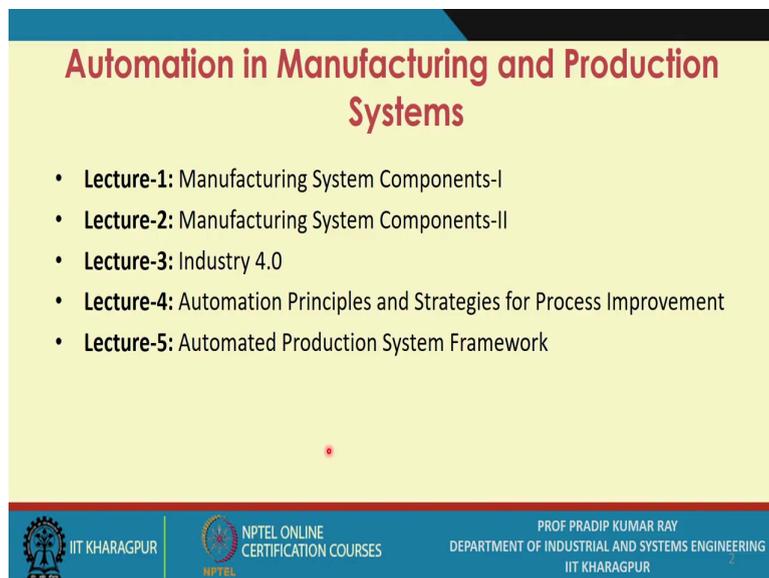


Automation in Production Systems and Management
Prof. Pradip Kumar Ray
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Lecture - 06
Manufacturing System Components – I

During the 2nd week we are referring to an important topic which is Manufacturing System Components.

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- **Lecture-1:** Manufacturing System Components-I
- **Lecture-2:** Manufacturing System Components-II
- **Lecture-3:** Industry 4.0
- **Lecture-4:** Automation Principles and Strategies for Process Improvement
- **Lecture-5:** Automated Production System Framework

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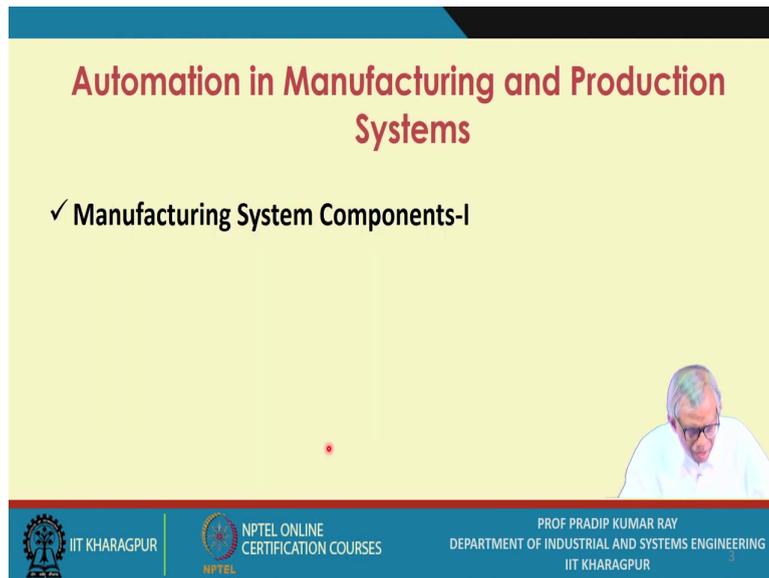
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During this week our main focus would be that under what conditions or what kinds of activities you are carrying out within a particular manufacturing system. Let us first identify them and then you will come to know that for making a manufacturing system or a production system an automated one, what are the different kinds of activities you need to consider.

In the 1st lecture hour we will be referring to a group of components Manufacturing System Components, during the 2nd lecture session we will continue discussing with all these system components. And then in the 3rd lecture sessions we will be bringing in a particular concept to manufacturing systems referred to as Industry 4.0.

In the fourth lecture session we will be referring to certain Automation Principles and Strategies for Process Improvement or process performance improvement and in the last lecture session Automated Production System Framework, there could be many kinds of framework, at least one integrated framework you must be aware of.

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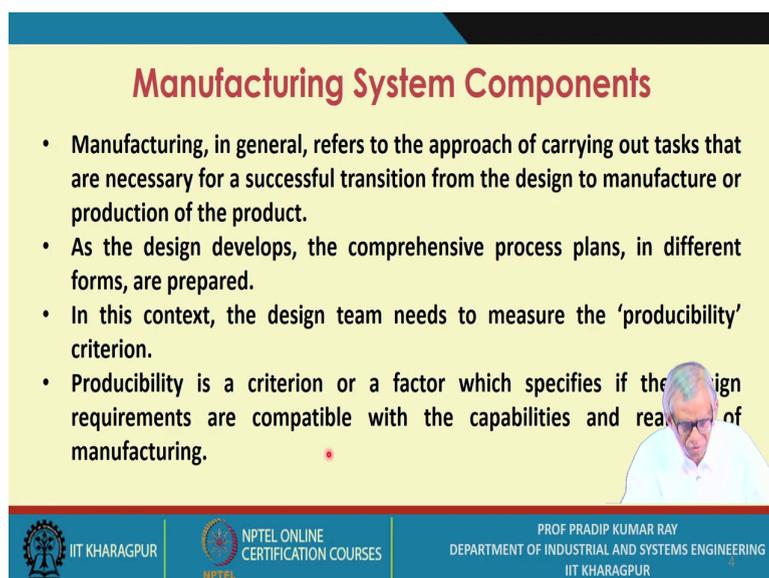
✓ Manufacturing System Components-I

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Now during this lecture session let us focus on Manufacturing System Components.

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Manufacturing System Components

- Manufacturing, in general, refers to the approach of carrying out tasks that are necessary for a successful transition from the design to manufacture or production of the product.
- As the design develops, the comprehensive process plans, in different forms, are prepared.
- In this context, the design team needs to measure the 'producibility' criterion.
- Producibility is a criterion or a factor which specifies if the design requirements are compatible with the capabilities and resources of manufacturing.

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You will come to know that what are the activities you are supposed to carry out to run a production system or a manufacturing system and what kinds of automation you need to propose if automated system becomes a feasible alternative.

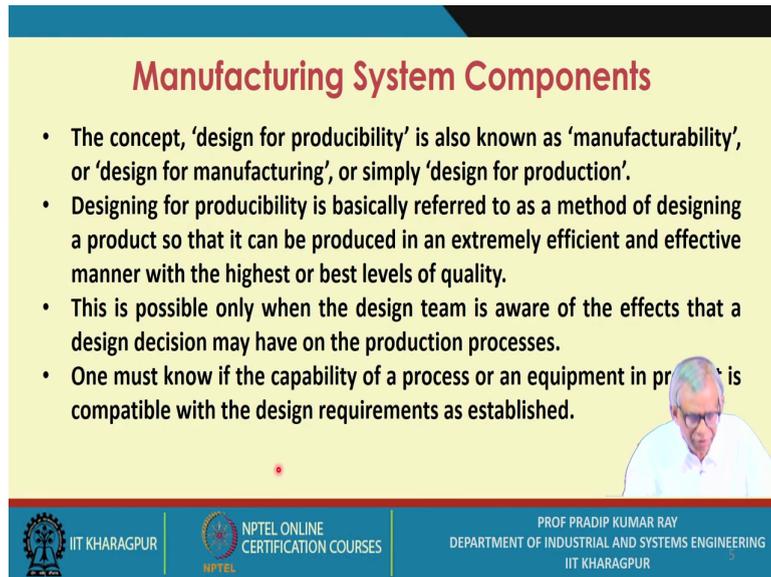
Manufacturing, in general, refers to the approach of carrying out tasks or the jobs that are necessary for a successful transition from the design to manufacture or production of the product. With the help of manufacturing system you are converting your design of the product into a product.

As the design develops, the comprehensive process plans, in different forms are prepared. The design is chosen; next you check that what kind of process plans you need to develop for preparing a process plan against a particular part or the component or the product. You have to follow different types of process planning approaches.

Now, the design team needs to measure the 'producibility' criterion, that means, you are proposing a design; to what extent this design is manufacturable. This is referred to as a producibility and many a time this is referred to as manufacturability, with the given the manufacturing systems are you in a position to produce a part as per its design specifications or not.

The producibility is a criterion or a factor which specifies if the design requirements are compatible with the capabilities and realities of manufacturing. Sometimes this is referred to as the quality of conformance-- first you start with quality of design and then you check to what extent you can have quality of conformance.

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Manufacturing System Components

- The concept, 'design for producibility' is also known as 'manufacturability', or 'design for manufacturing', or simply 'design for production'.
- Designing for producibility is basically referred to as a method of designing a product so that it can be produced in an extremely efficient and effective manner with the highest or best levels of quality.
- This is possible only when the design team is aware of the effects that a design decision may have on the production processes.
- One must know if the capability of a process or an equipment in product is compatible with the design requirements as established.

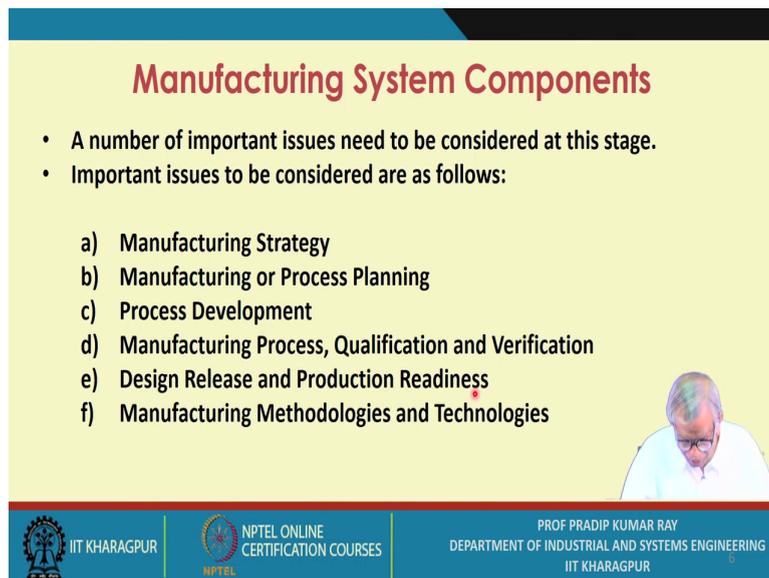
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The concept 'design for producibility' is also known as 'manufacturability'. Designing for producibility is basically referred to as a method for designing a product so that it can be produced in an extremely efficient and effective manner. Efficient in the sense that as minimum time as possible, that means, we are referring to manufacturing lead time.

It should be as minimum as possible along with the quality conformance or the specification conformance; effectiveness means you are producing output and all these outputs is entire volume of production in terms of the number of units and all these units are conforming to the acceptable standards or the specifications and with the highest or best level of quality.

This is possible only when the design team is aware of the effects that a design decision may have on the production processes. One must know if the capability of process or equipment in product is compatible with the design requirements as established.

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Manufacturing System Components

- A number of important issues need to be considered at this stage.
- Important issues to be considered are as follows:
 - a) Manufacturing Strategy
 - b) Manufacturing or Process Planning
 - c) Process Development
 - d) Manufacturing Process, Qualification and Verification
 - e) Design Release and Production Readiness
 - f) Manufacturing Methodologies and Technologies

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Many time this is referred to as the process capability. The process capability is ability of a process to produce as per its specifications. Now suppose you want to create an automated system for monitoring the process capability against each part are going to produce. To what extent these requirements can be fulfilled by implementing an automated system. A number of important issues need to be considered at this stage, that means, you have got the design of the product now you have to ensure that this particular design is manufacturable.

What are the important issues to be considered? First one is manufacturing strategy. While you maintain a particular strategy manufacturing strategy what are the activities you need to carry out? Can these activities be made automated?

Through process planning approach, against a particular design, once its bill of material is known and then what are the different types of parts you are required to produce and for producing those parts what sort of process plans you have to propose.

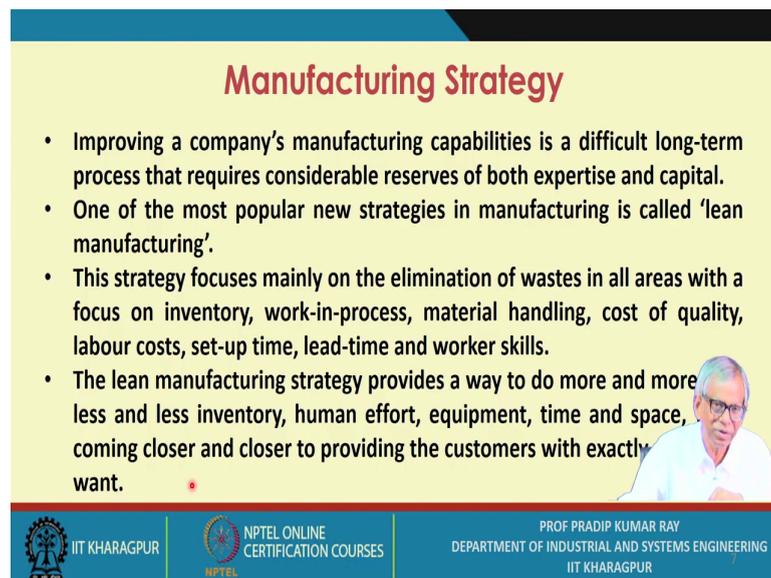
You determine this process plan in such a way that what are the processes or the operations to be carried out their sequences, the types of the material handling systems, types of work holding devices and the type of the machine tools.

All these the details you have to write in the document. Process planning actually is linking the design with the manufacturing. Then there is one important issue called process

development, manufacturing process qualification and verifications that you have to constantly do.

To what extent these activities can be carried out automatically that you have to think of. Design release and production readiness, those details must be known and the manufacturing methodologies.

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Manufacturing Strategy

- Improving a company's manufacturing capabilities is a difficult long-term process that requires considerable reserves of both expertise and capital.
- One of the most popular new strategies in manufacturing is called 'lean manufacturing'.
- This strategy focuses mainly on the elimination of wastes in all areas with a focus on inventory, work-in-process, material handling, cost of quality, labour costs, set-up time, lead-time and worker skills.
- The lean manufacturing strategy provides a way to do more and more with less and less inventory, human effort, equipment, time and space, coming closer and closer to providing the customers with exactly what they want.

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Improving a company's manufacturing capability is a difficult long term process that requires considerable reserves for both expertise and capital, that means in order to improve the process capability, maybe at this point of time the new machine tool is to be installed for which capital investment is required.

One of the most popular new strategies in manufacturing is called 'lean manufacturing'. It is essentially the Japanese approach which is referred to as the JIT based manufacturing system-a part of the Toyota production system or TPS. This strategy focuses mainly on the elimination of wastes.

The automated system may be developed with which the wastes will be identified and the waste will also be classified. In a typical production system, you find that all these wastes are due to non-value adding activities.

Wastes in a typical production system are classified under seven categories. The focus is how to eliminate wastes; you should be focusing on inventory, work in process, inventory should be as minimum as possible, and material handling.

Your goal is zero material handling and the cost of the quality should be as minimum as possible. The labour costs and the setup time should be as minimum as possible and the lead time also should be minimum and the workers skills.

Lean manufacturing strategy provides a way to do more and more with less and less inventory, human effort, equipment, time and space, while coming closer and closer to providing the customers with exactly what they.

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Manufacturing Strategy

- Without a well-defined manufacturing strategy, companies can too often look for short-term solutions that may prove detrimental in the long run.
- Long-range strategic plans allow sufficient emphasis to be placed on identifying and anticipating manufacturing technologies of the future.
- In this manner, manufacturing is prepared for new technologies with the expertise and equipment early enough to stay ahead of competitors.
- The manufacturing strategy of a company should strengthen its ability to function in a much better or effective way in the long run.
- Specifically, it deals with the following important issues in order to be successful in this effort:

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Without a well-defined manufacturing strategy, companies can too often look for short-term solutions. Long range strategic plan that you have to develop here. We emphasize on identifying and anticipating manufacturing technologies of the future and then you check that to what extent a particular technology you can adopt, you can utilize this technology fully only when you opt for an automated system.

Manufacturing is prepared, strategy is prepared for new technologies with the expertise and equipment early enough to stay ahead of other companies or your competitors. Manufacturing strategy deals with a number of issues.

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Manufacturing Strategy

- i. future manufacturing technologies and requirements and essential expertise acquired early in development efforts,
- ii. compatibility of the manufacturing strategy with long-range corporate objectives and modernization initiatives,
- iii. long-term commitment for continuous improvement of manufacturing and supplier capability,
- iv. product and process designs and their effectiveness,
- v. long term partnerships with suppliers, and
- vi. “make or buy” decision criteria or parameters for outsourcing.

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like, future manufacturing technologies and requirements, and what kinds of expertise you need to have to explore and to use those technologies. Compatibility of the manufacturing strategy with long range corporate objectives and modernization initiatives.

Long term commitment for continuous improvement of manufacturing and supplier capability that continuous improvement strategy you have to adopt.

The product and process designs and their effectiveness, we should focus on both product design as well as the process design. Long term partnerships with suppliers, the supplier base you have to create. Again a particular design or for a particular of a product you will have to develop the bill of material.

And then for the parts listed in the bill of material, you have to take a decision whether you will go for in-house manufacturing with your manufacturing system or for a given part it will engage one or more suppliers; decision is “make or buy” decision.

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Manufacturing or Process Planning

- A typical manufacturing plan coordinates the various production planning elements, such as production readiness and qualification.
- Without the benefit of thorough manufacturing planning, major problems may occur when a product is first produced.
- These problems include high rework and scrap rates, low quality, missed schedules, poor communication, cost overruns, and degraded product performance.
- The manufacturing plan identifies the approach and details of all the tasks that are necessary for accomplishing manufacturing's strategies.

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A typical manufacturing plan coordinates the various production planning elements, such as production readiness and qualification. Without the benefit of thorough manufacturing planning, major problems may occur when a product is first produced.

These problems include; one is high rework and the scrap rates, that is to be avoided. If you want to have an automated system, no compromise on quality, missed schedules, you have to ensure that there will be smooth flow of materials within the production system.

Waiting time will be less or the queuing time will be less. Poor communication, cost overruns; that means, you have a budgeted cost and the actual one is much higher, much more than the budgeted one and the degraded product performance. The manufacturing plan identifies the approach and details of all the tasks that are necessary for accomplish manufacturing strategies.

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Manufacturing or Process Planning

- This includes all critical paths between design and production and the tasks necessary to assure a successful transition from design to manufacturing.
- As the design develops, the plan becomes more comprehensive and thorough.
- Although no standard plan exists that is adequate for all products, all manufacturing plans are concerned with meeting the cost, schedule, quality, performance, and environmental goals established for the product.

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All the critical paths you have to think of between design and production. What are the different ways the design can be converted into a manufactured product and the task necessary to assure a successful transition from design to manufacturing?

Whenever you propose a process plan always there is a scope for improvement. You cannot say that the process plan has become a matured one with no further improvement is possible.

There is no standard plan or the structure or the framework you mention for which you which is applicable for all products, all manufacturing plans concerned with meeting the cost, schedule, quality, performance and environmental goals established for all the products.

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Manufacturing or Process Planning

- An effective manufacturing plan should first be addressed during early product development and updated as the product design and customer needs change.
- This early involvement in manufacturing is essential to assure that the product design is compatible with the overall capability of the production system consisting of several types of fabrication, metal cutting operations, assembly, and tests that are needed to produce the product.

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You have to declare formally your environmental performance, not only your financial performance environmental performance.

Now you have to check whether it is effective if you opt for an automated system, whether from the environmental point of view, performance point of view, whether it is suitable or it is a feasible alternative or not. An effective manufacturing plan should first be addressed during early product development.

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Process Development

- Process development is involved typically in the following activities:
 - i. Identifying the company's manufacturing strategies and detailing their effects on product development process,
 - ii. Studying the current business environment, competitors, and new technologies with sufficient detail, and incorporating this knowledge into the product development process,
 - iii. Developing a detailed manufacturing plan that includes the supplier base and partners of the company,

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What is important is, once the manufacturing plan is developed then you go for the process development, what are the activities to be carried out, You have to identify the company's manufacturing strategies, you have to study the current business environment. Then you have to develop a detailed manufacturing plan that includes the supplier base and partners of the company.

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Process Development

- iv. Identifying manufacturing and supplier processes that need to be developed or improved, and
- v. Establishing a comprehensive manufacturability program that includes design guidelines for manufacturing's capabilities, methodologies and processes and process qualification.

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Identifying manufacturing and supplier processes that need to be developed or improved even the supplier process that is to be looked into. Establishing a comprehensive manufacturability program, or producibility program that includes design guidelines for manufacturing capability, manufacturing systems capability methodologies and the processes and their qualification.

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Manufacturing or Process Planning

- Just as design must continually use new technologies to stay competitive, manufacturing must also develop new processes and technologies to stay competitive and support new design technologies.
- Process development is similar to product development except that the “product” is a new manufacturing process, method, equipment, or technology.
- Methodologies of product development are used in process development.

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Now, when you refer to the manufacturing planning or process planning, we assume that any product has a new manufacturing process, method, equipment or technology that will assume methodologies of product development.

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Manufacturing Process, Qualification and Verification

- Qualification of suppliers, methods, tools, software, and processes is an important task that is carried out to ensure readiness of manufacturing before the actual production begins.
- Each manufacturing process and supplier is reviewed and verified with respect to its adequacy to support the programme objectives.
- Prototypes are used to test each manufacturing process for verification of performance parameters, such as tolerances, cost, cycle time, and quality.

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Once the manufacturing processes are known, you need to verify whether it is the best one or not.

Qualification of suppliers, methods, the tools, software and processes is an important task and in majority of the cases in a typical batch production system, particularly discrete part manufacturing system, you find that the 40 to 70% of the items listed in bill of material are basically procured from outside.

Each manufacturing process and supplier is reviewed and verified with respect to his adequacy to support the program objectives over time. Periodically you have to review the process plan, again you have to review the corresponding design. Prototypes are used to test each manufacturing process for verification of performance parameters. This is a part of the product development process. For a new product development process, you have to check to verify whether the tolerances, the costs for the life cycle time and the quality these are acceptable to you or not.

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Manufacturing Process, Qualification and Verification

- Documentation such as production procedures and test requirements are verified.
- The process begins with the manufacturing plan.
- The process of qualification and verification requires the coordinated efforts of all members of the design team.

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The documentation such as production procedures and test requirements are verified. First thing you must know that databases are to be created and for different activities you carry out once the databases are known; obviously, appropriate documentation system or management information system is to be developed.

The process begins with the manufacturing plan. The process of qualification and verification requires the coordinate efforts of all members of the design team.

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Design Release and Production Readiness

- One of the major milestones of any design programme is to know the time when the design of the product is stopped or frozen.
- The final design is released to manufacturing only when it is certified that the design is “mature” or “production ready”.
- This is an important event for any company constantly involved in new product development.

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It is a group activity and once the final design is approved then it is released to the manufacturing only when it is certified that the design is matured or production readiness. This is the condition to be implemented before a particular manufacturing system.

So, convert it into a 100% automated systems like FMS; but first you have to check whether the design is matured or not, this is an important event for any company.

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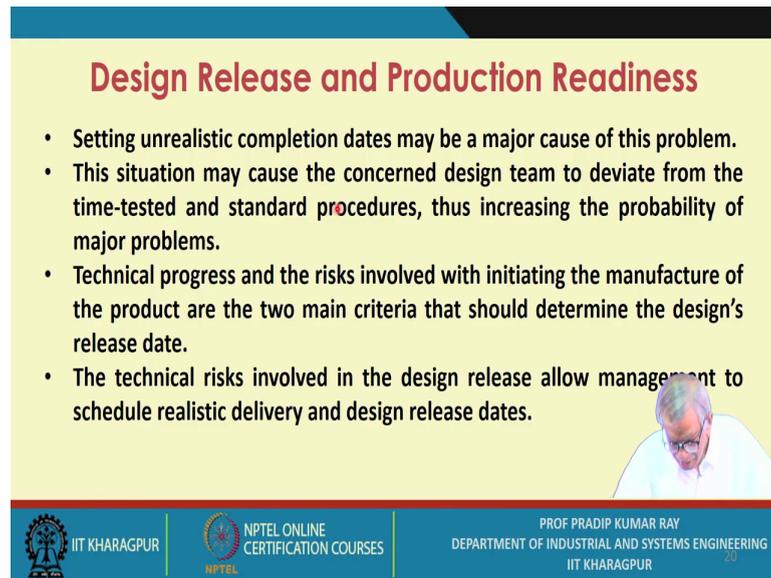
Design Release and Production Readiness

- Many companies have their own guidelines that control the point in time when the design is released to manufacturing.
- The timing of design release can, however, vary from one company to another, depending on company's size and the design's complexity, technical risks, and schedule requirements among other factors.
- One shortcoming in this respect arises when a design is released according to predetermined schedule requirements rather than its technical process (i.e., assessment of the design's maturity).

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Many companies have their own guidelines. The timing of design release is very important. One shortcoming in this respect arises. When a design is released according to predetermined schedule requirements rather than it is technical progress. This is sometimes referred to as the design maturity.

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Design Release and Production Readiness

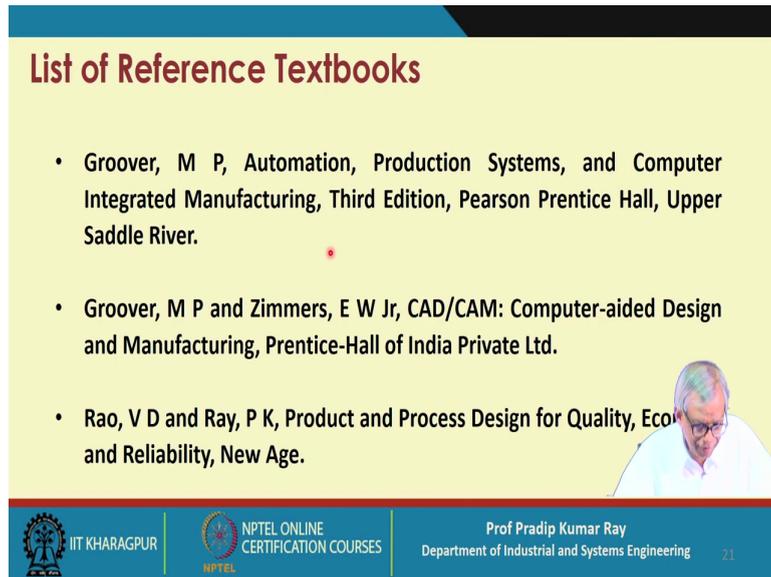
- Setting unrealistic completion dates may be a major cause of this problem.
- This situation may cause the concerned design team to deviate from the time-tested and standard procedures, thus increasing the probability of major problems.
- Technical progress and the risks involved with initiating the manufacture of the product are the two main criteria that should determine the design's release date.
- The technical risks involved in the design release allow management to schedule realistic delivery and design release dates.

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Now you have to check whether the conditions you have created in your production systems are the best one. For starting the production system and continue with the production system and it is assumed and assured that there will be smooth flow of materials within the production system.

The technical risks involve is also to be considered, not only the business risk but also the technical risk involved in the design allows management to schedule realistic delivery and design release dates.

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- Groover, M P and Zimmers, E W Jr, CAD/CAM: Computer-aided Design and Manufacturing, Prentice-Hall of India Private Ltd.
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There are many other activities while you build up your manufacturing strategy, while you select a manufacturing strategy, while you make the manufacturing plan or the process plan.

Particularly one very important consideration is that whether the design is matured one and once it is certified that it is a matured one, then you concentrate on the manufacturing and you make a proper plan documentation and then you may think of to what extent creating an automated system is feasible. We are emphasizing is that there must be a total systems approach.