Automation in Production Systems and Management
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Automated CAPP (Part-I)
Lecture - 54
Process Planning Approaches: Computer - Aided Process Planning

During this lecture session I will be referring to Computer-Aided Process Planning.

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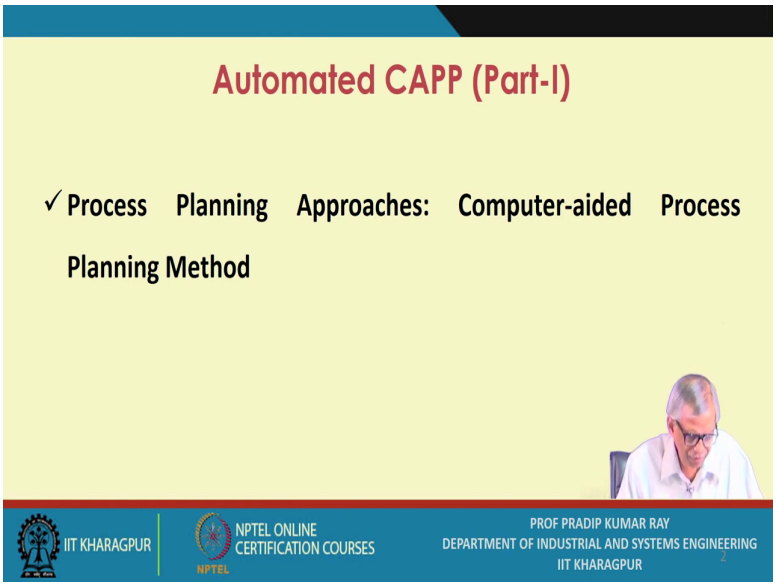

I am going to discuss certain very important aspects of the computer aided process planning methods including the types of the CAPP methods.

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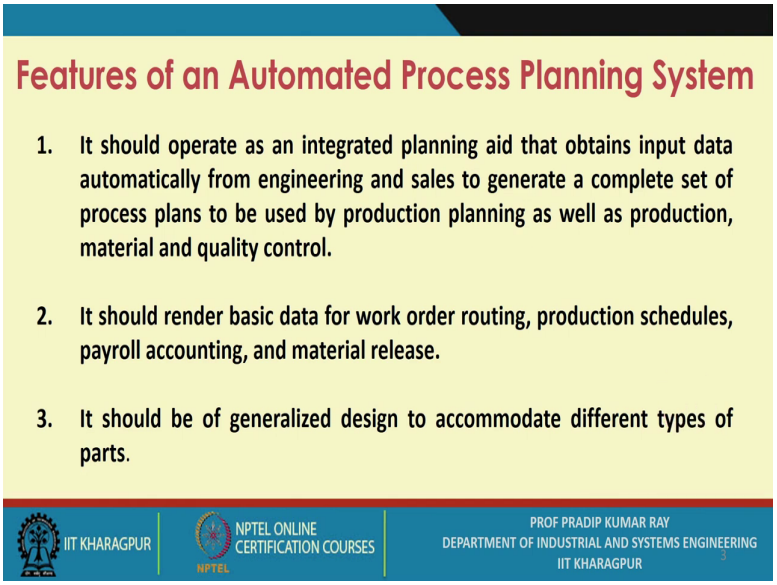

The features of an automated process planning system are as follows:

1. It should operate as an integrated planning aid that obtains input data automatically from engineering and sales to generate a complete set of process plans to be used by production planning as well as production, material and quality control.

2. It should render basic data for work order routing, production schedules, payroll accounting, and material release.

3. It should be of generalized design to accommodate different types of parts.

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Why computer aided process planning is required?

To translate the design requirements into manufacturing process details, a feedforward system is needed in which design information is processed by the process planning system to generate manufacturing process details. We want to optimize the system performance in a global context. Therefore, we have to integrate the CAPP system into the interorganizational flow.

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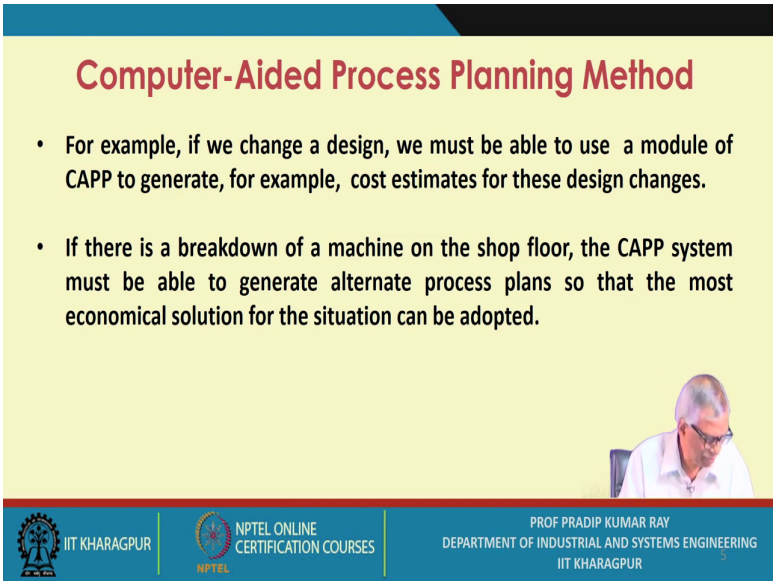

For example, if we change a design, we must be able to fall back on a module of CAPP to generate cost estimates for these design changes.

If there is a breakdown of a machine(s) on the shop floor, the CAPP system must be able to generate alternative process plans so that the most economical solution for the situation can be adopted.

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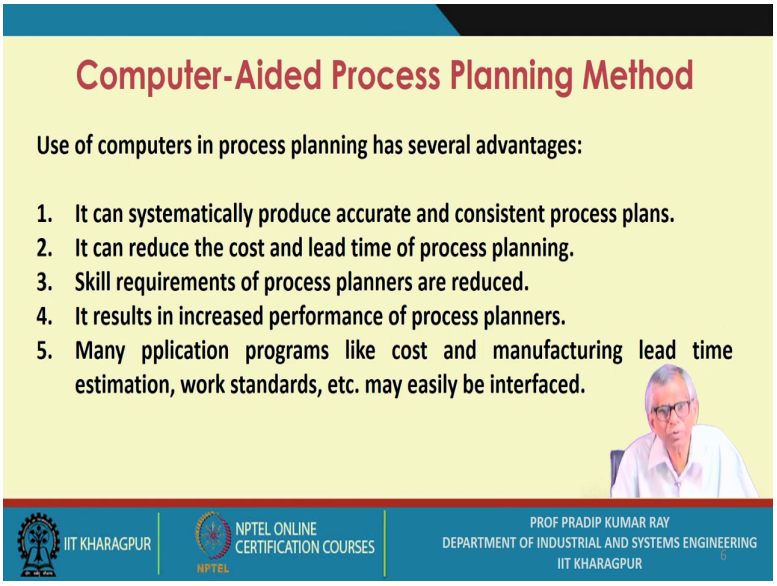

The use of computers in process planning also helps to achieve the following:

It can systematically produce accurate and consistent process plans. It can reduce the cost and lead time of process planning. The skill requirements of process planners are reduced. It results in increased productivity of process planners. The application programs such as cost and manufacturing lead time estimation and work standards can easily be interfaced.

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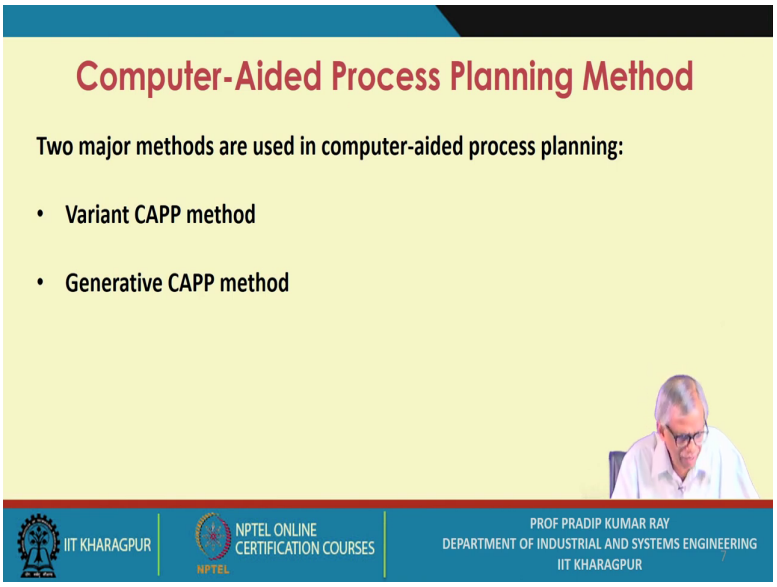

These are the advantages. There are two types of computers aided process planning approaches. First your start with the variant CAPP method and variant CAPP method is dependent on the part family formation. In this case you need to apply the group technology principles.

Generative CAPP method is actually 100% automated process planning approach that you cannot opt for immediately, you cannot jump on from manual process directly to 100% automated systems. You have to first adopt this variant CAPP method and if you are successful, then you feel like using the generative CAPP method and under generative CAPP method there could be a number of types.

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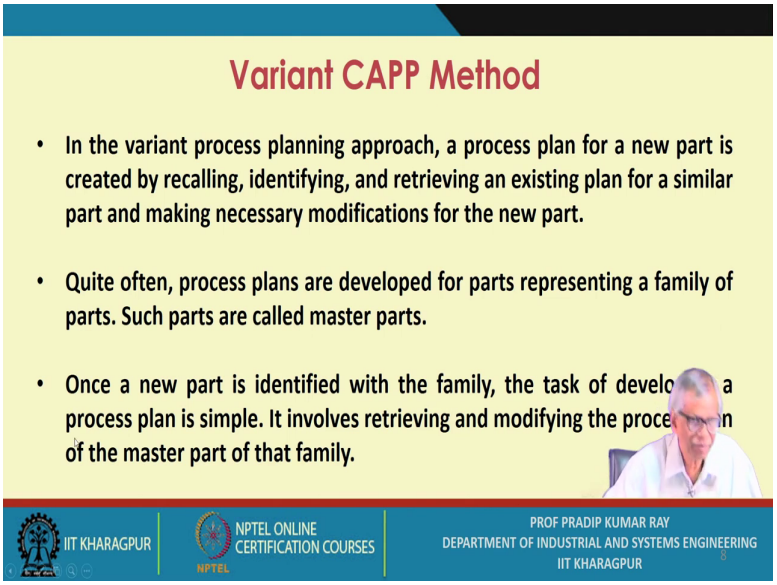

In the variant process planning approach, a process plan for a new part is created by recalling, identifying, and retrieving an existing plan for a similar part and making necessary modifications for the new part. Quite often, process plans are developed for parts representing a family of parts. Such parts are called master parts. Once a new part is identified with the family, the task of developing a process plan is simple. It involves retrieving and modifying the process plan of the master part of that family.

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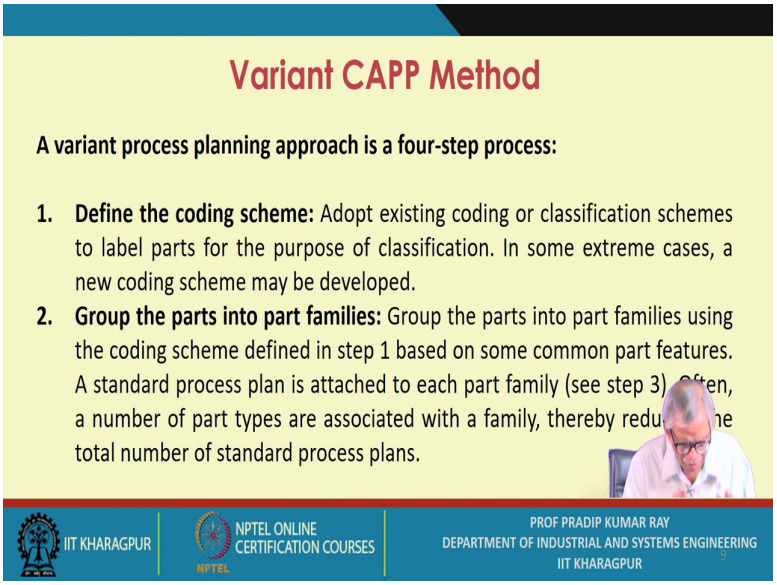

A variant process planning approach can be realized as a four-step process:

Define the coding scheme: Adopt existing coding or classification schemes to label parts for the purpose of classification. In some extreme cases, a new coding scheme may be developed.

Group the parts into part families: Group the parts into part families using the coding scheme defined in step 1 based on some common part features. A standard process plan is attached to each part family (see step 3). Often, a number of part types are associated with a family, thereby reducing the total number of standard process plans.

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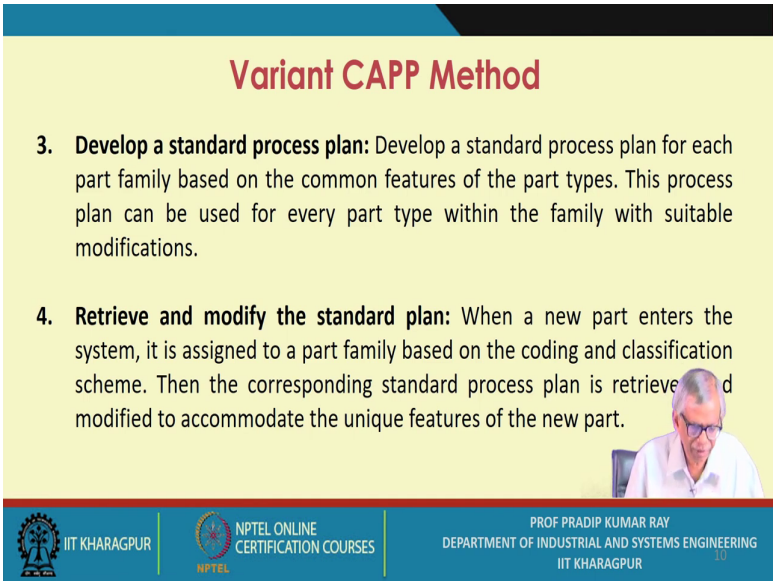

Develop a standard process plan: Develop a standard process plan for each part family based on the common features of the part types. This process plan can be used for every part type within the family with suitable modifications.

Retrieve and modify the standard plan: When a new part enters the system, it is assigned to a part family based on the coding and classification scheme. Then the corresponding standard process plan is retrieved and modified to accommodate the unique features of the new part.

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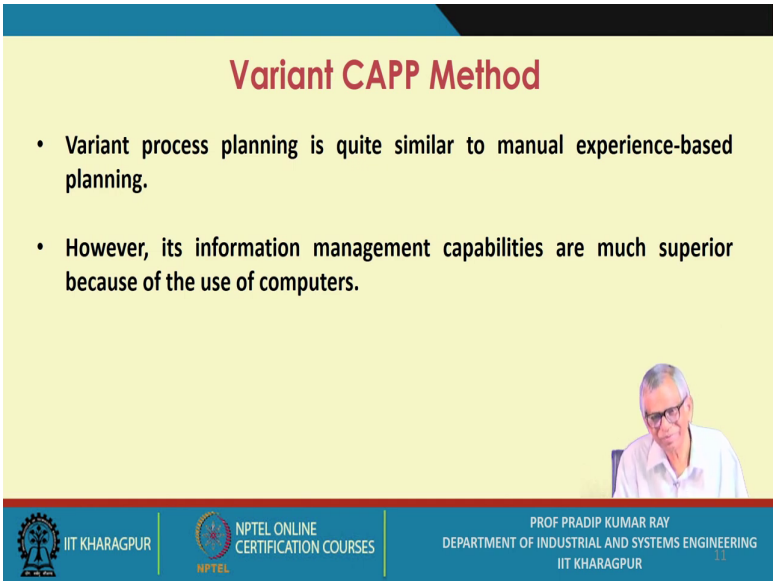

Now, the variant process planning is quite similar to manual experience-based planning because there is manual intervention because editing can be made automated for simple parts.

Manual intervention is accepted, but minimum manual intervention; that means, it is not a 100% automated. However, its information management capabilities are much superior because of the use of computers.

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Advantages of the variant process planning approach are explained here.

a) Efficient processing and evaluation of complicated activities and decisions, thus reducing the time and labor requirements.

b) Standardized procedures by structuring manufacturing knowledge of the process planners to company's needs.

c) Lower development and hardware costs and shorter development times. This is especially important for small and medium-sized companies whose product variety is not high, who have process planners and are interested in establishing their own process planning research activities.

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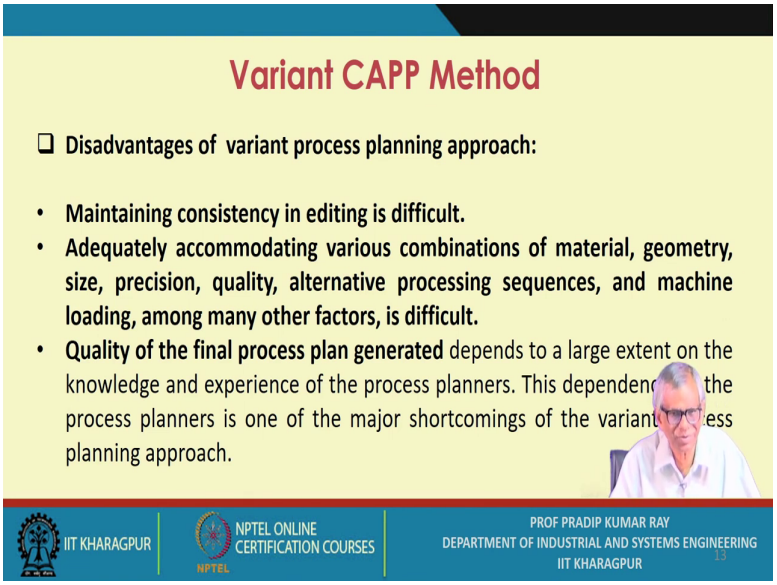

Disadvantages of the variant process planning approach are as follows.

first is maintaining consistency in editing is difficult because editing becomes a manual a manual operation, So, it is individual dependent. Adequately accommodating various combinations of material, geometry, size, precision, quality, alternate process sequences and machine loading, among many other factors is difficult.

what is the standard process plan document, and these are all other issues you need to consider because the process plan cannot just exist independently? So, it is affected as well as

it affects other subsystems also, and their databases. while you edit the process plan a person has to consider all these aspects, it becomes really difficult. It is not that easy.

Quality of the final process plan generated depends on a large extent on the knowledge and experience of the process planners. That is why it is it is essentially that as there is manual intervention and this editing part particularly or the studying the mastered process plan.

So, the person concerned who is involved, he must have the adequate knowledge and expertise not only one particular system, but for the entire the characteristic features of the entire production system or manufacturing system.

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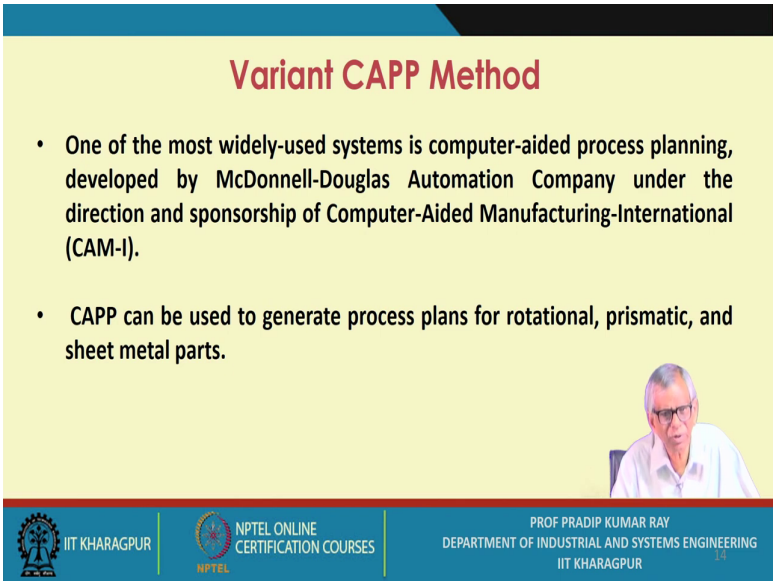

One of the most widely used systems is computer-aided process planning, developed by McDonnell-Douglas Automation Company under the direction and sponsorship of Computer-Aided Manufacturing-International (CAM-I). CAPP can be used to generate process plans for rotational, prismatic, and sheet metal parts.

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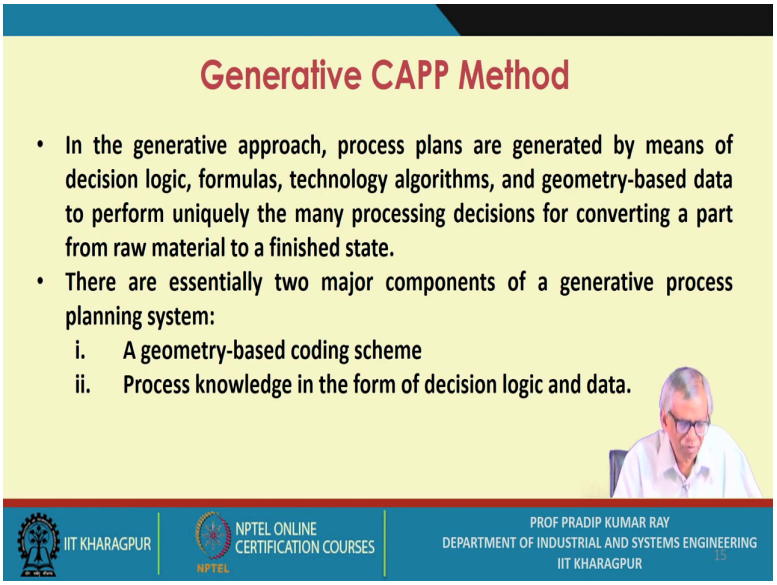

Now, what is generative CAPP method? In the generative approach, process plans are generated by means of decisions logic. These are the tools and techniques you use; the decisions logic formulas, technologies, algorithms and the geometry-based data to perform uniquely many processing decisions for converting a part from raw material to the finished state.

You need to use several kinds of the tools, algorithms that will be a part of the system; some of these the tools and algorithms have mentioned. There are essentially two major components of a generative process planning system. 1st one is the geometry-based coding scheme means, you are defining the parts in totality. And once you are successful in this and the next step you go for the process knowledge, in the form of decision logic and the data.

The process knowledge with respect to the given part for which the generative CAPP method will be the developed.

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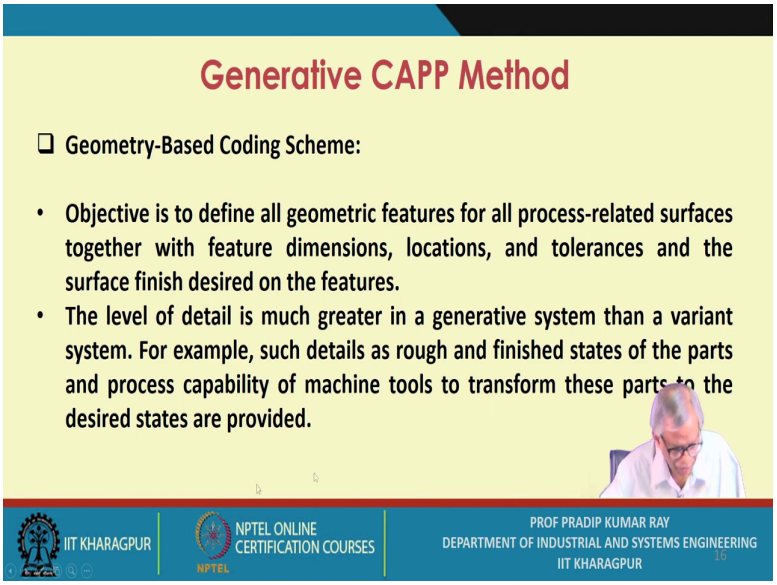

Let me highlight few important issues related to the geometry-based coding scheme.

The objective is to define all geometric features for all process-related surfaces together with feature dimensions, locations, and tolerances and the surface finish desired on the features.

The level of detail is much greater in a generative system than a variant system. For example, such details as rough and finished states of the parts and process capability of machine tools to transform these parts to the desired states are provided.

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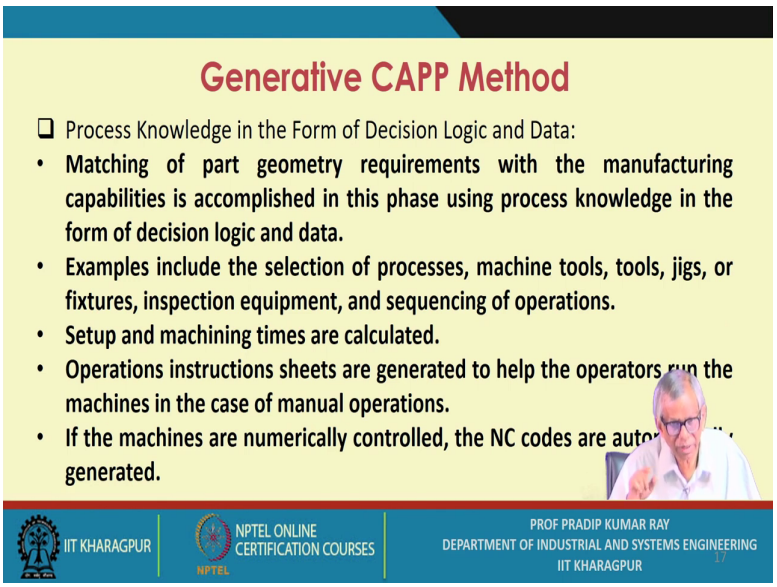

Now, next is the process knowledge in the form of decision logic and data. The matching of part geometry requirements with the manufacturing capabilities is accomplished in this phase using process knowledge in the form of decision logic and data. Examples include the selection of processes, machine tools, tools, jigs, or fixtures, inspection equipment, and sequencing of operations. Setup and machining times are calculated. Operations instructions sheets are generated to help the operators run the machines in the case of manual operations. If the machines are numerically controlled, the NC codes are automatically generated.

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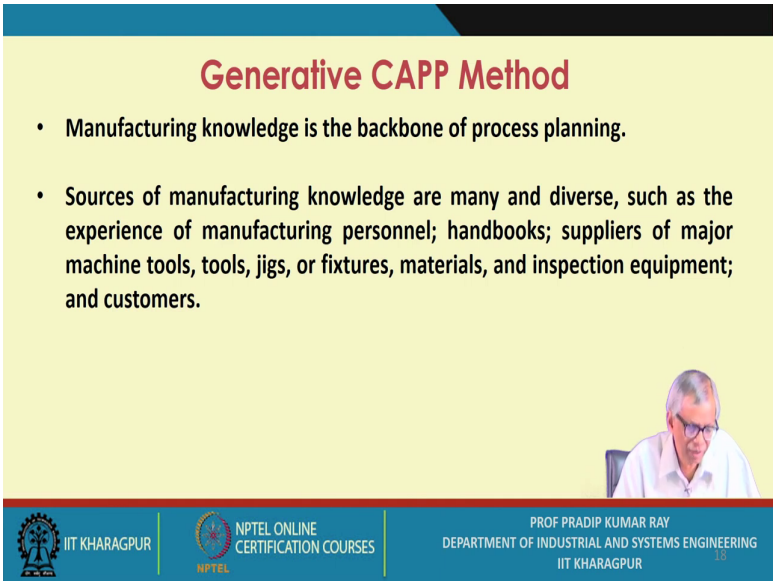

Manufacturing knowledge is the backbone of process planning.

The sources of manufacturing knowledge are many and diverse, such as the experience of manufacturing personnel; handbooks; suppliers of major machine tools, tools, jigs, or fixtures, materials, and inspection equipment; and customers.

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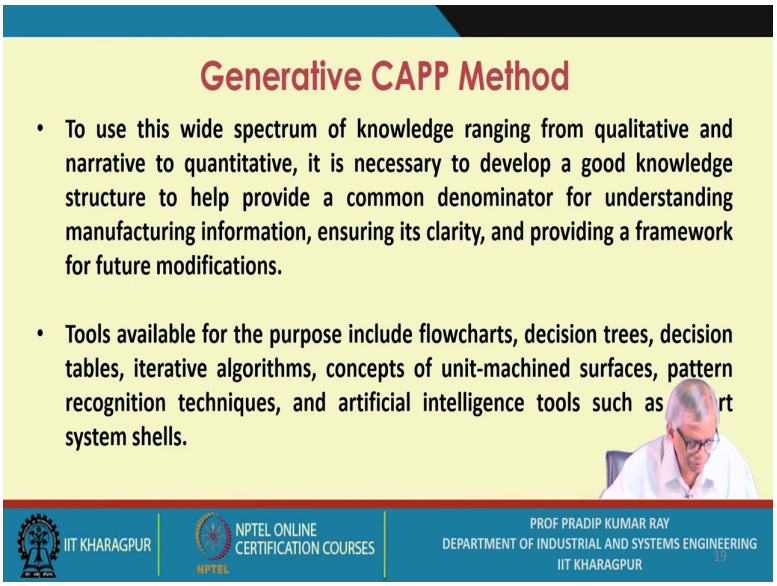

To use this wide spectrum of knowledge ranging from qualitative and narrative to quantitative, it is necessary to develop a good knowledge structure to help provide a common denominator for understanding manufacturing information, ensuring its clarity, and providing a framework for future modifications.

Tools available for the purpose include flowcharts, decision trees, decision tables, iterative algorithms, concepts of unit-machined surfaces, pattern recognition techniques, and artificial intelligence tools such as expert system shells.

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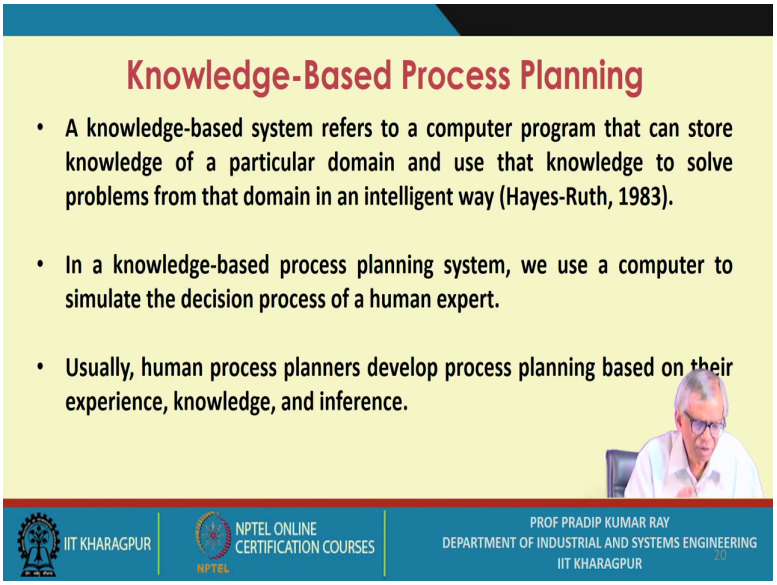

A knowledge-based system refers to a computer program that can store knowledge of a particular domain and use that knowledge to solve problems from that domain in an intelligent way (Hayes-Ruth, 1983). In a knowledge-based process planning system, we use a computer to simulate the decision process of a human expert. Usually, human process planners develop process planning based on their experience, knowledge, and inference.

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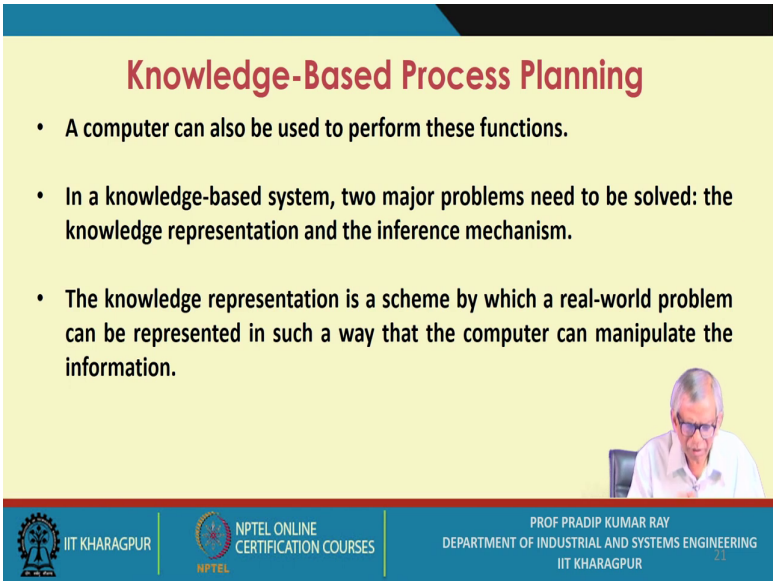

A computer, to some extent, can also be used to perform these functions. In a knowledge-based system, two major problems need to be solved: the knowledge representation and the inference mechanism. The knowledge representation is a scheme by which a real-world problem can be represented in such a way that the computer can manipulate the information.

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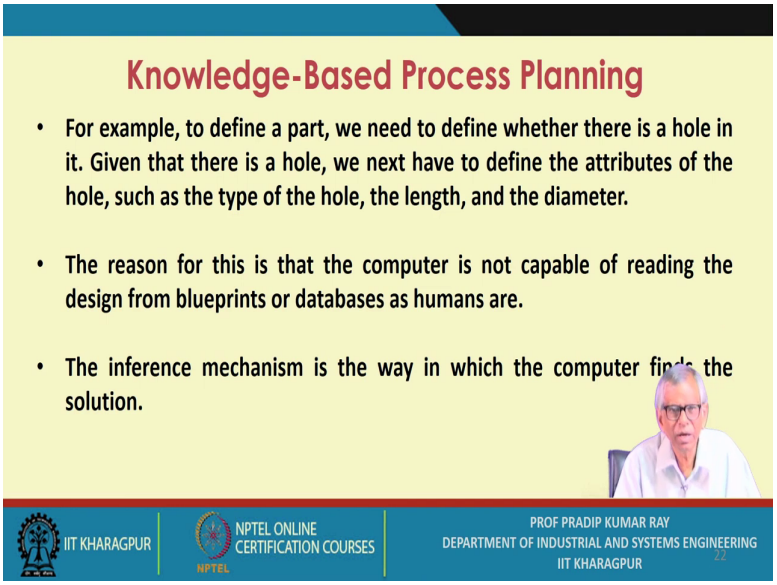

For example, to define a part, we need to define whether there is a hole in it. Given that there is a hole, we next have to define the attributes of the hole, such as the type of the hole, the length, and the diameter. The reason for this is that the computer is not capable of reading the design from blueprints or databases as humans are. The inference mechanism is the way in which the computer finds the solution.

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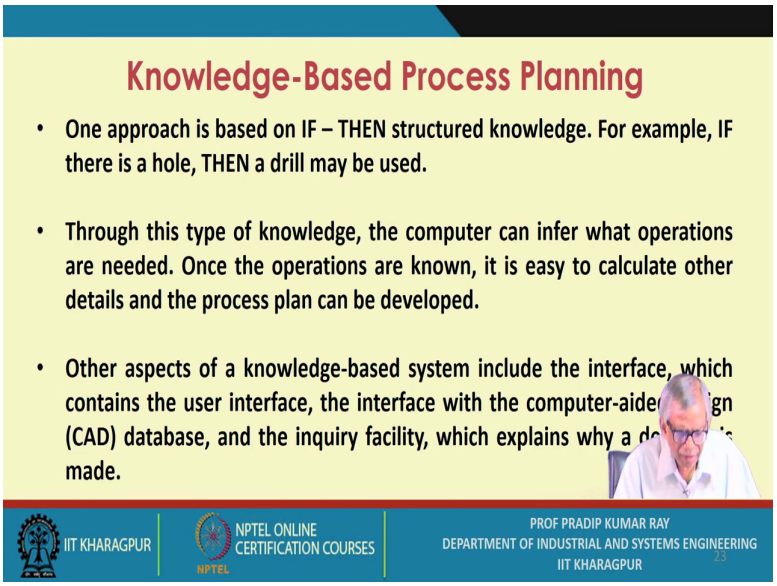

One approach is based on IF – THEN structured knowledge. For example, IF there is a hole, THEN a drill may be used.

Through this type of knowledge, the computer can infer what operations are needed. Once the operations are known, it is easy to calculate other details and the process plan can be developed.

Other aspects of a knowledge-based system include the interface, which contains the user interface, the interface with the computer-aided design (CAD) database, and the inquiry facility, which explains why a decision is made.

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