11

INTRODUCTION TO ENGINEERING MANAGEMENT

11.1. INTRODUCTION

What should the manager know about the tools, techniques, and fundamentals of *operations research in management science* ? In each chapter, we have given the important questions based on the specific ideas included within the chapter. Now we have to explain this question to get an appreciation for the knowledge of *operations research in management science.* To do so we will first discuss the mathematical analysis to deal with a particular real-life problem.

Whether in a private, nonprofit, or public organization, the most important and distinguishing problem of a manager is problem solving. The field of *operations research* (*management science*) is devoted to helping managers in their problem-solving process. This is done through the application of mathematical models to discuss the problems. We will provide some skills for understanding the importance of mathematical model building by first considering the problem-solving process.

11.1-1. Problem Solving Defined

Of course, it is an activity we are sucessful, or we would not be in a position to go through this book we have solved the basic problems of survival and of education in the modern world, but perhaps we have never explicitly considered what problem solving is all about. Perhaps the simplest way of the problem-solving process is

1. Define the problem   2. Identify the alternatives   3. Select the best alternatives

This procedure seems very straightforward. Of course, the key point is to through this process in such a way that the *'best'* alternative is really identified and chosen.

11.1-2. The Problem-Solving Process

Now it may be useful to give some additional information related to go the problem solving process. An extended view of this process is given in in Fig. 11.1. (on the next page)

First, the existence of a problem must be recognized. This recognition may occur because of changes in reality, because of changes in the individuals perception or because of changes in his or her notion ought to be. The individual may also be recognizing for improvement.

A problem solver's first step is *'bounding'* the problem. In fact, we must think about what to think about. The event that has created our awareness of a problem may be only a symptom of the actual problem.

Finally, the problem solver must determine a strategy for evaluating the effects of the alternatives.

Where do the models of *operations research* (*management science*) fit into the problem solving process ? The use of these models usually falls into the area within the circle of the figure 11.1.

11.2. MANAGEMENT SCIENCE MODELS

11.2-1. Models and Problems Solving

In fact, the management problem solver has an interest to forecast "how things work". One important role of the model is to increase the managers *understanding* of how things work.

Broadly speaking, a model is a device for helping our rational thinking. More specifically the models we are interested in give a simplified form of a complex system. A model is an economizing device reducing the infinite number of possibilities to a much smaller, finite number of categories.

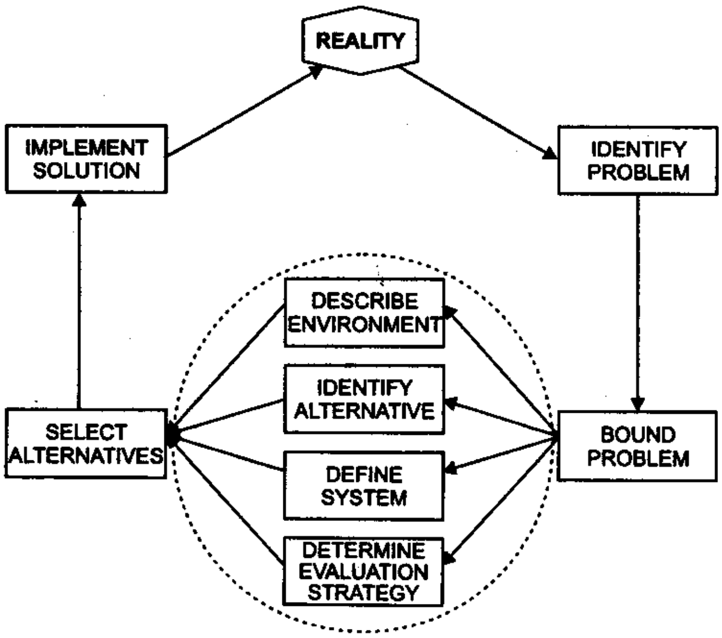

Fig. 11.1. The Problem-solving process

A model simplifies a problem solver's view of a problem by leaving out much information. In fact, a model used for problem solving will include the important features, or elements, of the system under study, as well as the interrelationships among these elements that determine causes and effects.

Thus, the managerial problem solver can use such a model, if it exists, to perform experiments and test hypothesis much as a natural scientist uses the laboratory. Because of this similarity, the area of management concerned with model building is often referred to as management science.

11.2-2. Successful Applications

The mathematical models of management science can be applied successfully to the real-world problem. Various types of these models are in widespread applications, and often provide fruitful resutls for managers.

11.3. ENGINEER AND MANAGEMENT SCIENCE/OR

It has been discussed that problem solving is the most important work of a manager, that model, building is a help to problem solving, and that the mathematical models of management science are an important special class of models. Now we hope that we have learned something about the field of management science (operations research). Yet we believe that we should learn enough about the field so that we are in a position to apply the models and techniques avilable in real-world situations. We can obtain solutions through the use of special prupose computer programs. Working in this area, we should have the following skills :

1. The ability to recognize situations in which operations research (management science) can be use used more effectively.
2. The ability to conduct two-way communication with a technical specialist, i.e. we must be able to
   (a) explain the nature of our problem, and
   (b) understand the specialist's product sufficiently well to verify its usefulness
3. The ability to understand the results of management science so that we can obtain full value from the information available.

We will avoid devoting a great deal of time to the technical details of the mathematical discussion associated with the management science models.

11.4. WHEN SHOULD OPERATIONS RESEARCH BE USED ?

We have discussed a number of examples of "successful" application of the models and techniques of *operations research* (*management science*) to real life problems, but it is obvious that every real-life problem is not discussed by formally applying these tools and techniques. How can the best decision be made to use the approaches of operations research ?

11.4-1. Benefits Versus Cost

The application of a mathematical model of a problem is "successful" if the *benefits* exceeds the costs. Here the costs involve the time for model formulation, the time and cost of data collection, the time and cost of developing the necessary computer programs, and the cost of using computers required for the mathematical analysis.

These costs can easily exceed the estimates of the benefits resulting from an analysis. However these costs will continue to decrease, so that, in future, the potential benefits of applying these models will exceed the costs in a number of problem areas.

The connection between the benefits and costs can be made clear as shown in the following figure.

The gross benefits of using mathematical models increase rapidly as the problems with the highest payoff are analysed first, and continue to increase but at decreasing rate. The cost of using the models are initially small, but increase at an increasing rate. However, the costs associated with 1985 technology increase much faster than the costs associated with 1995 technology. Thus, in order to maximize net *benefits* the number of problems has increased from point A in 1985 to point B in 1995 (see Fig. 11.2). It is expected that this increase will continue to make it more important for the modern manager to know model-building skills in the future.

For example, the expenses from the product transportation and distribution of an organization may run into millions of rupees annually.

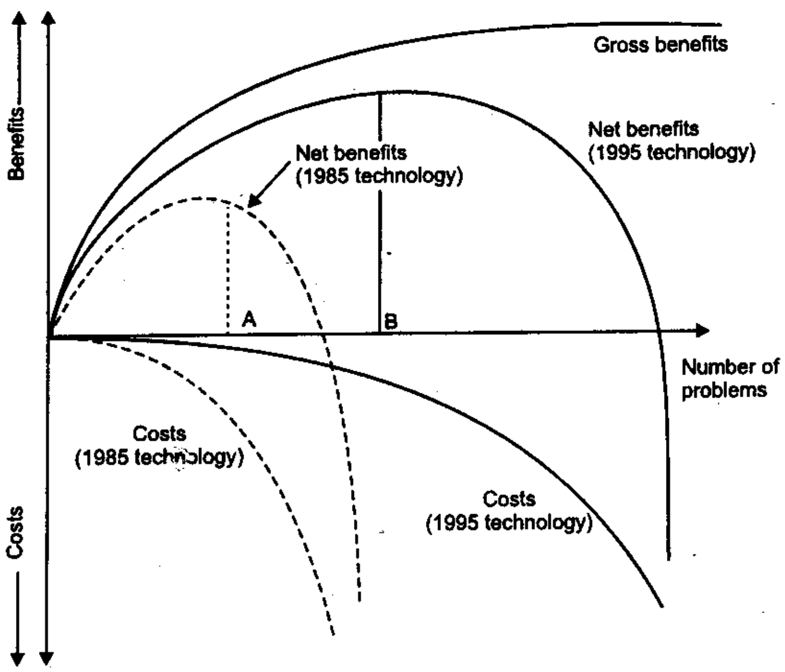

Fig. 11.2.

In other cases, computer programs may be available. The costs of analysis may be only a few thousand rupees, and these costs can easily be justified, even in small systems dealing with small problems.

11.4-2. Conceptual Value

In a particular situation, suppose that a mathematical model-building is not justified. Are the concepts of model-building useful in the problem solving process ? For this we must know about linear optimization models, network models, planning models waiting line models, decision trees, and so on. Mathematical models should also teach us something about the basic knowledge of some important problems.

For example, in linear optimization models, we understand not only the application but also something fundamental about distribution problems in general. Undestanding these general concepts is important because they should carry over into situations for which the model is not applicable. We believe that managers can exercise their judgement most effectvely if they understand the basic ideas of a problem and the expected nature of good situations.

The general waiting-line model is also a good example. The customer who understands the waiting-line models should be able to make a good judgement about the level of service by realizing the great value of the ideal time of the server. The value of idle time is contrary to our basic training to conserve time.

Therefore, one benefit of an understanding of mathematical model building is that it gives various ways of thinking about a problem as a linear optimization model, a network model, or a waiting line model. In each case, our thinking can also help to find the information for the best solution. These benefits should accrue to a manager with model-building skills, even if no formal analysis is done.

11.5. THE ENGINEER AND MANAGEMENT SCIENCE

The entire trust of the book has been on the presentation of management science for managerial use. Management science models are often developed around a current managerial problem. The manager stands between the real system and the support system as shown in the following figure.

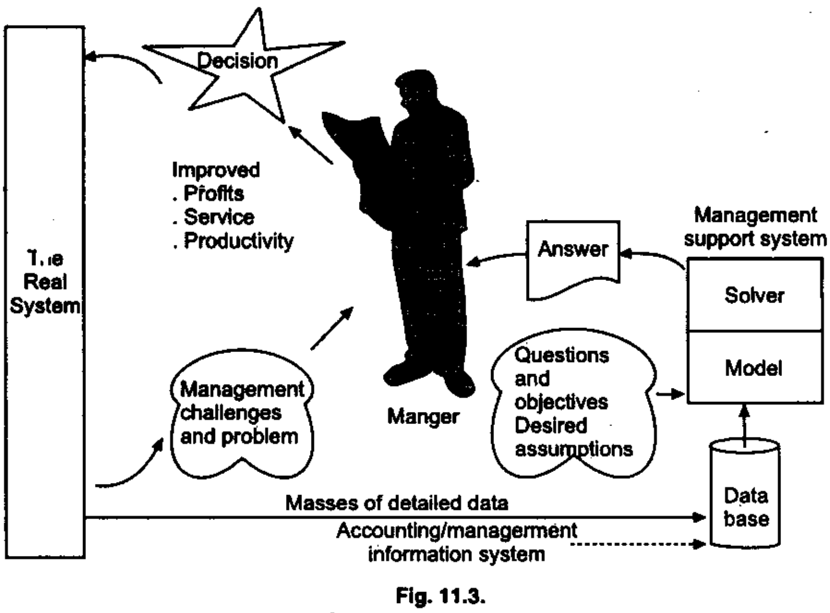

Fig. 11.3.

The support system does not make decisions. However, the manager does, working interactively with the support system.

Managers who know how to apply the management science support system suitabily also distinguish its limitations. The answers given by models are always the best possible in connection to the model. But these are different variables that are not given in the model but they are of great importance to make a system-wide optimization. Management science has an extremely useful input, even though it cannot produce a decision (answer) which is optimum for the system as a whole. The role of management science is to reduce the quantitative part of the problem. The contribution plays an important role in the manager's trade-off process between objective and subjective parts as well as a role in the development of the process itself.

11.6. CHOOSING A MODEL

To analyze a specific problem which model should be selected, either formally or simply as a way of considering the problem ? For example, there is often no one correct procedure of modeling a problem. Additional ideas can be obtained by considering a problem in terms of different mathematical forms-as a network model or a linear optimization model. However, some models do 'match' better with a specific problem than others. Thus it becomes important to recognize important characteristics of a problem having implications for selecting a model.

In thinking about a problem, one strategy is to look for the problem characteristics as shown in the following figure.

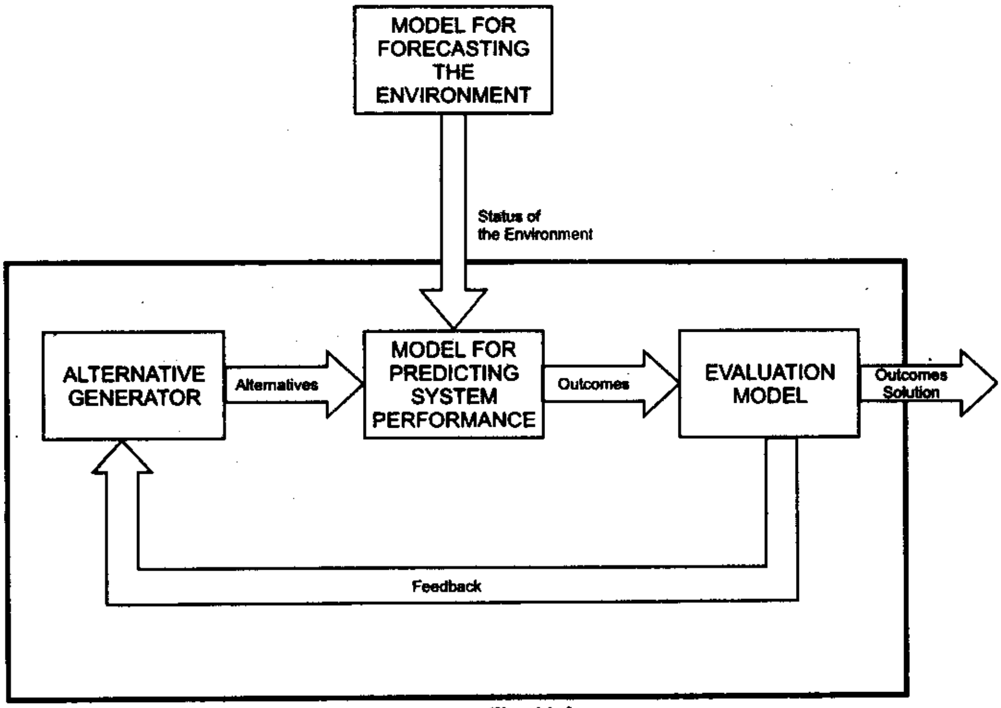

Fig. 11.4.

Some of the models are appropriate for problems in which important elements can only be discussed in terms of probability statements. Such examples are the waiting-line models and the Monte-Carlo simulation models. The next question is connected to the nature of relationships among the important activities of the problem.

The relationships are required to linear in order to apply the linear optimization models. An important issue in a problem might how the relationships among the problem activities change over time. If so, Markovian models might be useful in analyzing the problem elements from one state to another.

Finally, third question is related to the purpose of analysis. If we are in need of best solution to a problem, then we should look to the optimization models. In case, we wish to estimate only the outcomes of choosing an alternative or the impact of changing one activity of the problem on the other activiites then one of the pnedictive models would be appropriate.

11.6-1. Matching Problem Characteristics and Models

Suppose we ask questions about the environment, the nature of relationships and the purpose of the analysis. We identify the following characteritics.

1. Simple algebraic relationships among the elements of the problem.
2. A relatively certain environment.
3. A clearly defined, function of the decision variables to be maximized (or minimized).

In this situation, a linear optimization model would be chosen . Then ask the following questions.

1. What is the nature of the environment (deterministic or risky) ?
2. What is the nature of the relationships among the problem activities ?
3. Is there a clearly defined, function of the decision variables to be maximized (or minimized).

Then observe if your answers to these questions are consistent with that chapter shown in table .... If not try to reconcile the differences.

Example. (The Cash Management Problem). *The cash balance of a firm normally fluctuates because of a lack of synchronization between cash inflows from accounts receivable, cash sales, and so forth, and cash outflows from payments on accounts and notes payable. The cash management problem is concerned with optimally financing these outflows with cash-on-hand, lines of credit, or sales of marketable securities, while investing net inflows in the appropriate marketable securities.*

Suppose you were presented with the cash management problem of a large organization. How would you make your analysis ? Are any of the models of management science appropriate for aiding this analysis ? What questions should you ask and what additional information would you require ?

11.6-2 Skills of Modern Managers :

1. The ability to understand the results of *operations research* (*management science*) studies so that they can obtain full value from the information available to them.
2. The ability to recognize situations in which Operations Research (Management Science) can be used more effectively.
3. The ability to conduct two-way comunication with a technical specialist, i.e. they must be able to
   (a) explain the nature of their problem to a specialist in a meaning ful way
   (b) understand the specialists product sufficiently well to verify its appropriateness and potential usefulness
4. The ability to conceptualige a problem in terms of a particular model of Operations Research (Management Science), even if no formal analysis is performed.
5. The ability to formulate models suitable for analysing small straight forward problems, utilize standard computer programs to obtain solutions, and interpret results.

If one has applied these skills, he has added an important role to his managerial growth and abilities.

Write the important role of a manager for decision matcing.

11.7. APPLICATION IN SALES PLANNING

There is same tendency on the part of many traditional accountants to view the accounting system as "neutral" in its impact on business decision making. They justify this view by noting that the "flow of funds" through the firm may be accounted for in a variety of ways, but the flow represents the same set of facts no matter how the accountant deals with it. The accountant employing the analytical techniques of managerial economics on the other hand seeks to unearth the "financial truth" underlying the accounting statements.

Some critical issue that general accounting analysis often overlooks are problems relating to product-line, pricing, resource valuation and sales allocation. Since many firms make several related products, the interaction between pricing, resources valuation and sales has important implications in decision making. But business decisions are often made by administrators who, competent as they may be professionally, are not always sensitive to changes in relationship between pricing and sales. These changes though buried under standard accounting practices, may be significant for resource valuation.

Literature describing application of GP technique in business decision making situations is overwhelming.

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