TABLE OF CONTENTS

		Page
LIST O	F FIGURES	ix
	F TABLES	χi
	DWLEDGEMENTS	xiii
FOREV	VORD	xv
1.	Introduction	1
1.1	Technological Change	3
1.2	Factors Influencing Technological Change	5
1.3	Technological Voids and Technological Developments	8
1.4	Acquisition of New Technology	8
1.5	Management of Technological Change	10
1.6	Modelling in the Management of Technological Change	12
1.7	The Technological Change Process	14
1.7.1	Technological Change Process Stages	16
1.8	Comparative Management of Technological Change	17
2.	Research in the Management of Technological Change	21
2.1	Industry Studies	22
2.2	Experience and Technology Change	23
2.3	Management of Studies	24
2.3.1	Comparative Management of Technological Change	26
2.4	Summary	27
3.	Economics of Production and Technological Change	30
3.1	Characteristics of Isocost Curves and Isoquants	33
3.2	Production Function Theory	35
3.2.1	Neo-classical Production Functions	37
3.2.2	Vintage Model: Substitutability Before and After the Investment	40
3.3	Costs of Production	43
3.4	Increase in Production Input Costs	44
4.	Productivity and Technological Change	48
4.1	Experience Curve Analysis	48
4.1.1	Use of Experience Curves	50
4.1.2	Simple Transition Model	55
4.2	Performance Evaluation and Productivity Measurements	61
4.2.1	Total Productivity Index	62
4.2.2	Computation of Productivity Change	63
4.2.3	An Example of Productivity Maximization	63
4.3	Difficulties in Defining and Measuring Productivity	65
4.4	The Impact of Productivity	67
5.	Modes of Technological Change	69
5.1	Endogenous Factors and Their Effect on Technological Change	73
5.2	Exogenous Factors and Their Effect on Technological Change	74
5.3	Modes of Technological Change	75
	~ ~	

		Page
5.4	Diffusion and Substitution of Technology	76
5.4.1	Substitution Models for Technological Change	79
5.4.2	Use of the Innovation Index in a Determining Market Substitution	
	Index	83
5.5	Origins of Technological Change	84
6.	Sources of New Technology	
6.1	Technology Acquisitions	86
6.1.1	Motivation, Rewards, and Incentives	86 89
6.2	Technology Transfer	89
6.2.1	Effectiveness of Technology Transfer Directed Toward Less	US
	Developed Countries	90
6.2.2	Technology Transfer Pricing	93
6.3	Technology Licensing	95
6.4	Patents and Other Methods of Protection of Inventions	98
6.4.1	Patent Protection	102
	Access to the contract of the	
	Appendix 6A - Basic Concepts of Game Theory or Strategic	
	Competitive Decisionmaking	106
7.	Technology Pricing and Economic Evaluation	118
7.1	Pricing New Technology - Impact of Diffusion and Marketing	122
7.2	Technology Pricing Strategies	124
7.2.1	Technology Pricing Analysis	125
7.3	Pricing Mature Technology-Substitution Effects	128
7.4	Cost/Benefit Analysis of Learning and Technological Change	128
7.4.1	Objectives of Technological Change	133
7.4.2	Technological Change Decision Problems	133
8.0	Technological Forecasting	138
8.1	Methods and Techniques of Technological Forecasting	142
8.2	The Delphi and Other Subjective or Expert Opinion Techniques for	
	Technological Forecasting	144
8.2.1	The Delphi Technological Forecasting Technique	144
8.3	Cross-Impact Forecasting of Technological Change	150
8.3.1	KSIM-QSIM	153
8.3.2	Recent Improvements and Revisions of the Cross-Impact Method	156
	Appendix 8A - Example of a Cross-Impact Technology	
	Forecast - Shipbuilding	162
9.	Product, Process, and Service Innovation Cycles	165
9.1	Diffusion of Innovations	165 168
9.1.1	Commercialization of Innovations	169
9.2	Capacity Expansion and Cost Reduction	170
9.2.1	The Effect of the Size of the Firm	171
9.3	Product Innovation and Development	172
9.4	Management of Innovation	174
9.5	The Innovation Process	175

		Page
10. 10.1 10.2 10.2.1	Decision Theory and Hierarchial Processes Alternative Process Technology Choice Decisions Choice Among Technological Alternatives Mixed Qualitative and Quantitative Technological Choice Problems	179 184 187 190
	Appendix 10A - Case Study - Selection of an Approach and Landing System for Kilimanjaro International Airport (Kia-Tanzania)	194
	Appendix 10B - Case Study II - Technological Change Decisions in Copies and Products	206
	Appendix 10C - The Analytic Hierarchy Process	220
11. 11.1 11.2 11.2.1 11.2.2 11.2.3 11.2.4 11.3 11.3.1 11.4 11.4.1 11.5 11.5.1	The Economic Impact of Technological Change International Flow of Technology Comparative Management of Technological Change Comparative Management Factors Rationale for Comparative Management Analysis Criteria for Measurement of Management Processes Technological Change and the Management Organization Comparative Management Models Model Evaluation Impact of Technological Change on Worker and Manager Labor/Management Cooperation Government Role Developing Country Technology Gap Appendix 11A - Summary of Comparative Management of Technology Studies	224 225 226 228 230 231 232 232 235 235 236 237 237
	Appendix 11B - Japanese and U.S. Technology Development	241
	Appendix 11C - Support of Technology Development	247
12. 12.1 12.2 12.3 12.3.1 12.4 12.4.1	Environmental Impact and Future Role of Technological Change Impact of Technological Change on Developing Countries Environmental Impact of Technological Change in Industrial Countries Technological Change Decision Making Future Management Challenges Technological Risk Management Probabilistic Technology Risk Assessment	249 249 252 253 254 255 260
13.	Strategic Management of Technological Change	262
	Index	265

LIST OF FIGURES

		Page
1.1	Factors Influencing Technological Change	6
1.2	Relations of Choice, Timing, Scale, and Rate of Introduction of	12
4.0	Technological Change	13
1.3	Transfer of Outputs from Old to New Technology	13
1.4	General Framework of Model	
1.5	Diagrammatic of Relationships of Factors of Management of Technology	ogicai 14
4.0	Change	15
1.6	The Technological Change Decision Process	15 16
1.7	Productivity (Performance) of Old and New Process Technology	
1.8	Construct of Comparative Management of Technological Change	18
3.1	Input/Output Feedback Cycle	31
3.2	Productivities	31
3.3	Isocost Curves	34
3.4	Isoquants	34
3.5	Effects of Returns to Scale on Isoquants Spacing	35
3.6	Isoquant Map for Three Technologies	36
3.7	Marginal Cost in Shipbuilding	38
3.8	Isoquant Curves of Technological Change	41
3.9	Technological Production Function, Showing Relationships Between	
	Development Expenditures, Production Costs, and Technology	42
3.10	Movement of Technological Production Function Over Time as a	
	Function of Previous Decision	43
3.11	Effect of Change in Isocost	44
3.12	Off Design Operations	45
3.13	Choice Among Multiple Technologies with Cost and Input Constraints	s 45
4.1	Market Control	51
4.2	Experience Curves of Old and New Processes	53
4.3	Cost Driven Transfer to New Technology	53
4.4	Demand Driven Transfer to New Technology	54
4.5	Resulting Learning Curve for p(t) constant	58
4.6	Resulting Learning Curve for p(t) Linearly Increasing	58
4.7	Resulting Learning Curve with p(t) Parabolically Increasing	59
4.8	Cost Curve for Combined Use of Two Technologies - No Transfer of	
	Experience Assumed. Percentage use of new technology [p(t)]	
	constant.	59
4.9	Cost Curve for Combined Use of Two Technologies - No Transfer of	
7.5	Experience Assumed. Percentage use of new technology [p(t)] linear	arh/
	increasing.	60 60
4.10	Domain of Feasible Technology Utilization	60
4.10	Domain of Feasible Technology Offization	00
5.1	Technology in Life Cycle	72
5.2	S-Shaped Curve of Technological Diffusion	76
5.3	The Flow of Ideas from Science to Technology to Production	77
5.4	Trends in Technology Substitution Time	78
6.1	Technology Transfer Process	88
J. 1	recimology manaier riocess	- 00

		Page
6.2	Evolution of a Technology	94
6.3	The Development of Price Obtainable by Licensing versus Cost of R&D/Innovation	07
6.4	Licensor's Payoff Matrix	97 97
6.5	Percentage U.S. Patents Issued to U.S. and Other Inventors	100
6.6	Impact of Price Reduction of Competition to Monopoly of	100
	Patent Holders	102
7.1	Monopolistic Pricing of New Technology	119
7.2	Price Change and Introduction of New Technology	120
7.3	Break in Long Run Average Total Cost Resulting from Technology	
	Change (TC)	121
7.4	New Technology Utilization by Monopolist	121
7.5	The Impact of Diffusion on Technology Pricing	123
7.6	Economic Effects of Diffusion of Innovation	124
7.7	Effect of Rate of Output on Cost of Production	131
7.8	Net Cumulative Profit (Benefit) of Plants with Same Obsolescence But	
	Different Cumulative Output	132
7.9	Comparison of NPV and IRR	134
7.10	Effect of Technology Switch (Without Discounting)	136
7.11	Decision Analysis - Three Technologies and Five Decision Points	136
8.1	Trends in Technology	140
8.2	Technology Forecasting and Planning Model	141
8.3	The Construction of the Cross-Impact Matrix	152
9.1	Product, Process, Service Innovation Interdependence	168
9.2	Innovation Investment Cycles in Shipyard Automation	169
9.3	Product Development Process	173
9.4	The Product and Related Process Innovation Cycle	176
9.5	Product Innovation Life Cycle Costs and Revenues	176
10.1	Simplified Technological Change Decision Problem	179
10.2	One-Stage Decision Tree	181
10.3	Market Research Decision Problem	183
10.4	Utility Function	184
10.5	Learning Curves of Alternative Technologies	186
10.6	Hierarchial Management of Technological Change	188
10.7	Three Stage Model	189
10.8	Analysis of Technological Alternatives	191
12.1	Technology Risk Cost Envelopes	260
13.1	Process of Strategic Management	262
13.2	General Approach to Strategic Planning	264

LIST OF TABLES

		Page
7.1	Simple Cost/Benefit Example	135
8.1	Classical, Decision, and Policy Delphi: A Comparison	147
10.1	Decision Matrix - Uncontrollable Future Events	180
10.2	Uncertain Outcome Decision Matrix - Uncontrollable Future Events	180
10.3	Joint and Marginal Probabilities	182
10.4	Conditional Probabilities	182
11.1	Major Management Parameters	227
11.2	Comparative Management Questionnaire	229