

Managerial and Engineering Economy

ECONOMIC DECISION-MAKING

THIRD EDITION

George A. Taylor

Managerial and Engineering Economy

ECONOMIC DECISION-MAKING

THIRD EDITION

George A. Taylor

*Thayer School of Engineering
Dartmouth College*



D. VAN NOSTRAND COMPANY
NEW YORK CINCINNATI TORONTO LONDON MELBOURNE

D. Van Nostrand Company Regional Offices:

New York Cincinnati

D. Van Nostrand Company International Offices:

London Toronto

Copyright © 1980 by Litton Educational Publishing, Inc.

Library of Congress Catalog Card Number: 79-66276

ISBN: 0-442-24866-0

All rights reserved. Certain portions of this work copyrights © 1975, 1964 by Litton Educational Publishing, Inc. No part of this work covered by the copyrights hereon may be reproduced or used in any form or by any means—graphic, electronic, or mechanical, including photocopying, recording, taping, or information storage and retrieval systems—without written permission of the publisher. Manufactured in the United States of America.

**Published by D. Van Nostrand Company
135 West 50th Street, New York, N.Y. 10020**

10 9 8 7 6 5 4 3 2 1

Preface

MANAGERIAL AND ENGINEERING ECONOMY is designed to provide a sound introduction to economic decision-making, that is, selecting the best alternative according to economic criteria. The book is intended for students of engineering, business administration, economics, accounting, and finance. Considering the breadth of the subject, the text also provides fundamentals for students majoring in the sciences, social sciences, or humanities and, as a study and reference tool, for executives in all functional areas. The only prerequisites are basic algebra and the ability to think quantitatively.

The author has consistently aimed to show how this discipline establishes a guide for every course of action in an industrial enterprise. Economic decision-making also provides the basis of communication—the common ground—between all sectors of the organization: engineering, planning, marketing, finance, production, and administration.

Several significant improvements have been made in the Third Edition. This edition uses the Standard Functional Symbols in all examples and problems. This format, which originated with an *ad hoc* committee of the Engineering Economy Division of the American Society for Engineering Education, was adopted by the Society and appeared in the *Engineering Economist*, Volume 14, Number 2. This publication gives two sets of standards: mnemonic and functional. Because the mnemonic set that was adopted was not truly mnemonic and opened the way for error, it has since been discarded. Meanwhile, the existence of a clearly understandable set of functional factors led most writers and ANSI, the American National Standards Institute, to adopt the functional set. The Third Edition uses the Functional Symbols as a universal language. Although writers may use functional symbols, it is still a universal practice to describe the factors in the derivations, in the tables, and in the text by the traditional names, as for example: “single-payment compound-amount factor.” (See Section 3.12.)

Another improvement in the Third Edition concerns particularly instructors teaching a basic, one-term course in Engineering Economy. The limited time available for study, assignments, and class recitations requires the instructor to

decide what material to include in the course and what must be omitted from the text.

In this edition we continue to give a complete coverage of the subject, but here for the first time we indicate to instructors and other users how they can recognize the basic from the extended materials. Certain sections are marked with an asterisk to indicate "supplemental study." All of these supplemental sections occur in the body of the text because that is where they belong. The supplemental material is logically derived from the reasoning in the basic material. It is developed by an intellectual extension of the basic reasoning and does not break the continuity of the student's thinking. Instructors pressed for time in a one-term course can therefore omit the sections marked with an asterisk without loss of continuity, decrease in quality, or sacrifice in the competence they expect in the course. These sections are identified in the "Contents" for the convenient reference of instructors.

Even with the omission of these supplemental sections, instructors may find that they still have more material than they can cover. If time is severely limited, instructors may benefit from a list of the chapters that should be covered:

Chapters 1-8 inclusive, but entirely omitting Continuous Interest Sections 3.18-3.24 and Dual Rates. Sections 8.14-8.20.

Chapter 11 except for Obsolescence Factors Sections 11.13-11.15.

Students who pass the course with a knowledge of these fundamentals can associate with either engineer or manager in this kind of decision-making. If more time is available, after having covered the foregoing basics, instructors may elect any of the other areas—with the possible omission of supplementary sections. They may want to cover part of Chapter 15 Taxes or Chapter 18 Public Economic or Chapter 10 Economic Life. Finally, there is an expanded discussion of the effects of inflation on economic decisions in Section 16.13.

A Solutions Manual for Instructors with solutions to the problems in the text and suggestions on how to use these problems to stimulate class discussions is available.

My sincere thanks go to the students and members of the executives programs who studied with me during the many years of developing this book and who gave constructive ideas and encouragement.

George A. Taylor

Contents

1	Alternatives	1
1.1	Decision-Making Defined	
1.2	The Two Roles of the Executive	
1.3	The Manager's Role in the Functional Areas of the Company	
1.4	The Search for Alternatives	
1.5	Economic Decision-Making	
1.6	The Cost Commitment of a Decision	
1.7	Engineering Efficiency Versus Financial Efficiency	
1.8	Searching for Low Engineering Efficiency	
1.9	Cost-Reduction Expenditures	
1.10	Income-Expansion Expenditures	
1.11	The Scope of a Decision: Human Elements of Profits	
1.12	Criteria for Adoption	
2	Requiring a Rate of Return	16
2.1	The Profit Motive	
2.2	Cost of Capital	
2.3	Opportunity Cost	
2.4	Charging Capital Cost Against Equipment	
2.5	Time Value of Money	
2.6	Discounting Future Incomes or Disbursements	
2.7	Example of the Time Value of Money	
2.8	Influence of the Time Value of Money on a Decision	
2.9	Productivity of Capital and Minimum Required Rate of Return	
2.10	The Accounting Viewpoint	
2.11	Rate of Return, Yield, and Interest	
2.12	Yield Is After Recovery of Capital	
3	Rate-of-Return Formulas and Derivations	26
3.1	Time Scale Technique	
3.2	Symbols and Terms	

- 3.3 Compound Rates of Return
- 3.4 Single-Payment Compound-Amount Factor
- 3.5 Single-Payment Present-Worth Factor
- 3.6 Uniform-Series Compound-Amount Factor
- 3.7 Sinking-Fund Deposit Factor
- 3.8 Capital-Recovery Factor
- 3.9 Uniform-Series Present-Worth Factor
- 3.10 Formulas Summarized
- 3.11 Formulas Visualized
- 3.12 How to Write and Read the Formulas
- 3.13 Formulas Related
- 3.14 Adding and Subtracting Are Forbidden
- 3.15 Nominal and Effective Rates
- 3.16 Simple Rates of Return
- 3.17 Cost and Income Gradients: The Arithmetic-Series Factor
- *3.18 Continuous Cash Flow and Continuous Compounding
- 3.19 Understanding Continuous Interest Rates
- 3.20 Comparing Continuous and Conventional Interest
- 3.21 Derivation of Formulas for the Lump-Sum Cash, Flow of P or F at Continuous Interest
- 3.22 Derivation of Formulas for the Continuous Cash, Flow of \bar{A} at Continuous Interest
- 3.23 Derivation of Formulas for the Continuous Cash, Flow of \bar{P} or \bar{F} at Continuous Interest
- 3.24 Derivation of Formulas for the Lump-Sum Cash, Flow of A at Continuous Interest
- 3.25 A Variety of Interest Tables
- 3.26 The Convention Used in This Text

4 Rate-of-Return Formulas Applied 52

- 4.1 Rate-of-Return Tables
- 4.2 Interpolation and Errors
- 4.3 Solutions for n
- 4.4 Solutions for i
- 4.5 Time Values of Sums and Series
- 4.6 Time Values of Nonuniform Series
- 4.7 Time Values of Arithmetic Series
- 4.8 Comparing Alternatives
- 4.9 The Test of Investments
- 4.10 Limiting Values of Formulas
- *4.11 Applications of Continuous Formulas
- *4.12 Continuous Flow and Instant Flow with Continuous Interest

5 Equivalence 68

- 5.1 Equal Time Values
- 5.2 Equivalence Defined

- 5.3 Evaluating Alternatives by Equivalences
- 5.4 Meaning of Equal Equivalence
- 5.5 Effect of Changing the Required Rate of Return
- 5.6 Equivalence vis-a-vis Reality
- 5.7 Equivalence and the Usage of Funds
- 5.8 Practical Equivalence Comparisons

6 Annual-Cost and Annual-Worth Comparisons 77

- 6.1 Annual-Cost Computation
- 6.2 Reasons for the Annual-Cost Comparison
- 6.3 Making an Annual-Cost Comparison
- 6.4 Sinking-Fund Concept
 - Practical Use of the Sinking Fund
 - Straight-Line Depreciation Plus Average Interest
 - Only Differences are Relevant
- 6.8 Meaning of an Annual-Cost Comparison
- 6.9 Concept of Economic Life
- 6.10 Comparisons Involving Unequal Lives
- 6.11 Study-Period Method When Lives Are Different
- 6.12 Implication of the Study-Period Method
- 6.13 Considering Future Replacements
- 6.14 Computing Maximum or Minimum Advantages When Lives are Different
- 6.15 The Annual Cost of a Limited Service Period
- 6.16 Combined Cost-Reduction and Income-Expansion Expenditures
- 6.17 Levels of Investment by Annual-Cost Method
- 6.18 Levels of Investment from Standpoint of the Extra Investment
- 6.19 The Confusion Between Financing and Making the Extra Investment,

7 Present-Worth Analyses 101

- 7.1 Present-Worth Comparisons of Alternatives
- 7.2 Importance of the Time Period
- 7.3 Equal Economic Lives
- 7.4 Meaning of a Present-Worth Comparison
- 7.5 Study-Period Method of Analysis When Lives Are Unequal
- 7.6 Comparisons Involving Predictions of Future Machines
- 7.7 Comparisons over Specified Service Period
- 7.8 Capitalized-Cost Comparisons
- 7.9 Capitalized-Cost Comparisons If Both Lives Are Not Infinite
- 7.10 Unique Value of Present-Worth Comparisons
- 7.11 Deferred Investments
- 7.12 Use of a Study Period in Deferred Investments
- 7.13 Levels of Investment
- 7.14 Significance of the Extra Investment

- 7.15 Income-Expansion Expenditures
- 7.16 Levels of Income-Expansion Investments
- 7.17 Income-Expansion Expenditures from Standpoint of the Extra Investment
- 7.18 Mutually Exclusive Proposals
- 7.19 Valuation

8 Rate-of-Return Comparison

126

- 8.1 Analysis of Income-Expansion Investments by Rate-of-Return Method
- 8.2 General Solution in Income-Expansion Expenditures
 - 8.2.1 A Direction Finder
- 8.3 Nonuniform Income
- 8.4 Direct Methods of Solution
- 8.5 Levels of Income-Expansion Investments
- 8.6 Cost-Reduction Investments
- 8.7 Annual Costs Are Equivalent at True Rate of Return
- 8.8 Analysis of the Extra Investment
- 8.9 General Solution in Cost-Reduction Investments
- 8.10 Assumptions Pertinent to the Rate-of-Return Analysis
- 8.11 Levels of Cost-Reduction Investments
- 8.12 Importance of Rate-of-Return Method of Comparison
- 8.13 Accounting Versus Engineering Economy Viewpoints on Rate of Return
- 8.14 Rejection of the Extra Investment
- *8.15 Analysis if Savings Precede Costs
- *8.16 Income-Expansion Projects in Which the Savings Precede Costs
- *8.17 Income-Expansion Projects with Dual Rates of Return
- *8.18 Explanation of Dual Rates of Return
- *8.19 Predicting the Existence of Two or More Rates of Return
- 8.20 Arguments Regarding the Rate-of-Return and Other Methods
- 8.21 Using Calculators or Computers

9 The Cost of Capital

160

- 9.1 Sources of Capital
- 9.2 Cost of Debt Capital
- 9.3 Cost of Equity or Plowback Capital
- 9.4 What Does the Shareholder Expect to Receive?
- *9.5 Computing Cost of Capital Retained in Business
- *9.6 Effect of Retained Earnings on Book Value
- *9.7 Earnings-Price Ratio
- *9.8 Comparison of Methods for Computing Cost of Capital
- 9.9 Cost of New Equity Capital
- 9.10 Depreciation and Cash Flow

- 9.11 Capital Budgeting
- 9.12 Period Planning
- 9.13 Variations in Cutoff Rate
- 9.14 Role of the Extra Investment
- 9.15 Rationing for Strategic Investments
- 9.16 Opportunity Cost of Capital
- 9.17 Cost of Capital and Earnings on Net Worth
- *9.18 Limits on Financing and Investing

10

Economic Life

183

- 10.1 Effects of Choosing Wrong Life Period
- 10.2 One-Horse Shay Type
- 10.3 Military Aircraft Type
- 10.4 Like-for-Like Type
- 10.5 Predicting a Pattern of Deterioration
- 10.6 Predicting a Deterioration Gradient
- 10.7 Factors Determining Deterioration
- 10.8 Factors Determining Obsolescence
- 10.9 Deterioration and Obsolescence Type
- *10.10 Obsolescence and Deterioration as an Annual Cost
- *10.11 A Comparative-Cost Model for the Deterioration and Obsolescence Type
- *10.12 Differentiating the Annual-Cost Model
- *10.13 Estimating a Deterioration and Obsolescence Gradient
- 10.14 Military Aircraft Type with Deterioration Gradient
- 10.15 Functional Degradation
- 10.16 1-Year Life
- 10.17 Definitions of Economic Life
- 10.18 Kinds of Lives
- 10.19 Heeding All Factors in Economic Life

11

Replacement Economy

213

- 11.1 The Meaning of Replacement
- 11.2 Degradation Versus Disposal
- 11.3 Depreciation
- 11.4 Book Value
- 11.5 Investment Value of Existing Equipment
- 11.6 The Irrelevance of Book Value
- 11.7 Loss on Disposal of Equipment
- 11.8 Inclusion of All Relevant Costs and Revenues
- 11.9 Selecting Economic Life of Present Equipment
- 11.10 Military Aircraft Type
- 11.11 One-Horse Shay Type
- 11.12 Like-for-Like Type

- *11.13 Deterioration and Obsolescence Type with Estimated Gradient
- *11.14 Combined Military Aircraft and Gradient Type
- *11.15 Which Method of Analysis?
 - 11.16 Replacement Due to Inadequate Capacity
 - 11.17 Treatment of Inherent Extra Capacity
 - 11.18 Replacement by Leasing
 - 11.19 Second-Hand Equipment
 - 11.20 Improving Present Equipment
 - 11.21 Retention for Standby
 - 11.22 Replacement of an Income Property
 - 11.23 Frequency of Replacement Tests

12 Economy of Variations in Operating Activities 242

- *12.1 Variations in Output
- *12.2 Fixed Costs and Variable Costs
- *12.3 Input-Output Relationship
- *12.4 Unit Costs
- *12.5 Management Action to Meet Variations in Output
 - 12.6 Increment Cost
 - 12.7 Sunk Cost
 - 12.8 Problem of Setting Unit Cost
 - 12.9 Make-or-Buy Decisions
 - 12.10 Dumping
- *12.11 Operations Above Normal
- *12.12 Joint Costs, Joint Products, By-Products, and Diverse Products
- *12.13 Price Cutting
- *12.14 Shutting Down Plants
 - 12.15 Break-Even Chart
- *12.16 Capacity and Demand Factors
- *12.17 Pricing to Raise Capacity and Demand Factors
- *12.18 Scheduling and Assigning Loads

13 Minimum Cost Points 271

- 13.1 Minimum Costs
- 13.2 Locating the Minimum Annual Cost
- 13.3 Model for Kelvin's Law
- 13.4 General Case of Minimum Annual Cost
- 13.5 Minimum First Cost
- 13.6 Extent of Present-Economy Problems
- 13.7 Economic Lot Sizes in Manufacturing
- 13.8 Economic Lot Sizes in Purchasing
- 13.9 Optimal Versus Suboptimal Solutions
- *13.10 Behavior of Unit Cost

- *13.11 Unit Cost in Relation to Capacity
- 13.12 Effect of Lot Size on Selection of Equipment

14 Analysis of Risk and Uncertainty 297

- 14.1 Classes of Hazards
- 14.2 Investments to Reduce Risk
- *14.3 Probability of Occurrence of Disasters: Weighting of Uncertainty
- *14.4 Computing Annual Cost of Damage from Disasters
- *14.5 Damage as a Continuous Instead of Discrete Function of Disaster Intensity
- *14.6 Common Sense of Probabilities
- *14.7 Probability Distributions
- 14.8 Why Insure?
- 14.9 Basing Probabilities on Insurance Assessments
- 14.10 Levels of Investment to Reduce Risk

15 Taxes 319

- 15.1 Property Taxes
- 15.2 Income Taxes
- 15.3 Analysis Including Corporation Income Taxes
- 15.4 Cost of Gifts by Corporations
- 15.5 Cash Flow
- 15.6 Useful Lives
- 15.7 Analysis if Tax Life Equals Economic Life
- 15.8 Analysis if Tax Life Exceeds Economic Life
- 15.9 Why Use Accelerated Depreciation?
- 15.10 Analysis Using Sum-of-the-Year's Digits Depreciation
- *15.11 Analysis Using Double-Rate Declining-Balance Depreciation
- *15.12 Switchpoint in the Double-Rate Declining-Balance Method
- *15.13 Derivation of the Geometric-Series Factor
- *15.14 Application of the Geometric-Series Factor
- 15.15 Relevance of Book Value
- 15.16 Comparison of Three Methods of Computing Tax and the DCF Method
- 15.17 Gain or Loss on Disposal and Trade-In Allowance
- 15.18 Expensing
- 15.19 Investment Tax Credit
- *15.20 Timing of Incomes and Disbursements
- *15.21 Carry-Back and Carry-Over of Losses
- 15.22 Income Tax Effects on Borrowing
- *15.23 Choosing a Method of Depreciation
- 15.24 Effect of Long Write-Off Period
- 15.25 Analyses Disregarding Tax Disbursement

16	Forecasting	370
16.1	Inclusion of All Relevant Items	
16.2	Expecting Nonuniform Costs	
16.3	Aids to Forecasting	
16.4	Forecasting Life Periods	
16.5	Result of Incorrectly Predicting the Life Period	
16.6	Forecasting Salvage Value	
16.7	Forecasting Utilization	
16.8	Using Factors of Safety	
16.9	Break-Even Analysis	
16.10	Best-Worst Choice	
16.11	Quantitative Treatment of Irreducibles	
16.12	Price Changes	
16.13	Inflation	
16.14	Sensitivity and Sensitivity Analysis	
16.15	Post-Audit	
17	Industrial Methods, Techniques, and Formulas	396
17.1	Two Classes of Spending Decisions	
17.2	Four Essential Investment Decisions	
17.3	The Decision Is Always Between Alternatives	
17.4	Importance of Cost of Capital	
17.5	Importance of the Cutoff Rate	
17.6	Three Essential Reasons for Scientifically Analyzing Spending Decisions	
17.7	Comments on Some Popular Methods	
17.8	Scientific Methods in Practice	
*17.9	Discounted Cash-Flow Method	
*17.10	Elements of MAPI Method	
*17.11	The MAPI Formula Itself	
*17.12	MAPI Worksheets	
*17.13	Non-MAPI Formula Situations	
*17.14	Rate-of-Return Method	
18	Public Economy	429
18.1	Profit Motive in Public Economy	
18.2	Cost of Capital	
18.3	User's Benefit-Cost Ratio	
18.4	The Combined Benefit-Cost Ratio	
18.5	The Benefit-Cost Philosophy	
18.6	Some Differences Between the User's and Combined B-C Ratios	
18.7	The Rate-of-Return Method Compared with the Benefit-Cost Method	
18.8	Areas of Public Enterprise	

- 18.9 Cutoff Point in Public Economy
- 18.10 Public Utilities

19

Economic Differences Between Alternatives

449

- 19.1 Sensitivity to Alternatives
- 19.2 Overrating Equipment
- 19.3 Underrating Equipment
- *19.4 Industrial Research to Establish Differences
- 19.5 What Are the Alternatives?
- 19.6 The Need to Keep Alternatives Separate
- 19.7 The Case of No Alternatives
- 19.8 Designing for Imperfection
- 19.9 Designing for Short Life
- *19.10 Awareness of Losses
- *19.11 Awareness of Advantages
- *19.12 Differences That Are Harder to Predict
- *19.13 Research to Establish Economic Patterns

Bibliography

482

Appendix

487

- Definition of Certain Symbols
- Discrete Rate-of-Return Factors
- Continuous Rate-of-Return Factors

Index

531

Alternatives

1.1 DECISION-MAKING DEFINED

Economic *Decision-Making* expresses the primary objective of this book, and the expectation that the subject will be a dynamic and valuable tool to the person who learns to use it. We can demonstrate this immediately by noting the following definition of decision-making.

Competent decision-making is a two-part activity:

1. The generation of all the alternative courses of action that the situation demands.
2. The selection of the best course of action from these alternatives.

This definition disagrees with those definitions which merely limit decision-making to choosing between alternatives X and Y . The reason for our two-part definition is that no manager, given the authority of choosing a course of action, can defend a bad decision by pointing out that he made a mathematically correct choice between two very poor alternatives. It is the decision-maker's job to conceive, create, discover, and develop all possible courses of action that the given situation demands. A decision to approve expenditures for products X or Y always must imply that products Z , X_1 , or Y_1 should not be approved. If X is selected, enormous—perhaps fatal—losses can result if Z subsequently proves to be the product that should have been selected.

The manager is called on to provide the “best” solution to a given problem, and thus he must innovate, simply because existing alternatives may be greatly inferior to those which he can create. This, of course, is a large responsibility, and unfortunately one for which few managers have been educated. But whether a manager knows how to innovate or not, he will be responsible as long as he is the designated decision-maker.

If the first phase of decision-making is innovation, then the second is economic discrimination, or (as it is called in this text) economic decision-making. The principles and techniques of this discipline are the subject of this book. Many

decision-makers function without a knowledge of economic decision-making, and this lack invites unbelievable losses—as the reader will observe in the many examples in the text.

It may seem that limiting our subject to economic decision-making eliminates consideration of innovation. While innovation constitutes a different subject and a separate mode of thinking, an understanding of the economic criteria can develop an awareness of other courses of action that might exist or can be devised. This awareness often can put the decision-maker on the track of new alternatives of significant economic potential, and it will certainly make him cautious of merely choosing between two alternatives without considering that other, better choices might exist.

Knowing the criteria by which these alternatives will be selected or rejected is in itself an operational guide to identifying or discovering other courses of action. For example, if product *Y* is more trouble-free than *X* (a desirable feature, say, because competent repair service is unavailable) might we develop product *Z* which is even more reliable, or *Y*₁ which provides almost the same features as *Y* or *Z* at a lower price? This thinking will be guided by economic awareness. Practiced in this manner, the subject becomes a dynamic management tool.

This suggests that we might examine in more depth the responsibilities and great opportunities which exist in the decision-maker's role.

1.2 THE TWO ROLES OF THE EXECUTIVE

Every executive has basically two roles, and many executives perform only one of these.

His first role is to "maintain standards," that is, to see that activities are performed as planned, that costs do not exceed the preset standard cost, that labor performs the job by the preset standard method, that the required labor and material are on hand, that shipments occur on schedule in the right quantity, that planned quality of the product does not deteriorate, and so on. Maintaining present standards is a major task performed by many executives not only with "sleeves rolled up" but often after regular business hours. It is commonly understood that if something can go wrong it will, and so the executive seems continually to be repairing the breaches which develop in business operations. Even with strict adherence to the exception principle, the exceptions are enough to keep an executive busy. The executive's function in this role is like that of a servomechanism, because every dynamic system needs continuous readjustment to make it follow the standard. No one denies that this function demands great effort.

The second role of the executive is to improve the existing standards so that the company can maintain or improve its profits. In this role the executive must generate alternatives. Ideally, he challenges every standard and method in his sphere of responsibility, searches for alternative ones, and adopts them according to economic criteria. This role is vital because any company that is content

only to maintain its existing standards will find itself failing because of competitive pressure. The company that successfully keeps its status quo, while other companies improve their methods and increase their profits, will eventually discover it cannot meet the prices established by its progressive competitors. Many executives, nevertheless, are unprepared to fill this challenging role, and too often their education in economic decision-making is badly neglected or totally lacking. George Terborgh¹ says, "When we consider the advanced techniques now employed in other areas of business management, we may well wonder if equipment policy is not, in general, the most backward sector of all. We are inclined to think it is." We suggest that this statement can be broadened to include the whole area of economic decision-making.

Regardless of how hard an executive works in his role of "maintaining standards," his company can fail and he can fail personally as a manager. Let us not overlook the fact that some executives have worked very diligently, faithfully, and successfully to maintain standards. Some executives indeed have been so preoccupied in this task that there has been no change in standards in their business in many years. (The most successful ones, in this respect, may be out of business.)

What we have said, therefore, is that every manager has two fundamental roles:

1. Maintain the existing standards
2. Create improved standards.

Reflection on the two roles of the manager will lead to the conclusion that everyone, whatever his level or area of authority, ought to function as a decision-maker. To perform these roles he must realize that for every existing course of action under his control there is an alternative course of action which can be economically superior and that it is his responsibility as the manager to search for and discover that alternative. He cannot claim a lack of education in the processes of decision-making as an excuse for his inability to accept and adequately perform that responsibility. On the other hand, the opportunities to perform as this kind of a decision-maker are unlimited and the rewards for competent performance are high.

1.3 THE MANAGER'S ROLE IN THE FUNCTIONAL AREAS OF THE COMPANY

Modern management principles make the operating managers and administrators responsible for identifying the areas that should be improved and for seeing that the improvement is made. This replaces the concept that the only function of the operating manager is to control his area (and very likely to resist changes, since changes disturb his control).

Modern management makes the staff departments responsible to the operating

¹George Terborgh, *Dynamic Equipment Policy* (New York: McGraw-Hill, 1949), p. 216.