Study Guide for

Render
Stair

INTRODUCTION TO MANAGEMENT SCIENCE

Prepared by John L. Harpell

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PREFACE

This study guide, if read and studied, will help the student: (1) to understand exactly what the individual management science topics are all about and, (2) to understand how and why the mathematical models actually work. Most of the examples used in this study guide have been very well received when classroom tested on students without a particularly strong mathematical background. Humor and college student experiences have been used as a setting for many of the examples, hopefully without being insulting to anyone.

The topics covered in this study guide are those most often taught in introductory management science classes. The specific topics of this study guide can be found in the Table of Contents. This Table of Contents list of topics is exactly the same as the textbook for which the study guide was developed, Introduction to Management Science, by Barry Render and Ralph Stair, Jr.

There are four parts to each chapter of this study guide: A) Outline of Key Points, B) Multiple Choice Questions, C) Problems, and D) Answers to Multiple Choice Questions and Problems. **Bold type** has been used to indicate the most important words and phrases for each topic, including almost all the words in the textbook chapter glossaries. Underlining has been used to emphasize key concepts that will be helpful. Some of the multiple choice questions are keyed to the textbook rather than this study guide. The problems are oriented toward increasing an understanding of the material while avoiding tedious and boring mathematical computations.

The student who has carefully studied this study guide as a complement to attending classes, should have an excellent foundation in management science. Best wishes for success in your chosen career.

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CHAPTER 1
INTRODUCTION

A. Outline of Key Points

1. **Management Science**, which is stressed in this book, is a logical, rational, and quantitative approach to decision making. Furthermore, management science involves a scientific approach to managerial decision making. The application of management science has been greatly expanded by the increasing availability and power of computers and computer networks.

2. Today's complex managerial environment is full of difficult decisions. Before reaching a decision one should subject the situation to careful analysis. Very often this analysis should include a management science analysis. However, this **quantitative** (management science) **analysis** should always be combined with a logical qualitative analysis.

3. **Management Science** utilizes some very specific steps, namely: (A) define the (correct) problem, (B) develop a model, (C) acquire input data, (D) develop a solution, (E) test the solution, (F) analyze the results, and (G) implement the results. These steps are not isolated from each other but, instead, overlap each other. It is not unusual to be working on several steps simultaneously, although the main emphasis will be upon completing the steps in the order listed here.

4. The first step, defining the problem, is the most important and often the most difficult as well as the most easily overlooked. A **problem** is a situation which must be solved, while the counterpart of the problem is the objective or goal to be obtained. It is not unusual to have progressed through several steps and then realize that the problem must be redefined.

5. A **model** is a partial representation of a situation or a reality. Iconic models are physical models (such as model airplanes). Schematic models are pictures, drawings, or charts (such as a road map). **Mathematical models**, are the basis for quantitative analysis. Almost all mathematical models are directly related to either profit maximization or cost minimization.

6. Most management science models contain variables and parameters. **Controllable or decision variables** can be manipulated by someone, in contrast to **uncontrollable variables**. In business problems the most common uncontrollable variable is time. **Parameters** are generally known quantities that are related to the problem and usually may be considered fixed.

7. A fundamental management science model expresses total profits:

   Total (taxable) profits = Total revenue (income) - total cost

8. **Input data** are quantitative information used in developing a management science solution. Data sources include: organizational reports and documents, individual statistical sampling, and other direct measurements.

9. In most instances, the input data available to the management scientist is either incorrect or inappropriate or even both. Very often the data just don't exist and must be collected by the analyst. No matter how sophisticated your MS model, if you use garbage for input data you'll get garbage for output. **GIGO** = **G**arbage **I**n, **G**arbage **O**ut. Using a computer in this situation will help you to create garbage much more quickly, even though you may be able to intimidate people more easily.

10. Several different model manipulative methods are available to the analyst. In the **trial and error approach** you select the best results from several trials. The **complete enumeration approach** calls for computing the results under every conceivable variable combination. Some models utilize a series of specific calculations, called an **algorithm**. When these steps are repeated over and over, they are said to be **iterated**. The model type determines which manipulations are required.

11. Models should be tested for internal validity and also for external validity. In **internal validity testing** the mathematical representations must make sense with respect to each other. In

external validity checking, the results obtained from the model must make sense when compared with the realities of the situation being studied.

12. **Post-optimality or sensitivity analysis** means the model is being tested to see how much the impact of the model output would change if a small change were made in the input data (or model equations). The more sensitive a model, the more likely that a small change in any other factor will dramatically change the results.

13. The particular management science techniques that will be studied in the book include:

- **linear programming** (how to allocate scarce resources among competing alternative uses)
- **transportation problem** (with multiple production facilities and multiple warehouses learn how much should be shipped for any combination)
- **assignment problem** (with multiple workers and jobs study how to assign which worker to which job)
- **goal and integer programming** (an extension of linear programming)
- **network analysis** (graph the order in which large construction projects have to be put together so that you can save time and money)
- **inventory control** (how much should be ordered and when should it be ordered)
- **queuing theory** (a study of waiting lines - alias queues - and how many check-outs you should have)
- **simulation**, of the type subject to computerization (pretending the future is here so that you can discover problems in advance and eliminate them before they even begin to occur)
- **decision theory** (how to make decisions under conditions of certainty, of risk, and of uncertainty)
- **forecasting** (looking to see what the future will bring if conditions don't change)
- **markov analysis** (a study of how many customers change stores - or products, etc. - each time period and the long range

implications of how many customers you will gain or lose).
- **dynamic programming** - a management science technique that divides problems into a number of decision stages such as each month of the year. The outcome of the decision in the first period (or stage) affects the outcome in future periods.

14. Additionally, the appended modules contain independent studies of mathematical tools and game theory.

15. The most beautiful management science (MS) study in the world may very well be collecting dust somewhere. The analyst who performed this study may have received many accolades from friends for a beautiful job well done. If, however, the results of the study were never implemented, then the study was useless - from an organizational point of view.

16. The problem definition, the first and most important of the steps in the scientific approach to decision making, is often a cause of the lack of implementation of MS projects. The initial problem statement may not have considered all of the relevant perspectives or all of the areas of the organization impacted by the problem or the results. Sometimes problems are stated in terms of solutions or available MS models. Often MS models are used without due consideration being given the difference between model assumptions and reality conditions. Timeliness is extremely important. A decent solution to the right problem is needed before the problem changes or ceases to exist.

17. There are some management scientists who travel around with a favorite model, just looking for a place to apply it. Very often a simple analysis or a major modification of model is more appropriate than the blind application of MS models. When managers understand the analysis being performed (or at least think they do), they are more likely to accept the results. Quantitative analysts will frequently use simulation rather than a mathematically more correct model, simply so that the managers will feel more comfortable with the analysis.

18. Many people in an organization are devoting a considerable portion of their lives to that organization in exchange for a reward package from the organization. Any change, whether good or bad for the organization as a whole, is likely to disrupt the current equilibria. Any person in an extremely comfortable position now, has little to gain and much to lose from any change, no matter how apparently innocuous. A manager"saved" from making certain decisions, or "saved" from having to interact with other people, has also been stripped of power. A self-assured analyst may find it hard to relate to the terrifying impact this may have upon an insecure manager.

19. Emphasis upon manager involvement in MS will increase the likelihood of implementation significantly. Use of the correct manager(s) in problem formulation will tend to assure organizationally oriented problem definitions. Involvement of managers will improve their understanding of the goals of the MS project and also will commit the manager to the results. A manager who has been involved with an analysis may find it hard to reverse his position when the results are unfavorable.

20. The attitude of the management scientist can have significant impact upon implementation of the MS study. If the analyst gets involved in finding the real problem and works with the managers concerned, the chances of implementation increase significantly. The chance of implementation may be further enhanced by the analysts' involvement in implementation and control (seeing that implementation does indeed produce the desired result).

21. The degree of integration of MS into the organization will also have an impact upon the likelihood of implementation. There appears to be a regular life cycle of MS in the large organization, culminating in a diffusion of the MS function throughout the organization. The more ingrained the MS function is within the organization, the more likely MS projects are to have their results implemented.

22. **Management Information Systems** (MIS) have come a long way in the past decade. When MIS first appeared it usually meant that most of the data contained in the computer were dumped upon all the managers. Now MIS does a much better job of giving each manager the information he or she needs in a format which facilitates use of the data.

23. When MIS have been tied in with computerized MS model packages, the combination is referred to as a **decision support systems** (DSS). A DSS allows the manager making decisions to ask, "What if?" questions. This gives the manager greater ease in integrating qualitative considerations with the quantitative results of the MS models.

24. Barring unforeseen changes, the impact of MS on organizations is expected to continue growing. Eventually, this is expected to result in organizations where most managers are quite familiar and comfortable with MS models.

25. The field of **artificial intelligence** is rapidly becoming integrated with MS. Three of the important subsets of the field of artificial intelligence are: **expert systems**, **robotics**, and **natural language programming**.

26. An **expert system** is developed by a knowledge engineer who studies the decision making approach of an expert and then duplicates that decision making approach with a computer. Expert systems are comprised of three distinct components: the **knowledge base** (which contains the information which the expert knows), the **rule base** (which contains the **heuristics** or rules of thumb used by the expert), and the **inference engine** (which allows the user to perform complete analyses). An expert system may be used to replace experts or to train potential new experts. This is an area to be watchful for resistance from people who see their jobs being threatened.

27. Commercially used **robots** bear little resemblance to the romanticized versions of the movie industry in that most robots would duplicate only limited human body functions. A typical

robot might look like a pair of arms performing some assembly or painting operation on an automobile assembly line.

28. In **natural language programming** the emphasis is upon telling the computer what to do as compared to typical programming today where the computer is told how to perform the desired steps. A whole new series of computer languages are being developed for this and other aspects of artificial intelligence.

B. Multiple Choice Questions

1. In analyzing a problem you should normally study

   A. the qualitative aspects.
   B. the quantitative aspects.
   C. both A and B above.
   D. neither A nor B above.

2. Management Science is

   A. a logical approach to decision making.
   B. a rational approach to decision making.
   C. a scientific approach to decision making.
   D. all of the above.

3. Frederick Winslow Taylor

   A. was a military researcher during World War II.
   B. pioneered the principles of scientific management
   C. developed the use of the algorithm for MS.
   D. all of the above.

4. The most important and often the most difficult step in the scientific method is

   A. develop a model.
   B. acquire input data.
   C. define the problem.
   D. develop a solution.

5. A physical model is an example of

   A. an iconic model.
   B. a schematic model.
   C. a mathematical model.
   D. a stochastic model.

6. An algorithm is
   A. named after Algorismus.
   B. named after a ninth century Arabic mathematician.
   C. a series of steps or procedures to be repeated.
   D. all of the above.

7. An analysis to determine how much a solution would change if there are changes in the model or the input data, is called
   A. sensitivity or post-optimality analysis.
   B. schematic or iconic analysis.
   C. futurama conditioning.
   D. both B & C above.

8. In the accompanying software package, the way to select a particular quantitative technique is:
   A. depress the down arrow (↓) until the double arrow cursor (→→) is beside the desired technique, then depress enter.
   B. depress the up arrow (↑) until the double arrow cursor (→→) is beside the desired technique, then depress enter.
   C. depress the letter representing (to the left of) the desired technique, then depress enter.
   D. all of the above.

9. In the accompanying software package, the way to abort (to leave) a particular quantitative technique is:
   A. depress the escape (Esc) key.
   B. depress the Enter key.
   C. depress the Page Down key.
   D. depress the Page Up key.
   E. none of the above.

10. In the accompanying software package, when in the help mode of any particular quantitative technique, the way to return to the program is:

    A. depress the escape (Esc) key.
    B. depress the Enter key.
    C. depress the Page Down key.
    D. depress the Page Up key.
    E. none of the above.

11. In the accompanying software package, when entering any particular quantitative technique, the way to execute any of the following (Help New Load Save Edit Run Print Install Directory Esc) is:

    A. depress the first letter of the word.
    B. depress the first letter of the word, except for the escape (Esc) key.
    C. move the cursor to the appropriate word and then depress enter.
    D. none of the above.

12. Decision variables are:

    A. controllable.
    B. uncontrollable.
    C. parameters.
    D. constant numerical values associated with any complex problem.

13. An expert system includes:

    A. a knowledge base and a rule base.
    B. a rule base and an inference engine.
    C. heuristics and an inference engine.
    D. all of the above.

C. Problems

1. Expand the following acronyms: GIGO, PERT, CPM, MS, MIS, DSS, and AHP.

2. Match the following management science techniques with the succeeding list of technique purposes

A. dynamic programming
B. decision theory
C. linear programming
D. assignment
E. simulation
F. markov analysis
G. forecasting
H. inventory control
I. transportation
J. queuing theory
K. networks

a. Answers "How Much" and "When" to order.
b. Minimizes the total shipping cost between multiple sources (production facilities) and destinations (warehouses).
c. To maximize profits or minimize cost while allocating scarce resources among competing alternatives.
d. To study long range market shares or conditions given the current situation along with the propensity of the system to change over time.
e. Looking to see what the future will bring if all other conditions don't change.
f. A dynamic model that acts like a real process and when run on a computer a large number of times helps us to make better decisions.
g. a technique that divides problems into a number of periods where the outcome of the decision in the first period affects the outcome in future periods.
h. To save time and money, graphs the order in which the parts of large construction projects must be put together.
i. A study of waiting lines in order to find the optimum number of service (checkout) facilities.
j. Shows how to make choices under conditions of certainty, of risk, and of uncertainty.
k. Shows how to assign workers to jobs in order to minimize total cost.

3. If total revenue was $15,000 and total cost was $10,000, what would total profit be?

D. Answers to Questions and Problems

Multiple Choice Questions

1-C; 2-D; 3-B; 4-C; 5-A; 6-D; 7-A; 8-D; 9-A; 10-A; 11-B; 12-A; 13-D.

Problems

1. GIGO - Garbage In Garbage Out;
PERT - Program Evaluation and Review Techniques;
CPM - Critical Path Method;
MS - Management Science;
MIS - Management Information Systems;
DSS - Decision Support System;
AHP - Analytic Hierarchy Process.

2. A-g; B-j; C-c; D-k; E-f; F-d; G-e; H-a; I-b; J-i; K-h.

3. Total profit = total revenue - total cost
Total profit = $15,000 - $10,000
Total profit = $5,000.