits from an FMS. What are the FMS design-related issues? The first is the types of workstations.

In a particular workstation you just look at the type of machines you require. This the types of machines are determined by part processing requirements.

You refer to your process plan. Once you study the process plan you will come to know the operations required and the processes required and for getting these processes what are the machine tools available. You will be preferring a NC technology.

Consideration of work stations must also include the load unload area and it should also include the coordinate measuring machine, or inspection machines, variations in process routings and FMS layout.

FMS layout is very much dependent on the type of material handling systems you use. It could be a straight-line layout.

If it is a straight-line layout say the single row or the double row then you have to use the AGVs. Once AGVs you use, the layout will be either single row straight line or the double row straight line. If variations in process sequence are minimum, then inline flow is appropriate.

In line flow, the conveyor built is there definitely and there will be feed mechanism at different work stations. FMS layout is very much dependent on the process routings and on a particular process route you need to use the different kinds of material handling systems.

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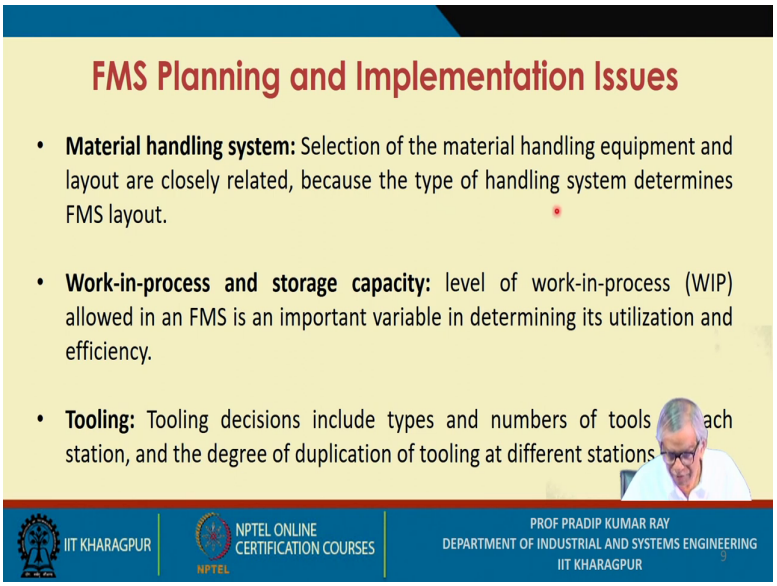

Next important issue is the material handling systems. Selection of the material handlings equipment and the layout are closely related FMS layout because the types of handling systems determine actually the FMS layout. Work-in process and storage capacity: make sure that WIP amount is as minimum as possible.

If the WIP is more; the throughput time will be more and the efficiency will be reduced and the utilization of the resources or the machine tool also may be very low.

You run your FMS in such a way that the WIP is held at the minimum level or variability in WIP is minimum. The next important issue is the tooling. Tooling decisions include types and numbers of tools at each station and the degree of duplication of tooling at different stations.

Related to the tooling what kind of problems you have to deal with. Like say related to WIP inventory control and storage capacity utilization, what kind of problems you might face? Are you in a position to formulate those problems? Are you in a position to solve those problems? So, these issues to be considered.

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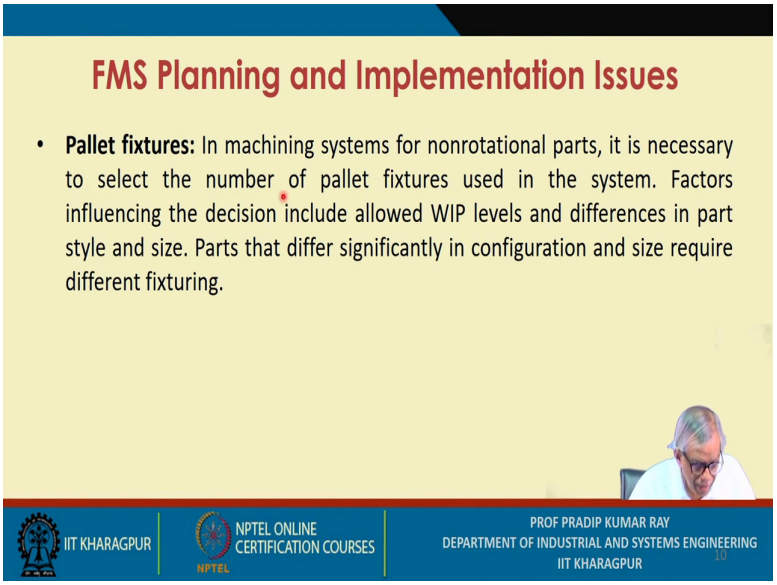

Next one is the pallet fixtures in machining systems. Palletization is a very important issue in FMS. In machining systems for non-rotational parts that means, the prismatic parts, it is necessary to select the number of pallet fixtures used in the system.

The kinds of pallets and fixtures are to be considered important factors influencing the decisions of WIP inventory.

The differences in part style and sizes. The level or varieties of parts that differ significantly in configuration and size require different fixturing.

Whether you can design a composite fixture is to be checked; that means, everywhere you try to use say the grouping principles. You can say the GT principles you have to use based on the similarity of parts.

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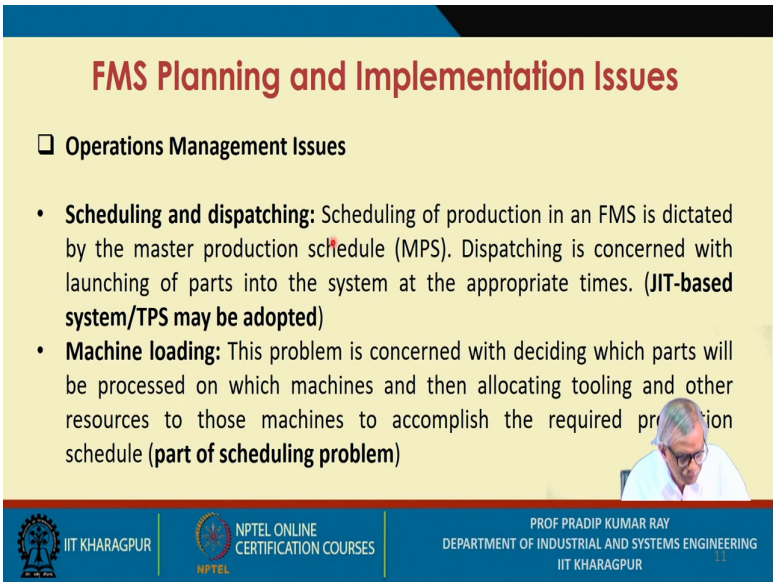

These are the operations management issues. Scheduling and dispatching, master production schedule in an FMS. Dispatching is concerned with launching of parts into the system at the appropriate times.

If you say now implement the JIT based manufacturing systems or the JIT based approaches, and under TPS Toyota production system a large number of the approaches you can use.

If you start converting your manufacturing system into JIT based manufacturing system, it becomes easier for you to the develop FMS. The machine loading problem is concerned with deciding which parts will be processed on which machines and then allocating tooling and other resources to those machines to accomplish the required production schedule part of scheduling problem.

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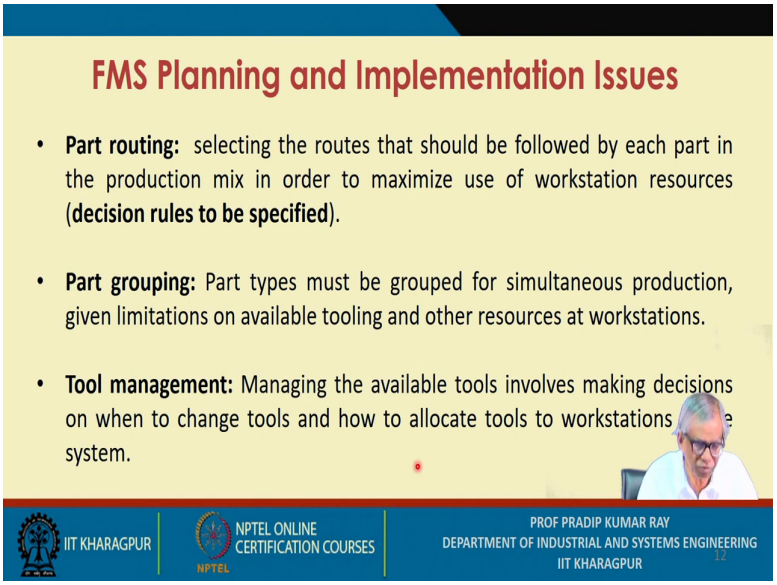

Like, you have to go to the loading problem and then the sequencing and then you go for the schedules. What is the special type of scheduling problems you need to deal with because of installation of an FMS?

Under certain conditions you are following a particular route? If the new conditions come you have to change the route, which particular route? This way you can just specify the decision rules. Part grouping is a must and the tool management strategies.

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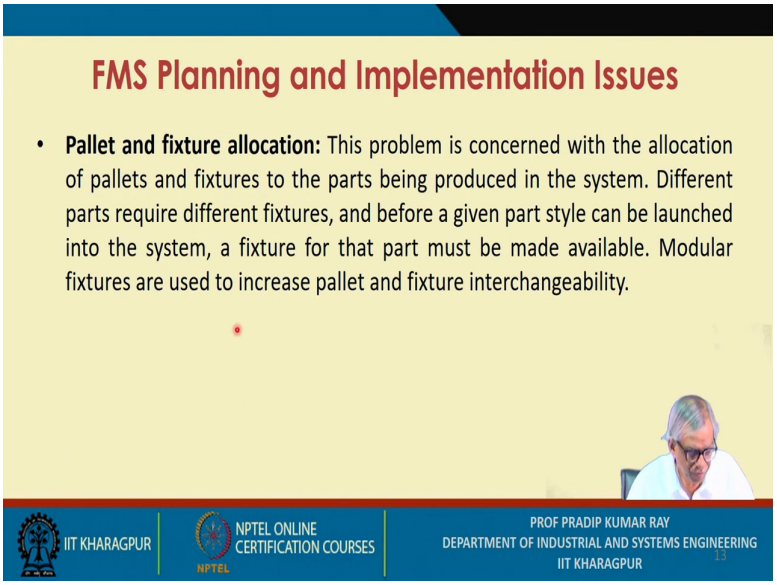

Pallet and fixture allocation: this problem is concerned with the allocation of pallets and fixtures to the parts being produced in the system, the part with the fixture part and fixtures with the pallet, that means, the entire system is formed is made and then that is loaded on an NC machine tool within an FMS.

The different parts require different fixtures and before a given part type can be launched into the system, a fixture for that part must be made available. The modular fixtures are used to increase pallet and fixture interchangeability.

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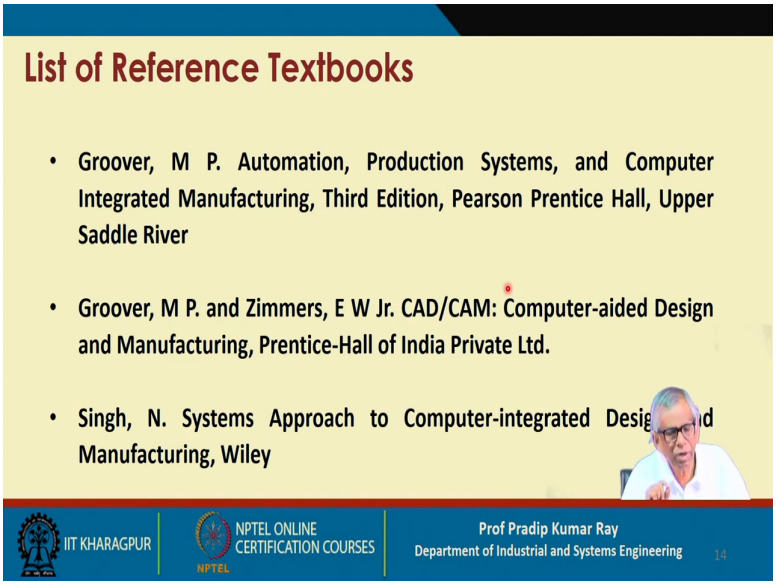

When you run an FMS the best possible the integration is you can achieve between the working of the physical subsystems and the working of the control subsystems.

If you can do that then you have the best design of an FMS. If it is the best FMS design you will be getting the best operational performance with the minimum manufacturing lead time or throughput time with maximum efficiency; the production rate will be very high as well as with the maximum quality.