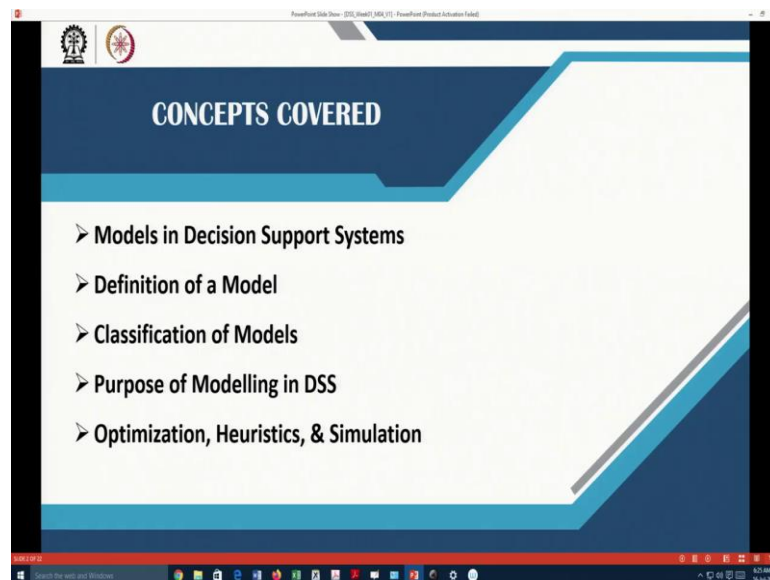


Decision Support System for Managers
Prof. Kunal Kanti Ghosh
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur

Module – 04
Models in Decision Support Systems
Lecture - 04
Models in Decision Support Systems

Hi, welcome to the 4th module of our course on Decision Support Systems! Today, we are going to talk about ‘Models in Decision Support Systems’. We have already discussed about models, we will slightly go into some more details.

(Refer Slide Time: 00:37)



The concepts that will be covered today will be the definition of a model, classification of models, purpose of modeling in decision support system and we will slightly give you an idea about certain terms which are widely used in DSS, those are optimization, heuristics and simulation.

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Models in Decision Support Systems

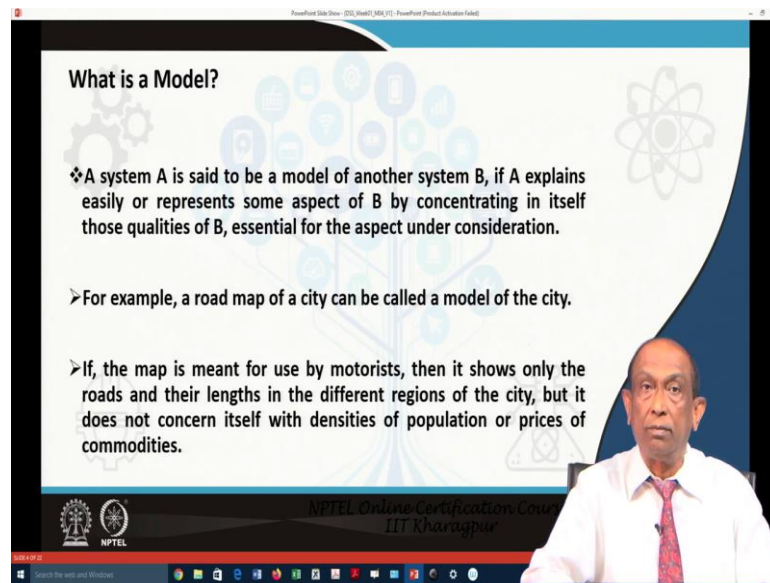
- ❖ The ability to generate and compare various alternatives to the problem under consideration is an essential characteristic of successful decision support systems.
- ❖ Models provide such an ability and that is why models are considered to be an important component of DSS.
- ❖ Model processes the data residing in the database of a DSS and generates meaningful output that can influence the decisions.

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When we talk about models in decision support systems, we must know that the ability to generate and compare various alternatives that have been formulated to solve the problem under consideration is mainly supported by these models. Models they have the ability to generate and compare various alternative solutions procedures. Models provide such an ability and that is why models are considered to be an important component of decision support systems.

Model, they basically processes the data which resides in the database of a DSS and then this models they generate meaningful output which can influence the decisions. Because it is the managers who will interpret this models, results of this models and then decide that which solution is the one that they will accept.

(Refer Slide Time: 03:03)

The image shows a presentation slide titled "What is a Model?". The slide content includes a definition: "A system A is said to be a model of another system B, if A explains easily or represents some aspect of B by concentrating in itself those qualities of B, essential for the aspect under consideration." It also provides two examples: "For example, a road map of a city can be called a model of the city." and "If, the map is meant for use by motorists, then it shows only the roads and their lengths in the different regions of the city, but it does not concern itself with densities of population or prices of commodities." The slide features a background with a stylized tree of icons and a molecular structure. In the bottom right corner, there is a video inset of a man in a white shirt and red tie. The NPTEL logo and "NPTEL Online Certification Centre IIT Khargapur" are visible at the bottom of the slide.

What is a Model?

❖ A system A is said to be a model of another system B, if A explains easily or represents some aspect of B by concentrating in itself those qualities of B, essential for the aspect under consideration.

➤ For example, a road map of a city can be called a model of the city.

➤ If, the map is meant for use by motorists, then it shows only the roads and their lengths in the different regions of the city, but it does not concern itself with densities of population or prices of commodities.

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A system A is said to be a model of another system B, if A explains easily or represents some aspect of B by concentrating in itself those qualities of B which are essential for the aspect under consideration. Once again I repeat a system A is said to be a model of another system B. If A explains easily or represents some aspect of B by concentrating in itself those qualities of B which are essential for the aspect under consideration.

For example, a road map of a city can be called a model of the city with respect to the problem that is getting studied. If the map is meant to be used by a motorist then it shows only the roads and their lengths in different regions of the city, but it will not concern itself with the population density or the price of commodities because they are not relevant with respect to the problem in hand. Thus abstraction is a very important feature of any model.

(Refer Slide Time: 05:10)

The slide is titled "What is a Model?". It features a background with a stylized tree of icons representing various fields like engineering, science, and technology. The text on the slide is as follows:

- Thus, abstraction is a very important feature of any model.
- The kind of abstraction used in a model depends on the real system represented by the model, and the purpose for which the model is constructed.

In the bottom right corner, there is a video feed of a man in a white shirt and red tie speaking. The NPTEL logo and "NPTEL Online Certification Course IIT Kharagpur" are visible at the bottom of the slide.

The kind of abstraction which are used in a model will depend on the real system that is getting represented by the model. And most important is the purpose for which the model is built.

(Refer Slide Time: 05:57)

The slide is titled "What is a Model?". It features the same background as the previous slide. The text on the slide is as follows:

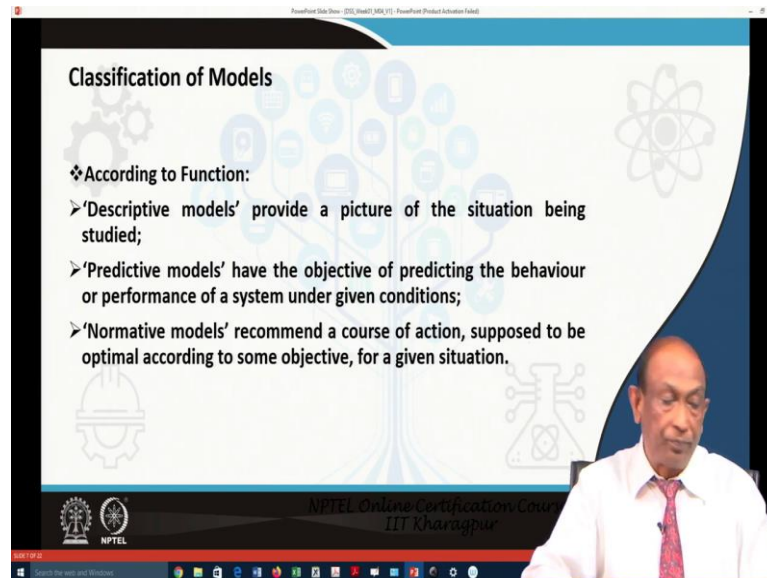
- The models used in decision support systems in management are usually logical and mathematical in nature;
- Models are made up of:
 - equations,
 - constraints,
 - initial values,
 - final values,
 - operational rules, and the like.

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The models that are used in decision support systems particularly in the area of management are usually logical or mathematical in nature. Models in the area of management mainly consist of equations, constraints, initial values, final values that is the boundary conditions, the operational rules and so on. Once again, models are made

up of equations, constraints, initial values, final values and the operational rules. So, boundary conditions are very important.

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The image shows a presentation slide titled "Classification of Models" with a speaker in the bottom right corner. The slide content is as follows:

Classification of Models

❖ According to Function:

- 'Descriptive models' provide a picture of the situation being studied;
- 'Predictive models' have the objective of predicting the behaviour or performance of a system under given conditions;
- 'Normative models' recommend a course of action, supposed to be optimal according to some objective, for a given situation.

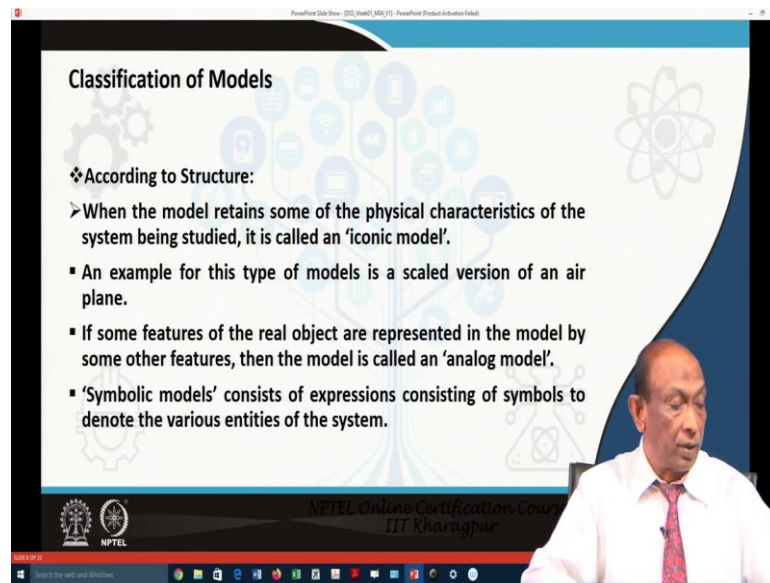
The slide features a background with various icons related to technology and science, such as a gear, a tree, a brain, a lightbulb, a microscope, and a chemical structure. The speaker is a man in a white shirt and a red tie, looking towards the camera. The bottom of the slide shows the NPTEL logo and the text "NPTEL Online Certification Course IIT Khargpur".

Now, we discuss about the classification of models, the different classes of models that we use in decision support systems. First according to function descriptive models. They provide a picture of the real life situation that we are going to study, the completely describe the different aspects of the real life situation and hence the name descriptive models.

Predicted models they have the property or their primary objective is to predict the behavior or the performance of the system under a given conditions given set of conditions, ok. And normative models, they recommend a course of action and that action is supposed to be optimal given the objective for a given situation; given a situation, given the objective normative models will recommend the optimal course of action.

So, descriptive models, they provide a picture of the situation being studied. Predictive models predict the behavior or performance of the system under consideration. And normative models recommend optimal course of action given the situation with clearly specified objective.

(Refer Slide Time: 09:31)

The image shows a presentation slide titled "Classification of Models" with a speaker in the bottom right corner. The slide content is as follows:

Classification of Models

❖ According to Structure:

- When the model retains some of the physical characteristics of the system being studied, it is called an 'iconic model'.
 - An example for this type of models is a scaled version of an air plane.
 - If some features of the real object are represented in the model by some other features, then the model is called an 'analog model'.
 - 'Symbolic models' consists of expressions consisting of symbols to denote the various entities of the system.

The slide also features a background graphic of a tree with various icons (gears, lightbulbs, etc.) and a logo of a stylized atom. The speaker is a man in a white shirt and tie. The bottom of the slide shows the NPTEL logo and the text "NPTEL Online Certification Course IIT Kharagpur".

Now, we classify models according to the structure. When a model retained some of the physical characteristics of the system that is that we are going to study it is called an iconic model. So, iconic model retains some of the physical characteristics of the system that we are going to study.

An example for this type of model is a scaled version of an air plane. If some features of the real object are represented in the model by some other features, then that type of model is called an analog model. And symbolic models consists of expressions which involve symbols to denote the various entities of the system. These are very much important in the field of management, industrial dynamics problems. They basically use symbolic models.

(Refer Slide Time: 11:01)

Classification of Models

❖ According to Time Reference:

- Static models do not refer to time;
- In Dynamic models, time is explicitly incorporated as an independent variable.
- An example for a dynamic model is a differential equation that specifies the rate of change of sales volume as a function of current sales and advertising expenditure.

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Then, we classify models according to time reference. Static models, they do not change overtime, they do not refer to time. In dynamic models, time is explicitly incorporated as an independent variable. An example of a dynamic model is a differential equation that specifies the rate of change of sales volume as a function of current sales and advertising expenditure.

So, according to time reference we have two kinds of models static models which do not refer to time, dynamic models they refer to time and we have given examples of dynamic models.

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The slide is titled "Classification of Models" and contains the following text:

- ❖ According to Degree of Uncertainty:
 - In deterministic models all the variables are deterministic, whereas in probabilistic models some or all of the variables are random.
- ❖ According to degree of generality of the model:
 - General models like linear programming have application in several functional areas of an organization whereas special models can be used only for specific problems

The slide also features a background graphic of a tree with various icons and a logo of a gear. The speaker in the bottom right corner is a man in a white shirt and red tie. The NPTEL logo and "NPTEL Online Certification Course IIT Kharagpur" are visible at the bottom of the slide.

Next classification of models according to the degree of uncertainty. In deterministic models all the variables are known and they are deterministic in nature, whereas in probabilistic models some or all of the variables are random in nature.

Next classification comes when we talk about the degree of generality that is there in the model. General models like say linear programming, they have application in several functional areas of an organization, whereas special models can be used only for solving specific problems.

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The slide is titled "Purpose of Modelling in DSS" and contains the following text:

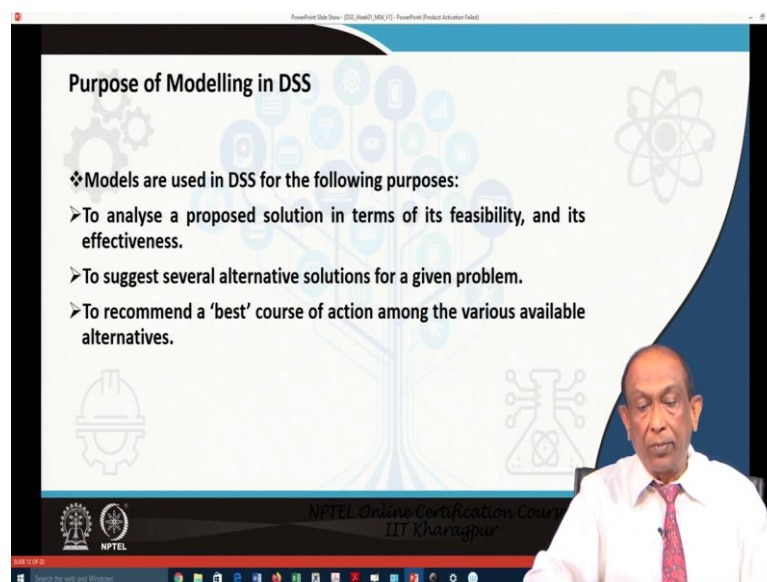
- ❖ Models are used in DSS for the following purposes:
 - To forecast or project the trends of a given activity by finding patterns in historical data.
 - To answer 'what if' questions such as what happens to next year's sales if the price is increased by 10%.

The slide also features a background graphic of a tree with various icons and a logo of a gear. The speaker in the bottom right corner is a man in a white shirt and red tie. The NPTEL logo and "NPTEL Online Certification Course IIT Kharagpur" are visible at the bottom of the slide.

We have already said that models are used in DSS, mainly to solve problems where we need to forecast or project the trends of a given activity by finding patterns in historical data. When we will talk about forecasting DSS, this kind of models will be highly relevant and used.

And also models are used to answer what if questions that is I already said sensitivity analysis type of problems, such as what happens to next year sales if the price is increased by 10 percent. And these kind of models are highly used in every organization through the use of spreadsheets. Spreadsheet models they are very effective in solving sensitivity analysis type of problems.

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Purpose of Modelling in DSS

❖ Models are used in DSS for the following purposes:

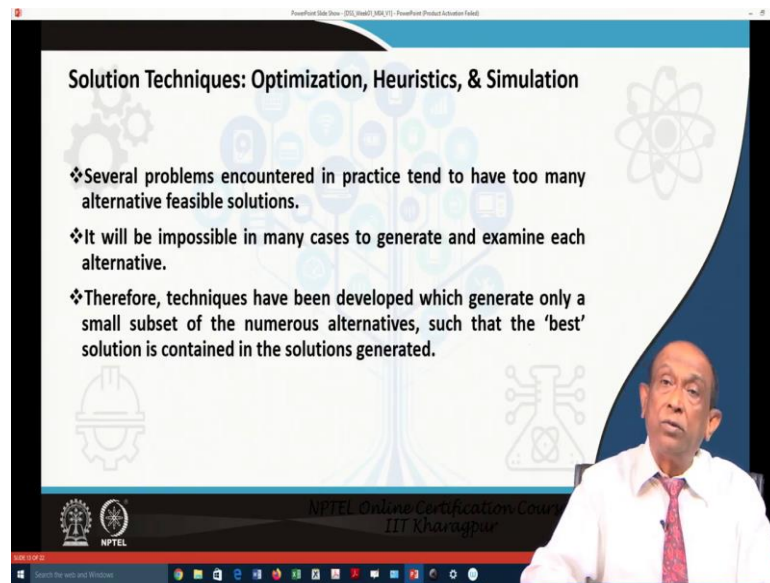
- To analyse a proposed solution in terms of its feasibility, and its effectiveness.
- To suggest several alternative solutions for a given problem.
- To recommend a 'best' course of action among the various available alternatives.

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Models are used in DSS to analyze a proposed solution in terms of its feasibility and its effectiveness to suggest several alternative solutions for a given problem and to recommend a best course of action among the various alternatives.

We have already mentioned about all of these points. Again I am repeating because one must be very-very thorough about the usefulness of the model; how to construct the model, the properties of the model; because next to managers, models are the most important components of this effective decision support system.

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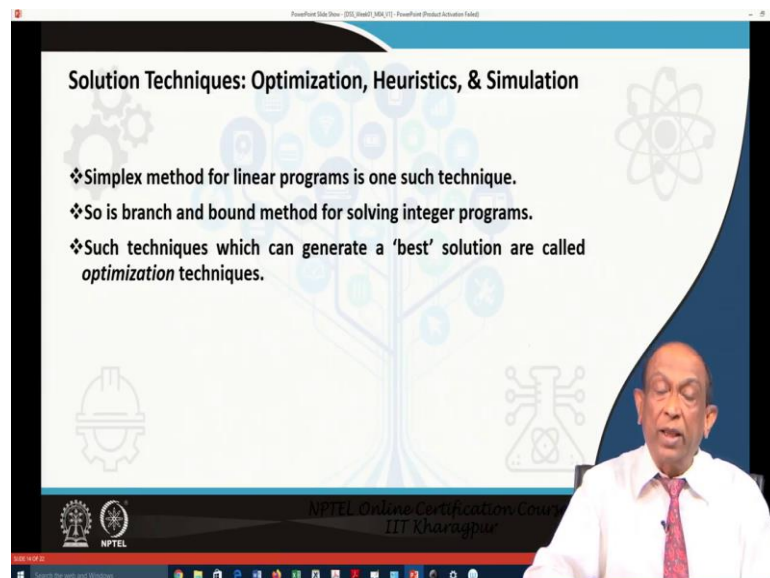
Solution Techniques: Optimization, Heuristics, & Simulation

- ❖ Several problems encountered in practice tend to have too many alternative feasible solutions.
- ❖ It will be impossible in many cases to generate and examine each alternative.
- ❖ Therefore, techniques have been developed which generate only a small subset of the numerous alternatives, such that the 'best' solution is contained in the solutions generated.

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Several problems encountered in practice tend to have too many alternative feasible solutions. And it will be impossible in most cases to generate and examine each alternative. Therefore, techniques have been developed which generate only a small subset of the numerous alternatives such that the best solution is contained in the solutions generated. And these kind of solution techniques are basically from optimization, heuristics and simulation.

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Solution Techniques: Optimization, Heuristics, & Simulation

- ❖ Simplex method for linear programs is one such technique.
- ❖ So is branch and bound method for solving integer programs.
- ❖ Such techniques which can generate a 'best' solution are called *optimization techniques*.

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Simplex method for linear solving linear programming type of problem is one such technique which generates optimal solutions. So is branch and bound method for solving integer solution, integer programming problems. And these techniques they generate the best solution on a given constraint and they are basically these techniques are known as optimization techniques. Some problems in real life are very complex.

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Solution Techniques: Optimization, Heuristics, & Simulation

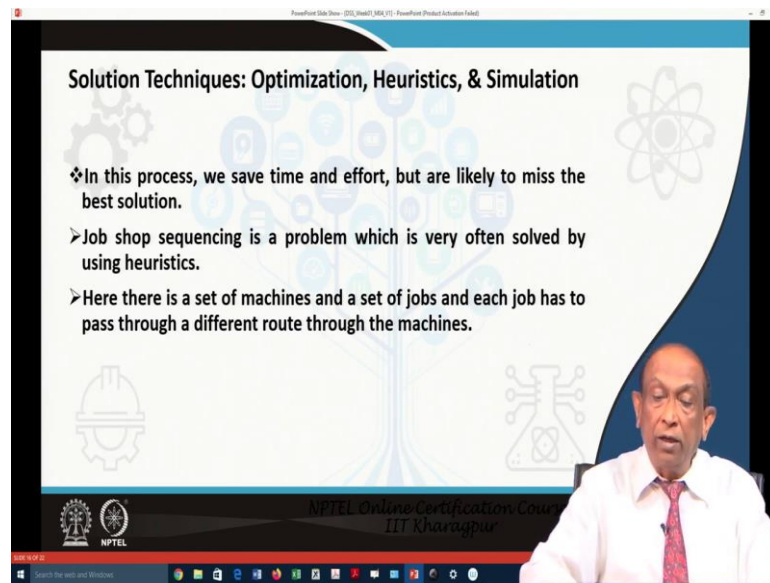
- ❖ Some problems are too complex.
- ❖ Even the optimization procedures, inspite of their tendency to examine only a subset of the feasible solutions,
➤ prove *too costly and time consuming* for them.
- ❖ In such cases we satisfy ourselves by generating a feasible solution, hopefully close to the optimum, by employing rules of thumb, called *'heuristics'*

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And even the optimization procedures, in spite of their tendency to examine only a subset of the feasible solutions prove too costly and time consuming for solving these kind of complex problems. In such cases, the managers they satisfy themselves by generating a feasible solution which is effective and hopefully very close to the optimum solution by deploying some rules of thumb and these rules of thumb are called heuristics.

So, when the problem in hand is very complex, then we have observed that optimization techniques, will take lot of time and it is also very costly to solve those kind of problems using those optimization techniques, so in industries managers they are more happy to use these kinds of heuristics. That is, they imply certain rules of thumb to generate a feasible solution which is an effective solution and hopefully that solution may be very close to an optimal solution. Even if it is not an optimal solution, the managers they are more satisfied with the effectiveness of that solution and that is what is most important in any decision support systems.

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Solution Techniques: Optimization, Heuristics, & Simulation

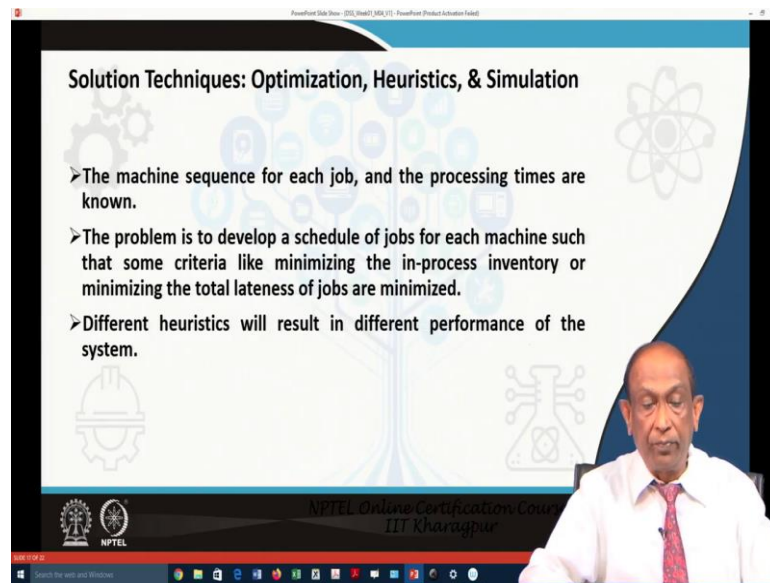
- ❖ In this process, we save time and effort, but are likely to miss the best solution.
- Job shop sequencing is a problem which is very often solved by using heuristics.
- Here there is a set of machines and a set of jobs and each job has to pass through a different route through the machines.

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So, by deploying heuristics the managers they save time and effort. They may likely miss the best solution, but the emphasis here is to generate an effective solution. For example, job shop sequencing or even scheduling is a very complex problem. If we try to find an optimal solution we will be left nowhere. So, in production shop such kind of job shop sequencing problems are often solved using heuristics.

In the job shop sequencing problem what is the problem? There is there will be a set of machines and set of jobs and each job has to pass through a different route through the machines, which job should be loaded and which job should follow which route, this is the problem.

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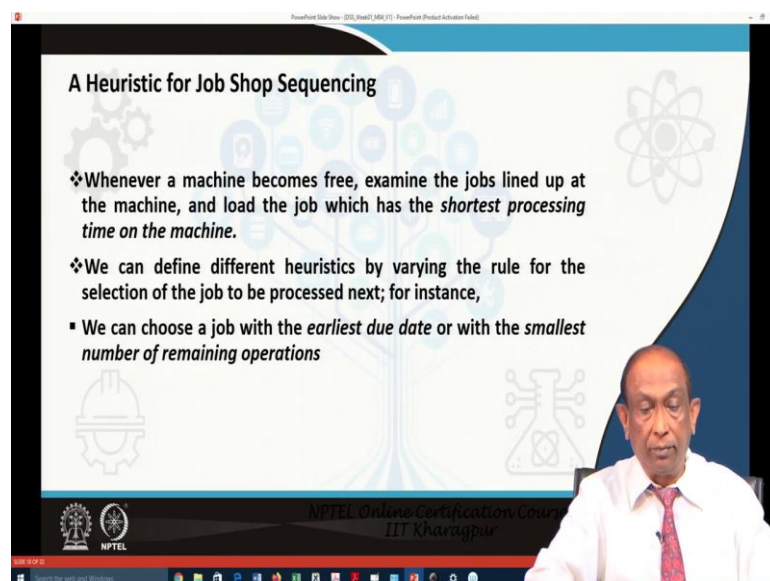
Solution Techniques: Optimization, Heuristics, & Simulation

- The machine sequence for each job, and the processing times are known.
- The problem is to develop a schedule of jobs for each machine such that some criteria like minimizing the in-process inventory or minimizing the total lateness of jobs are minimized.
- Different heuristics will result in different performance of the system.

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The machine sequence for each job and the processing times for those jobs in the respective machines are already known. The problem is basically to develop a schedule for those jobs for each machine such that some criteria like say minimizing the in process inventory or minimizing the total lateness of jobs is met. Different heuristics will result in different performance of the system. And depending on what the managers want the rules of thumb will be deployed.

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A Heuristic for Job Shop Sequencing

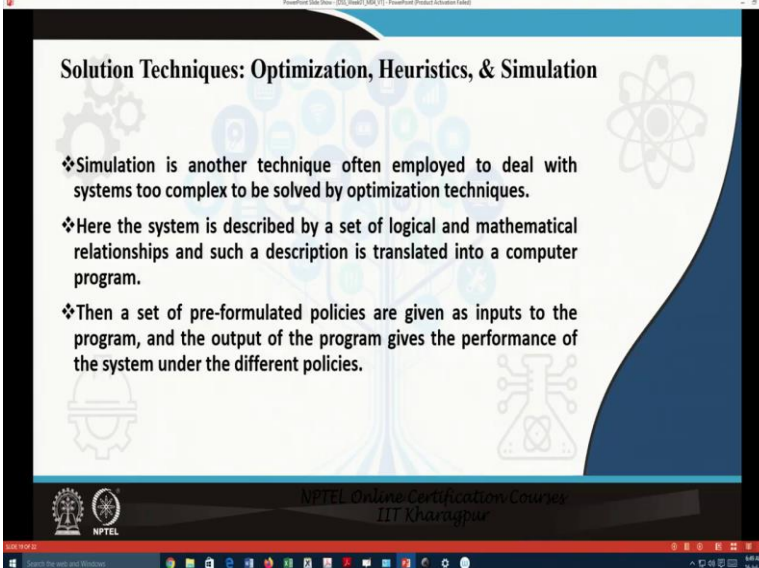
- ❖ Whenever a machine becomes free, examine the jobs lined up at the machine, and load the job which has the *shortest processing time on the machine*.
- ❖ We can define different heuristics by varying the rule for the selection of the job to be processed next; for instance,
 - We can choose a job with the *earliest due date* or with the *smallest number of remaining operations*

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For example, whenever a machine becomes free, examine the jobs that are lined up at that machine and load the job which has the shortest processing time on the machine. This is also known as shortest imminent processing time rule. This is one kind of heuristic.

We can define different heuristics by varying the rule for the selection of the job to be processed next. For example, we can choose a job with the earliest due date or with the smallest number of remaining operations. So, there are different kinds of heuristics and depending on what we want to achieve those kind of heuristics are used in job shop sequencing problem. Heuristics are very-very popular in solving job shop sequencing problems and also in scheduling.

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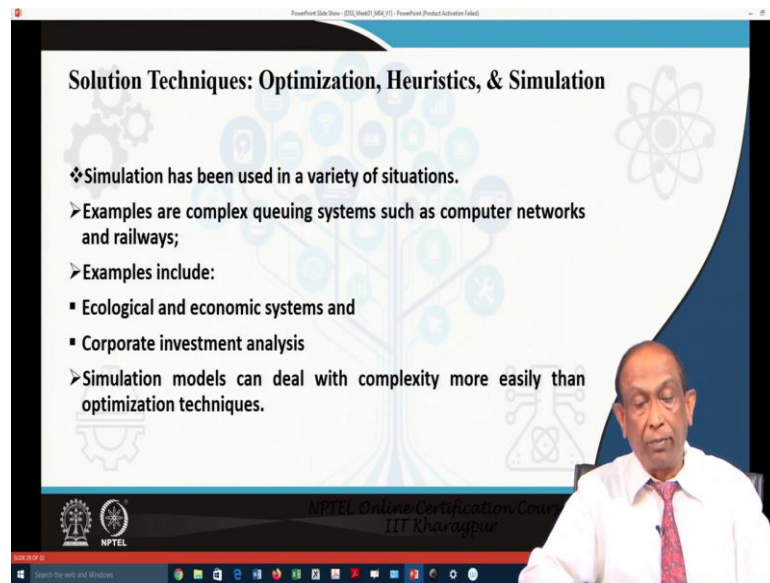
Solution Techniques: Optimization, Heuristics, & Simulation

- ❖ Simulation is another technique often employed to deal with systems too complex to be solved by optimization techniques.
- ❖ Here the system is described by a set of logical and mathematical relationships and such a description is translated into a computer program.
- ❖ Then a set of pre-formulated policies are given as inputs to the program, and the output of the program gives the performance of the system under the different policies.

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Next, we talk about simulation. Simulation is another technique, often employed to deal with systems that are complex, so complex that if we need to find an optimal solution we will be left nowhere. Here the system is described by a set of logical and mathematical relationship and such a description is translated into a computer program. Then a set of pre-formulated policies are given as inputs to the program, and output of the program gives the performance of the system under the different policies. The policies are embedded as part of the computer program.

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Solution Techniques: Optimization, Heuristics, & Simulation

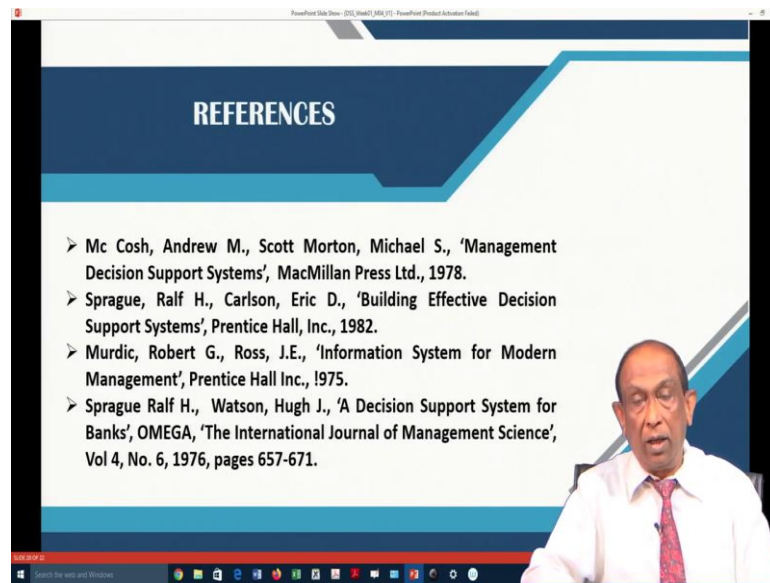
- ❖ Simulation has been used in a variety of situations.
- Examples are complex queuing systems such as computer networks and railways;
- Examples include:
 - Ecological and economic systems and
 - Corporate investment analysis
- Simulation models can deal with complexity more easily than optimization techniques.

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Simulation have been used in a variety of situations. Examples are queuing systems; for example, computer networks, railways. Examples include ecological and economic systems, and corporate investment analysis.

The beauty of simulation techniques is that simulation models can deal with complexity more easily and in a less costly manner compared to use of optimization techniques. And hence, heuristics and simulation they are very popular in designing decision support systems. Of course, optimization techniques have also been used in various DSS. It depends on the situation; depends on the complexity of the problem; depends on the affordability; and things like that.

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The image shows a presentation slide with a blue header containing the word 'REFERENCES' in white capital letters. Below the header, there is a list of four references, each preceded by a right-pointing arrowhead. The references are:

- Mc Cosh, Andrew M., Scott Morton, Michael S., 'Management Decision Support Systems', MacMillan Press Ltd., 1978.
- Sprague, Ralf H., Carlson, Eric D., 'Building Effective Decision Support Systems', Prentice Hall, Inc., 1982.
- Murdic, Robert G., Ross, J.E., 'Information System for Modern Management', Prentice Hall Inc., 1975.
- Sprague Ralf H., Watson, Hugh J., 'A Decision Support System for Banks', OMEGA, 'The International Journal of Management Science', Vol 4, No. 6, 1976, pages 657-671.

In the bottom right corner of the slide, there is a small video inset showing a man with short grey hair, wearing a white shirt and a red patterned tie, speaking. The background of the slide is white with blue geometric shapes. At the bottom of the slide, there is a Windows taskbar with various icons and a search bar.

So, this is all that I wanted to discuss in this particular module. The corresponding references have been given.

Thank you! Thank you all!