CHAPTER 1

THE ROLE OF MANAGEMENT SCIENCE

Management is basically a process of achieving a set of organizational objectives in an effective way. To be effective managers, we should be rational in our problem solving and decision-making. Management science is a discipline that includes a host of rational approaches to management decision-making. In this chapter we will discuss what modern management is and how rational approaches of management science play important roles in today's complex organizations.

Learning Objectives

From the study of this chapter, we will learn the following:

1. The basic process of management
2. The importance of decision-making in management
3. Steps of the scientific method
4. How people actually make decisions in reality
5. How management science can assist managers to make better decisions
6. A short historical background of management science
7. A new global economy
8. How to build a proper perspective about the role of management science
9. The meaning of the following terms:

Management	Management science
Decision-making	Operations research
Rational behavior	Decision science
Optimization	Economic person
Bounded rationality	Management information systems
Satisficing	Scientific method
e-Engineering	Systems approach

WHAT'S IT ALL ABOUT?

Life consists of a continuous process of making decisions and solving problems. From the days of childhood to our teenage years and then our adult lives, we try to stay healthy, be happy, do interesting things, and be economically secure. In the process we make numerous types of decisions. The environment in which we live is complex, with various components such as laws, regulations, morality, socioeconomic realities, and uncertainty about the future. Thus, decision-making is never simple.

Although we make decisions every day, we rarely spend time thinking about how we actually do make decisions. Perhaps we are too busy making decisions to think about decision-making. Since we want to be successful in almost everything we do, we would like to do the right things at the right times. No one is a perfect decision-maker, but each of us would like to be a successful one, at least for important decisions.

As individuals, we are experienced decision-makers. Every day we make many routine decisions—how to dress, which road to take to school, where to have lunch, and so on. We also make many important decisions—whether to look for a part-time job at the library or at a local bank, whether to take computer science or engineering as our minor, whether to go to a graduate school or look for a job, and the like. Although the consequences of some of these decisions may be relatively minor, important decisions such as choosing a spouse or a career can change our lives.

Some people believe that good decision-makers are born with special abilities. But we believe, and many empirical studies support our position, that decision-making abilities can be acquired through learning and experience. Managerial decision-making does not differ too much from personal decision-making. However, the magnitude, the nature, and the possible consequences are enormously greater for managerial problems. Thus, our purpose in studying management science is to learn the basics of rational decision-making and how they can be applied to solving real-world management problems.

A noted educator once stated that every U.S. child should know at least two foreign languages: English and mathematics. This educator had a rare perceptiveness in his definition of mathematics as a language. Mathematics is the language of rational thought. Thus, we will use mathematics in learning to be rational, consistent, and systematic in generating useful information for decision-making. Mathematics allows us to be precise and succinct in expressing our thought. Furthermore, mathematics enables us to manipulate important characteristics of problems in answering "what if" questions. That makes mathematics a perfect tool for rational decision-making.

Discussion of mathematics brings up an interesting and practical question: Can we really be perfectly rational in decision-making? We know we cannot. Decision-making in human organizations is never precise. We must analyze the inexact nature of human problems with imprecise tools, incomplete information, and our limited analytical abilities. Managers know this and therefore cannot be total idealists. They must get desired results through practical means. Then, the rational decision-making process based on mathematics must be practical. It can be and has been used in many real-world applications.

MANAGEMENT AND DECISION-MAKING

The lifeblood of an organization is **management**. In spite of all else, if management falters, an organization cannot long survive. Although management is vital to our society, we have no universal definition of management; management has different meanings to different people. We know pretty much what a private does in the army, a secretary in an office, an assembly line worker in a General Motors plant, a salesperson in a shoe store, and a nurse in a municipal hospital. However, we have

no standard view of a manager's job. Who managers are and what they do depend entirely upon the organization, the geographical location, the department, the expertise of the managers, and the number of people working with them, and many other related factors.

Over a half century ago Mary Parker Follet defined management as "getting things done through people." This broad and vague definition is still a very good description of management. Management is a dynamic living system which integrates human, financial, technological, and physical resources in such an effective way that the output becomes greater than the simple sum of its inputs. Thus, management emphasizes the following factors: (1) the determination of definite directions for the organization—a set of objectives; (2) the search for efficient ways to achieve the objectives through evaluating feasible alternatives; and (3) the analysis of the environmental constraints, both external and internal to the organization.

Traditionally, management has been regarded as the art of "getting things done." Thus, it emphasizes the "art" of performing the job. The individual manager's behavioral leadership qualities is an example of the "art" we are talking about. However, many recent studies have emphasized the "science" aspect of management—systemic approaches to problem solving and **decision-making**.

In reality, we believe management is a combination of art and science that requires both the behavioral and systemic approaches. In science, we can predict the phenomenon with a definite probability of occurrence when the ingredients of a process are accurately determined. For example, we can foretell with 99.99 percent accuracy the result of a chemical process when certain chemicals are added together in a given environment. However, such accuracy of scientific experimentation or prediction is impossible in a management process, because the ingredients (people and other resources) are unpredictable and the environment is dynamic.

Management is a dynamic system that involves constantly changing environments, technologies, and philosophies. Thus the basic function of modern management has become management of disturbance, problem solving, or decision-making. *Decision-making is the most fundamental function of management.* As a matter of fact, the late Herbert A. Simon, an eminent scholar of management and a Nobel laureate in 1978, stated that "decision-making is synonymous with management." Thus, managers are often evaluated on the basis of their performance in decision-making.

In order to improve the quality of decision-making, organizations and managers constantly seek ways to be more rational and systematic in making decisions. Thus, management science has become an integral part of modern management. Management science is a discipline that includes a host of rational approaches to management decision-making. The central theme of management science is the application of scientific and rational methodologies to the process of management.

Rationality in Decision-Making

In 1772, Joseph Priestly faced a decision, and asked the advice of Benjamin Franklin. Franklin responded as follows:[1]

Dear Sir:

In the affair of so much importance to you, wherein you ask my advice, I cannot, for want of sufficient premises, advise you what to determine, but if you please I will tell you how. When those difficult cases occur, they are difficult, chiefly because while we have them under consideration, all the reasons pro and con are not present to the mind at the same time; but sometimes one set present themselves, and at other times another, the first being out of sight. Hence the various purposes or informations that alternatively prevail, and the uncertainty that perplexes us. To get over this, my way is to divide half a sheet of paper by a line into two columns; writing over the one Pro, and over the other Con. Then, during three or four days consideration, I put down under the different heads short hints of the different motives, that at different times occur to me, for or against the measure. When I have thus got them all together in one view, I endeavor to estimate their respective weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a reason pro equal to some two reasons con, I strike out the three. If I judge some two reasons con, equal to three reasons pro, I strike out the five; and thus proceeding I find at length where the balance lies; and if, after a day or two of further consideration, nothing new that is of importance occurs on either side, I come to a determination accordingly. And, though the weight of the reasons cannot be taken with the precision of algebraic quantities, yet when each is thus considered, separately and comparatively, and the whole lies before me, I think I can judge better, and am less liable to make a rash step, and in fact I have found great advantage from this kind of equation, and what might be called moral or prudential algebra.

Wishing sincerely that you may determine for the best, I am ever, my dear friend, yours most affectionately.

B. Franklin

[1] Zeleny, M., Multiple Criteria Decision-making, McGraw-Hill (1982), 13.

This true story points out several important aspects of decision-making. The first is that the rational decision-making effort is really nothing new. As a matter of fact, the primary distinguishing characteristic of humanity has been humans' capacity to learn about their environment and to use such knowledge in an organized effort to accomplish desired goals. Some academicians trace the concept of decision-making for objectives to the days of the Old Testament or the ancient Greek philosophers. There is no practical value in seeking a detailed genealogy of rational decision-making. It should suffice to say that rational decision-making effort has always been a major task of humanity.

The second aspect that we want to point out in the Franklin story is that decision-making is constrained by environmental factors. The alternatives available to choose from are often constrained by the situation. Relative weights of importance are a function of circumstances. Franklin's method sought to reflect current circumstances when considering those alternatives that were available. The way we define the decision environment presents a host of constraints to the decision-making process.

The third aspect of the Franklin story which deserves our attention is that complex real-world problems usually involve multiple, sometimes conflicting, objectives. Indeed, management by multiple objectives is a fact of life in the manager's job. This particular element of complexity presents a host of difficulties in decision-making. Management by multiple objectives has been an important area of research in management science during the past 30 years.

Whenever we discuss rationality in decision-making, two basic approaches emerge—the *scientific method* and the concept of the **economic person**. We will now discuss them in detail.

The Scientific Method

The **scientific method** has evolved over a long period of time as a set of systematic steps for conducting research in the physical sciences—physics, chemistry, biology, astronomy, geology, and so on. It has been said that Sir Francis Bacon was the first person to formally suggest the method, over 400 years ago. Although the scientific method was established for the physical sciences, management scientists have borrowed the concept liberally for management decision-making.

TABLE 1-1 STEPS IN THE SCIENTIFIC METHOD AND THEIR EQUIVALENTS IN MANAGEMENT DECISION-MAKING

The Scientific Method	Management Decision-making
1. Define the problem.	1. Define the decision problem.
2. Collect data.	2. Search for data and information.
3. Develop hypotheses.	3. Generate alternative courses of action.
4. Test hypotheses.	4. Analyze feasible alternatives.
5. Analyze results.	5. Select the best course of action.
6. Draw conclusion.	6. Implement decision and evaluate results.

Table 1–1 presents the steps of the scientific method and their equivalent phases in management decision-making.

Step 1: Define the Decision Problem. This first step is the most crucial and difficult part. It has a preemptive role relative to the other steps. For example, suppose that you defined your problem as "Should I purchase a Dell PC or a Micron?" Your statement excluded not only other personal computers, but also many other types of decisions you face, such as whether to spend money on a skiing trip to Colorado, a new camera, or a new sound system.

Suppose you decide to redefine your problem as follows: "I am falling behind in my classes. I must purchase a computer to complete my term papers and other assignments quickly at home." Now the nature of the problem has been changed drastically in that all sorts of personal computers are now available alternatives—IBM, Macintosh, Dell, Compaq, Texas Instruments, Micron, and so on. *Finding a good solution to the right problem is far more important than getting the best solution to the wrong problem.*

Step 2: Search for Data and Information. In order to fully understand the nature of the problem at hand and its relationship to other problems, it is essential to have relevant data and information. Your selection of a personal computer may not be the real problem; perhaps it is your poor management of time: Your too-frequent social activities, declining grade-point average, and extracurricular activities may be interrelated.

It is important to collect relevant data and sort them out in such a way that they will provide information for decision-making. For example, you may want to gather information about the different personal computers available—price, warranty, software support, compatibility with other computer systems, versatility, and perhaps, input from some of your friends who have used computers concerning their satisfaction with their equipment.

Step 3: Generate Alternative Courses of Action. The next step is to generate alternative courses of action that could be taken to solve the decision problem. Most people limit their search for alternatives to those that are obvious and readily available. It is important to generate additional alternatives so that all feasible courses of action can be evaluated. For example, in searching for the best personal computer, you may want to check local computer dealers, your professors, and advertisements in websites of various PC manufacturers.

Step 4: Analyze Feasible Alternatives. Armed with information about the problem and the available courses of action, you must now turn to analyzing alternatives. The primary standards to be used in the analysis are the objective criteria—the things that you would like to accomplish. For example, you may set several criteria about your personal computer selection, such as price, software availability, and versatility.

You should then evaluate each alternative against the objective criteria. You can easily eliminate several alternatives that are clearly inferior to others. Such alternatives are often referred to as

dominated solutions. In order to evaluate the nondominated alternatives, you may wish to use your priorities for the objective criteria. For example, suppose that you have the following simple list of priorities written down on the back of an envelope:

1. Price.
2. Software support.
3. Service availability.
4. Warranty.
5. Reputation of the manufacturer.

Now you should be able to further eliminate some alternatives on the list.

Step 5: Select the Best Course of Action. Once the analysis of alternatives is completed, you can make a decision by selecting the best course of action. The final decision will be based on a number of considerations, some quantitative and some judgmental. For example, the price of a personal computer is a quantitative criterion. However, versatility and the reputation of the manufacturer represent judgmental considerations. Evaluation of decision criteria in terms of their priorities to you is perhaps the most efficient way to select the best course of action.

When we have a set of objective criteria we want to achieve, we often get into a tangle of trade-offs. In other words, sometimes we can achieve an important objective if we give up something else. If you are considering purchasing a personal computer which is loaded with memory and all the software you might need, it may take every penny you have in your savings account for your education.

Step 6: Implement the Decision and Evaluate Results. Decision-making means taking a certain action. Implementation of action plans is the final phase of decision-making. However, we do not stop there. We must always evaluate the results of the decision and ascertain whether the decision problem is resolved to our satisfaction. Feedback obtained through an evaluation process is a very important element of the scientific method. The implementation phase of management science is fully discussed in Chapter 21.

The Concept of Economic Person

When we study human decision-making behavior in organizations, we find two broad theoretical foundations—**normative** (prescriptive) and **descriptive**. The normative theories are concerned with how rational decisions *ought* to be made, whereas the descriptive theories are concerned with how decisions *are* made.

The normative (or classical) theory of rational decision-making is conceptually neat. It assumes an economic person with perfect rationality as the decision-maker. In other words, the decision-maker is assumed to have complete information on all relevant aspects of the decision environment, to possess a stable system of preferences, and to have the ability to analyze the alternative courses of action. Thus, the decision-maker is assumed to be a perfect individual to utilize the scientific method.

The concept of economic person presents a rational individual who always employs the scientific method to obtain the optimal solution for the organization. In other words, the economic person is like a decision machine that always seeks **global optimization**. Global optimization in this context simply means that the decision-maker seeks a solution that would result in the best overall organizational measure, such as finding the maximum profit or the least cost. Thus, several different economic persons would reach the same solution to a given problem. Clearly, no decision-maker in reality behaves like such an economic person. Furthermore, decision-makers have their own unique ways of approaching a problem, and it is not likely that many of them would reach the same solution.

Unfortunately, the concept of economic person is not capable of either handling several important features of real-world problems or reflecting the actual decision-making process of management. First, real-world decision problems invariably involve more than a single objective which renders optimization. As a matter of fact, most managerial decision problems involve multiple, competing, and sometimes incompatible objectives. For example, we have already discussed your personal computer selection problem in relation to your planned ski trip, new camera purchase, and new sound system purchase. Also, it is totally unrealistic to assume that the decision-maker has an omniscient rationality, perfect information about the decision problem, and a perfect set of preferences. Decision-makers typically have their own unique styles in approaching a problem, personal perspectives about the objectives of their organization, very incomplete information about the decision environment, and limited analytical abilities for searching for the best solution to a problem.

Management Science and the Systems Approach

Management science is concerned with the application of scientific approaches to generate concrete information that is relevant to the problem solving of the decision-maker. Special emphasis is placed on the analysis of the nature of the problem, the decision environment, the objectives of the organization, the judgment of the decision-maker, and the economic as well as noneconomic ramifications of the decision environment. As we have already discussed, management science is dedicated to finding the best **feasible** solution. Feasible implies that the best solution we seek must be workable, or implementable.

Since management science is a systematic and comprehensive approach to decision-making, it inevitably involves what is called the **systems approach**. A system is a whole composed of a set of components, their attributes, and certain relationships among components that perform a function. Thus, a manufacturing firm is a person-machine system. A stereo set, however, is a mechanical system; it is made up of components such as transistors, electronic converters, and speakers that transmit sound.

A precise analysis in human organizations, as contrasted to mechanical systems, is not possible because of uncertainties involved in human behavior such as motivation, performance, and cooperation among individuals. This fact further complicates the management decision-making process. Nevertheless, management science attempts to seek the best solution for the organization as a whole. Any managerial problem should be placed in proper perspective so that its impact on the entire organization and its environment can be analyzed. In other words, management science should be applied in a systems context.

Upon solving the original problem, management science applied in a systems context often uncovers new problems. This is a very important characteristic of management science. Therefore, the most effective way to apply management science is through continuous analysis rather than by a one-shot solution approach.

The basic objective of management science is to find a feasible solution which is best for the organization, global optimization. The process of finding a solution that is best for one or more parts of the organization is usually called **suboptimization**. Management science attempts to find a solution that is close to the global optimum by analyzing interrelationships among the system components that are involved in the problem.

The beginning of management science is unknown, as the birth of science itself is unknown. The roots of management science are as old as mankind's curiosity, civilization, and culture. There is evidence that some forms of scientific approaches to management existed during the era of the industrial revolution. Frederick W. Taylor, the father of **scientific management**, pioneered industrial engineering and systematic approaches to management through his time-and-motion studies in the late nineteenth century.

However, the name **operations research (OR)**, a term often used interchangeably with *management science*, began to be used only in the early 1940s. The origin of military operations research activities was in the United Kingdom during the early part of World War II. In order to devise the most effective military tactics and strategies, there was an urgent need for scientific approaches to analyze various logistics problems. The British, and later the U.S., military authorities formed groups of scientists to conduct research on military operations. It has been said that OR studies were instrumental in the victories in the air battle of Britain, the island campaign in the Pacific, the battle of the North Atlantic, and other phases of the war.

Synonyms for the term *management science* are numerous. A frequent substitute is *operations research*, and other terms such as *systems analysis, systems science, operations analysis, quantitative analysis, managerial analysis, decision analysis*, and *decision science* are also used. We have decided to use the term *management science* in this book because we are basically concerned with the systematic analysis of management decision problems. There is no organizational barrier for management science application. In other words, we can use management science for decision problems in government, military service, business and industry, academic institutions, health-care organizations, and many other areas.

How Managers Actually Make Decisions

Now that we know something about rational decision-making and management science, let us focus our attention on how managers actually make decisions in real-world situations. Management science permits the manager to utilize a scientific or analytical approach to problem solving. We believe management science has contributed more toward the acceptance of purpose-oriented management (often referred to as "management by objectives") than is usually appreciated by managers and scholars.

The role of management science is especially important today because of the following factors:

1. Technology is getting more sophisticated every day (high speed Internet, artificial intelligence, expert systems, mobile technologies, lasers, industrial robots, and so on.)
2. There is an increasing shortage of energy and critical materials (fossil fuels, certain crucial metals).
3. Managerial problems involve complex processes (customization, global outsourcing, production and inventory control, assembly-line balancing, location allocation, working-capital management, customer relations management, etc.).
4. Managerial problems are not only complex but are becoming even more important (oil-importing decisions that involve international relations, development of enterprise-wide information systems, negotiations about trade imbalances, dealing with newly formed nations).
5. The problems managers face are often new, and there is little benefit to be gained from past experience (the oil embargo of 1973).
6. The emphasis on management planning and long-range objectives requires proactive decision-making. Thus, managers attempt to forecast future problems and plan ahead before problems actually emerge (public transit systems, synthetic fuel development, electrical automobile research, gene-splicing devices).

Although we recognize the importance of management science in analyzing important decision problems, we also realize that management is a human process. There is an enormous gap between the manager's aspirations for use of the scientific method for problem solving and the actuality of trying to sort out a big mess from a disorganized chain of random events. In reality, the manager is not like the economic person who is totally rational and effective in utilizing the scientific method for decision-making.

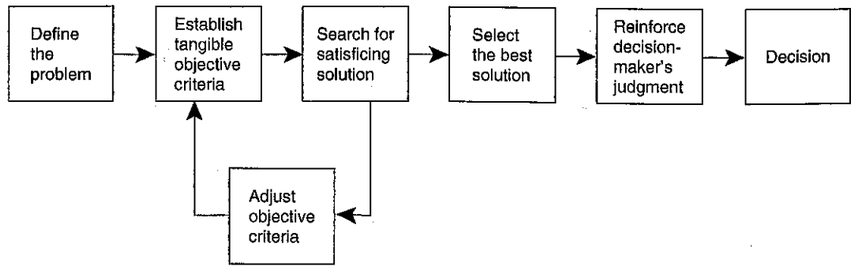

FIGURE 1.1
Decision-making Process

As we discussed earlier, the descriptive theories of decision-making are concerned with how decisions *are* actually made. The descriptive theories are based on an abundance of empirical data that leads to the now celebrated concept of **bounded rationality**. The late Herbert A. Simon stated that under bounded rationality individual decision-makers strive to be as efficient as possible in achieving organizational objectives, given their limited information-processing abilities. Clearly, bounded rationality does not mean irrationality. The decision-maker employs an "approximate" or "intentional" rationality in the process of attempting to do the best to achieve organizational goals within the given set of constraints.

As we can imagine, management science models developed under the unrealistic conditions of complete rationality have very limited real-world implications. In order to implement decision models, then, either we must sufficiently simplify the model so that the optimum solution can be easily derived or we must design a realistic model and seek satisfactory solutions. The first is the traditional approach, whereas the second approach attempts to retain a richer set of properties of the real decision environment by giving up optimization. Although the two approaches are quite different, they are both "satisficing" approaches based on the concept of bounded rationality and have been widely applied by management scientists. The **satisficing** approach attempts to obtain a good solution that is sufficiently satisfactory for a complex decision problem.

The global optimization model based on a single objective criterion (e.g., cost minimization or profit maximization) is often unrealistic. Perhaps the most practical way to develop a decision model would be to replace the abstract global optimization goal with tangible and measurable subgoals. These subgoals can be formulated on the basis of certain aspiration levels that are related to the organization's goals. Once a decision alternative satisfies a set of aspirations (or at least satisfies important ones), the search activity could be terminated. The satisficing model based on aspiration levels allows for a bounded rational decision by permitting reasonable amounts of analytical effort and incomplete information about the decision environment.

In reality, managers make decisions based not solely on solutions derived from management science models. As a matter of fact, management science models are often used to generate new information or to answer "what if" questions. Based on our discussion so far, we can present the decision-making process as shown in Figure 1–1.

The Role of Management Science

If managers are not completely rational and systematic in decision-making, what then is the role of management science? We can quickly come up with a number of important problems that we have not been able to solve with powerful computer-based management science models—the world population explosion, pollution, the energy shortage, international tension, hunger, communicable

diseases world-wide, decreasing natural resources, and so on. In the role of devil's advocate, let us ask what the world would be like today without systematic analysis of these complex problems. We are sure that the world would be a worse place. We believe management science will play an increasingly more important role in the future, precisely because of the manager's limited ability and rationality.

We are now quite comfortable with the notion that decision-making must consider environmental factors, multiple objectives, satisficing, and bounded rationality. We should not view management science as a panacea for managerial decision problems. Decision-making is and always will be based on human judgment, intuition, creativity, and perhaps courage, in addition to many systematic approaches. Much of the disillusionment and criticism of management science is the result of unrealistic expectations on the part of those who use it.

Management science plays the following important roles:

Purpose-oriented Decision-making

Management science application requires an organization to be purpose-oriented. Work activities are planned and carried out according to organizational objectives rather than simply rationalizing habits by saying "we have always done it this way." The question "What does this activity contribute toward important organizational objectives?" is frequently asked before resources are committed.

The basic approach of management should be to pursue long-range achievement of the organizational purpose rather than to seek only short-term monetary objectives. One of the primary reasons for the financial and productivity woes of many U.S. corporations is their emphasis on short-term profit objectives, often at the expense of long-term organizational goals.[2] Management science can be a catalyst in coordinating management functions for purpose-oriented decision-making in a long-term perspective.

Information- and Analysis-based Decision-making

Decision-making based on management science requires an efficient information-processing system. With the ever-increasing complexity of the environment and its vital impact on the organization's survival, information management becomes extremely important. Accurate and timely information must be processed in order to predict the future with an acceptable degree of accuracy. Thus, **management information systems** (MIS), decision support systems (DSS), and knowledge management (KM) have become important for management decision-making. We will have a full discussion of DSS in Chapter 21.

Decision-making for Multiple Objectives

Managers should be vitally concerned with the analysis of multiple objectives, not only with their formulation but with their priorities and trade-offs. We are keenly aware of the ever-increasing pressure for the simultaneous satisfaction of such factors as government regulations, economic optimization, industrial relations, and customer demands. Managers must analyze the direct conflict between the organization's economic survival and the other objectives that are related to ethics and social responsibilities. Recent chaos involving Enron, Arthur Andersen, WorldCom, etc., further reinforces the importance of this issue.

Managers are being held increasingly more accountable for the legitimacy of their objectives, priorities, and resolutions of the conflicts among the objectives of various interest groups. Thus, we expect to see more widespread application of systematic approaches in dealing with multiple goals and their trade-offs. We are moving to more open decision-making, requiring that the interests of a wide variety of group members be considered. This implies a need for open responsibility, to be able to explain why a decision was selected.

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2 Bibliographical data for all published material are given in the Bibliography at the ends of chapters.

Increased Emphasis on Speed

The essential purpose of management science is to increase the efficiency of the organization. Today, organizations compete in the borderless global marketplace. Thus, producing better quality goods and services at lower cost than competition is a prerequisite for organizational survival. Today, speed is of critical importance for competitive advantage. Management science can contribute a great deal to speedy decision-making by the organization.

Increased Attention to Group Projects

As we focus our attention on the effective utilization of human resources, group decision-making behavior has become increasingly more important. Most management science projects are interdisciplinary in nature. In other words, people from several different departments such as production, finance, marketing, and personnel would work together to solve a common problem. New information technology (IT), especially the Internet, is allowing virtual teams made up of the various specialists scattered around the world working together on many projects. This blend of MIS and management science effort promises exciting new means to aid groups in arriving at not only better decisions, but decisions more acceptable to the group as a whole.

Increased Attention to Knowledge Management

The environment in which organizations function is uncertain and changes constantly. To be successful in such a dynamic setting, organizations must learn at a faster rate than the rate of change. Thus, organizational learning has become an important corporate strategy for many firms. As a matter of fact, one of the most critical responsibilities of management for any organization is expansion of the organization's knowledge base. Management science can play a key role in knowledge management by making it more systematic and effective.

More Systematic Contingency Management

In the future, we will probably see more drastic changes in the environment than we have in the past. We will face a shortage of energy, materials, water, clean air, and many other resources. We will also see some important technological breakthroughs—cheaper and more powerful computers, new methods for harnessing energy, and new transportation methods, for example. We can also expect many political and economic crises in the international arena. All these changes will have varying degrees of impact on organizations.

However, an organization cannot be totally reactive to situations, functioning without plans. Nor can it be totally proactive, planning for every possible contingency. But with the aid of management science, management can establish the basic targets and explore the means to get there. With the availability of new business solutions based on IT and management science models, contingency management can be more systematic and orderly.

E-Global Age and Management Science

Globalization, digitalization, and deregulation have created a networked global economy where organizations compete. We have seen the birth of the European Union (EU), the emergence of the North American Free Trade Agreement (NAFTA), and formation of other regional economic cooperation blocs. However, the fall of the Berlin Wall in 1989 symbolized the beginning of a most dramatic change in international geopolitics. All communist governments in Central/Eastern Europe fell, as did the former Soviet Union in 1991. The military competition of cold war politics gave way to economic competition, especially among friendly industrialized nations. This trend further reinforced global competition as a way of life for most organizations.

The Networked World

During the past twenty years, we have seen quantum leaps in technological advances. Information and telecommunication technologies have revolutionalized the way organizations do business and the business they are engaged in. In conjunction with technological advances, there are three important laws which have brought the e-global age. They are:

1. **Coase's Law**—the noted economist, Ronald Coase, advocated vertical integration. To minimize the transaction cost of doing business, a firm would continue growing vertically until functions can be performed more cheaply outside the firm. Now Coase's Law works in reverse: firms will downsize their operations until doing them externally becomes more expensive than doing them internally. The Internet age has tremendously increased the opportunities to outsource operations globally.
2. **Moore's Law**—Gordon Moore, a co-founder of the Intel Corporation, predicted in 1965 that computing power would roughly double every 18 months while the cost would be reduced by about half. This law has been proven true ever since. Thus, for the same cost, computing power increases 10 times in five years, 100 times in ten years, and 1,000 times in fifteen years. The consequence of this law is that organizations must find new business solutions that would replace expensive production inputs with ever cheaper information and communication technologies.
3. **Metcalfe's Law**—Robert Metcalfe, the inventor of Ethernet and founder of 3Com Corporation, predicted that the value of a network increases with the square of the number of nodes (users). Today, there are millions of computers connected through the high speed Internet. Consequently, these networked computers and users are invaluable in doing global business.

As a consequence of globalization and digitalization, organizations of all types and sizes are doing business globally based on their core competencies. Any barriers and constraints that impede business based on speed are subject to elimination or modification. Thus, most countries have pursued deregulation and privatization of public enterprises. These activities in turn have generated more new opportunities for global business.

New Business Concepts

The above described trends and laws have brought kaleidoscopic changes in the way organizations think about their business strategies. Several important shifts driven by the new global economy are:

1. **Business Unit**—The traditional concept of business unit has been the organization. Even today, most business books are about how to manage the organization better by improving human resource management, quality, productivity, customer relations, marketing research, financial management, etc. However, today more firms are doing business by bringing their unique competencies to the value chain (adding value in the chain of producing and delivering a product or a service). Thus, the business-web or value network has become the new business unit. Some businesses simply bring an innovative business idea and form strategic alliances and partnerships with other firms who can provide financing, production, marketing, distribution, etc. Nike would be a very good example which is really a business-web.
2. **Business Mission**—The basic mission of any business used to be production. Now the primary mission of business is fulfillment of customers' requirements. Thus, customization has become a key competitive strategy area for most organizations. Many organizations now bring their customers into their strategic development and/or even ask customers to design their own products, e.g., Levi Jeans and Barbie Dolls.
3. **e-Customers**—The e-global age has brought a new type of customers. e-customers are those who are well-informed and intelligent customers who have the most current knowledge about

products and services. These Internet savvy customers are not easily fooled by promotional gimmicks. Also, they often form powerful communities to exercise influence on organizations about product/service quality and safety, social responsibilities, environmental issues, etc.

4. **Deintermediation**—The Internet based business has allowed customers to do business directly with the manufacturers or service firms to get what they desire, bypassing wholesalers and retailers. Dell Computer is a good example of this new business model. Customers pull in what they want, rather than organizations pushing their products toward the consumers. This new demand chain has a tremendous impact on the way businesses conduct their operations.

5. **e-Engineering**—Business organizations have gone through several strategic approaches during the past 50 years. During the 1960's and 1970's, the primary competitive area was cost reduction. Thus, many innovative ideas were developed to take advantage of the economies of scale, automation, and optimization. Then, in the 1980's quality was the key strategy area. We saw the development of Statistical Quality Control, Total Quality Management (TQM), 6 Sigma Quality, Zero Defects Management, etc. Then in the early 1990's there was a time-based competition approach, known as Business Process Reengineering (BPR). BPR's primary goal is to streamline processes across functional areas (production, finance, marketing, human resources, etc.) so as to speed things up while minimizing operational costs. Simultaneously, concepts of learning organization and knowledge management have become popular. Today, in the e-global age, organizations attempt to reinvent themselves by taking advantage of the Internet technology. This general approach is called e-engineering. e-engineering involves three levels: interpersonal working relationships (e.g., virtual R&D teams), interfunctional processes, and interorganizational relationships (alliances, partnerships, etc.). e-engineering can also create a business-web or value network.

Now it should be obvious that e-global age brings a host of new complexities to management. Consequently, there are more data and information that decision-makers must collect, decipher, and analyze. Many new approaches have been developed for these purposes—electronic data interchange (EDI), data mining, data warehousing, enterprise resource planning (ERP), scenario analysis, and the like. All these approaches are intended to help decision-makers make more effective actions. Management science has a much greater role to play in this ever more complex and dynamic business environment.

Building a Proper Perspective

As you study this book, you will be learning many analytical techniques and will be trying to find exact solutions to various problems. No doubt you will wonder whether it is worth the time and trouble to find *exact* solutions to the problems. For example, you might ask, "Is it necessary to find $x_1 = 1.285714$ or is it sufficient to say that $x_1 = 1.286$?" There is no clear-cut answer, but it all depends on the type of problem. For example, if the variable x_1 represents the number of cups of sugar to put into a cookie mix, either solution would be acceptable. However, if x_1 is the amount of a chemical required to test a chemical reaction, the second solution may not be acceptable.

Managers are often trained to make decisions based on real numbers and to eschew mere qualitative estimates. However, "real" numbers often give wrong or misleading information, and intelligent estimates are often required. For example, let us assess the U.S. health-care system by asking the question, "How many U.S. deaths are attributed to cigarette smoking or old age?" The official statistics give the answer of 0, because neither old age nor cigarette smoking makes the list of the principal causes of death. The key point here is not the precision or the official status of numbers but the understanding of what lies behind them and what they mean. An intelligent

TABLE 1-2 Key Considerations in the Modeling Process

Key Considerations	Modeling Approach: Complex Model Accurate Solutions	Modeling Approach: Simple Model Approximate Solutions
Resources required		
Cost	High	Low
Time	High	Low
Manpower	High	Low
Organizational acceptance		
Involving people	Low	High
Understanding the effort	Low	High
Implementation of the result	Low	High
Solution to the real problem	Good	Approximate

estimate based on good understanding is much more useful than precise statistics or exact computations, however authoritative, that are conceptually flawed. This principle should not be neglected in the application of management science.

What we should remember is that a management science model is a simple representation of reality. The purpose of building a model in the first place is to simplify a complex real problem so that we can understand and analyze it. In other words, if a model is almost as complex as the real problem it represents, it has lost its value.

As we shall see in Chapter 2, there is a law of critical few (or Pareto rule) in natural phenomena. We can analyze a management problem by examining a few critical variables. The modeling approach is based on this principle of focus on important issues. Thus, management science models represent good approximations to real problems. Solutions we derive by management science are solutions to the approximate models but not solutions to real problems. We must remember this important limitation of models. The role of management science must be placed in a proper perspective.

When we attempt to build more accurate models and more exact solutions to models, we must be prepared to expend greater amounts of time, energy, and resources. The critical issue is whether such efforts would be cost-effective. In other words, additional resources required to obtain more accurate solutions should be justified by the benefits derived from the better solutions to the real problems. However, there are other important considerations concerning organizational acceptance of the modeling effort. Generally speaking, complex modeling efforts tend to turn off the interest of those persons who would be implementing the solution. Thus, we must build a proper perspective about modeling in view of the trade-off considerations presented in Table 1–2.

Successful application of management science requires a considerable amount of artistic creativity and the desire for change. Management problems are like a big mess of gelatin that is hard to handle. In order to capture important features of a problem and analyze it for practical application, we must be imaginative, creative, and persistent. Also, we need to find ways to stimulate people who will be using the information generated by the models. Management scientists must serve as catalysts in their rejection of the status quo and of any hang-ups about systematic analysis. Such dedication is required to implement management science.

Summary

This chapter has provided a broad introduction to management science in terms of the meaning, role, history, and application to decision-making. You are not expected to be an expert in management science after reading

this chapter, but you should have a good feel for what management science is about. You should also have learned to use several new jargonistic terms such as optimization, economic person, scientific method, bounded rationality, satisficing, management information systems, new paradigm, expert systems, etc.

The ideas we have discussed in this chapter are useful in guiding our approaches to management problems and in deriving pertinent information that is essential for decision-making. We will be using mathematics throughout this book as a language of rational thought. Mathematical models are effective tools in transforming disorganized and complex real problems into simple and manageable problems. Perhaps the most important single item we should remember is that we must keep a proper perspective about the value, role, and limitations of management science.

GLOSSARY

Bounded Rationality—The concept of a person striving to be as efficient as possible in achieving organizational objectives, given limits on the person's ability to process information.
Business-web—A network of organizations in the form of a strategic alliance or partnership to create new values or business.
e-Engineering—An approach to reinvent the organization by leveraging the Internet technology to improve the interpersonal working relationships, interfunctional processes, and interorganizational relationships.
Economic Person—A completely rational individual who attempts to optimize economic payoff.
Global Optimization—The process of finding the best solution for the entire organization or system.
Satisficing—The process of achieving a good solution that is sufficiently satisfactory for a complex decision problem.
Suboptimization—The process of finding a solution that is best for one or more parts of the organization.
System—A consistent whole comprised of a set of components, their attributes, and certain relationships among the components that perform a function.

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ASSIGNMENTS

1-1. What is the difference between management and management science?

1-2. What is the relationship between management science and the broad area of management?

1-3. Try to recall a decision you made today. Discuss how you made the decision. Now follow the steps of the scientific method to see whether you would reach the same decision again.

1-4. What makes management an art or a science?

1-5. What are the advantages and disadvantages of the scientific method?

1-6. Contrast the normative and descriptive theories of decision-making.

1-7. What is the relationship between management science and the systems approach?

1-8. Consider a personal problem you face at the moment. Are there multiple objectives involved? If there are multiple objectives, are these objectives congruent, complementary, or in conflict? Discuss in detail.

1-9. "Management science is not a panacea for management problems, but it is the best medicine we have." Discuss your ideas about this statement.

1-10. Discuss the three laws that have shaped the digital age.

1-11. What are some of the important factors that have brought about the e-global age?

1-12. "Management science must provide precise answers to the problem." Discuss your opinions about this statement.