

Contents

<i>Preface</i>	V
<i>Acknowledgements</i>	VII
<i>Abbreviations</i>	XXIII
<i>Useful Computer Software</i>	XXVII
<i>About the Author</i>	XXIX

CHAPTER 1

Introduction

1.1 Work Organization and Methods Engineering	1
1.2 What is Work Study?	1
1.3 Work Study is a Tool for Increasing Productivity	2
1.4 Work Study is a Tool to Achieve Production Objective	3
1.5 Work Study is a Penetrating Tool of Investigation	4
1.6 Work Study and Productivity	5
1.7 Work Study is an Unquestioned Valuable Tool for the Management	5
1.8 Work Study is an Interdepartmental Function	6
1.9 Inter-Departmental Information Flow	6
1.10 Management Information Systems	7
1.10.1 Why MIS is Essential for the Managers?	7
1.11 Why we need Specialists in Work Study?	8
1.12 Psychological Aspects of Work Study	8
1.13 Conclusion	9
Further Reading	9
Criteria Questions	10

CHAPTER 2

History and Development of Work Study

2.1 Early Man is the Unacknowledged Pioneer in Work Study	11
2.2 The Industrial Revolution	11
2.3 Evolution of Management Thinking	12
2.4 Early Pioneers in Management Thinking - Pre-F.W. Taylor Period	12
2.5 Early Pioneers in the Development of Management Thinking in the 19th Century	14
2.6 Concepts of Scientific Management	15
2.7 Specific Aims of Scientific Management	15
2.8 Advantages of Scientific Management	15
2.9 Misconceptions of Scientific Management	16

2.10	Resistance to Scientific Management	17
2.11	Birth of Industrial Engineers	17
2.12	Industrial Engineering and Operations Research	19
2.13	Definition of Work Study	19
2.14	Earlier Form of Work Study	20
2.15	Work Study vs. Time and Motion Study	20
2.16	Definitions of Time and Motion Study	20
2.17	Broadened Concept of Time and Motion Study	21
2.18	Relationship between Method Study and Work Measurement	22
2.19	Conclusion	24
	Further Reading	24
	Criteria Questions	25

CHAPTER 3

The Concepts of Productivity

3.1	Introduction	27
3.2	The Concept of Productivity	28
3.3	Some Definitions of Productivity	29
3.4	Productivity vs. Production	30
3.5	The Input-Output Concept.....	31
3.6	Connotations of Productivity	31
3.7	The Measure of Productivity	31
3.8	Other Measures of Productivity	32
3.9	Levels of Productivity Measurement	33
3.10	The Concept of Increase in Productivity	33
3.11	Factors that Drive Productivity Growth	34
3.12	How to Increase Productivity?	34
3.13	Stewart's 12 step Productivity Improvement Strategy	36
3.14	Sumant et al's Productivity Improvement Techniques	38
3.15	The Benefits of Higher Productivity	39
3.16	Productivity and Standard of Living	40
3.17	Conclusion	41
	Further Reading	41
	Criteria Questions	41

CHAPTER 4

Factors Affecting Productivity

4.1	Introduction	43
4.2	How Ineffective Methods cause Low Productivity?	44
4.3	Factors Affecting the Enterprise Productivity	44
4.4	Internal and External Factors	45

4.5	Hard and Soft Factors	46
4.6	Factors Effecting the Productivity vs. the Basic Work Content	47
4.7	The Concept of the Work Content of a Product or an Operation	47
4.8	Basic Work Content	47
4.9	Excess Work Content or Added Work Content	48
4.10	Excess Work Content Added due to Imperfect Design and Specifications	48
4.11	Excess Work Content Added due to Inefficient Methods and Processes of Manufacture	52
4.12	Excess Work Content Added due to Factors within the Control of the Management	53
4.13	Excess Work Content Added due to Factors within the Control of the Work-Force	54
4.14	Summary of the Factors that Add to the Ineffective Work Content to the Production	55
4.15	Productivity Improvement by Group Technology	57
4.16	How Industrial Engineering Techniques Help in Minimizing the Excess Work Content and the Ineffective Times?	57
4.17	Impact of IoT and AI on Productivity Enhancement	58
4.18	Conclusion	58
	Further Reading	59
	Criteria Questions	59

CHAPTER 5

System Approach to Productivity

5.1	Development of System Approach	61
5.2	What is a System?	61
5.3	Definition of a System	62
5.4	Components of a System	63
5.4.1	Input	63
5.4.2	Conversion Process	63
5.4.3	Output	63
5.5	Types of Systems	64
5.6	Elements of Control in System Approach	65
5.7	Environment	66
5.8	Open and Closed Systems	66
5.9	Systems and Subsystems	67
5.10	Relationship between the Systems and Subsystems	68
5.11	Combination of Subsystems	68
5.12	The Management Cube	70
5.13	Planning Pyramid	70

5.14	Decision Theory	71
5.15	Problem Analysis v/s Decision Making	72
5.16	Characteristics of Decision Making	73
5.17	Situations under which Decisions are Taken	73
5.18	Classifications of Decisions	73
5.19	Different Approaches to Decision Making	74
5.20	Systematic Decision Making	75
5.21	Information Flow	76
5.22	Bias in Decision Making	76
5.23	Decision Tree	77
5.24	Summary of the Features of Management as a System	78
5.25	Conclusion	79
	Further Reading	79
	Criteria Quotations	80

CHAPTER 6

Method Study - Select

6.1	Introduction	81
6.2	Concept of Method Study	81
6.3	Definitions of Method Study	82
6.4	Scope of Method Study	82
6.5	Aims of Method Study	82
6.6	The Three Levels of Method Study	83
6.7	The Basic Procedure for Method Study	83
6.8	Method Study - Selection of the Jobs	84
6.9	Factors Involved in the Selection of Jobs for Method Study	84
6.10	Conclusion	86
	Further Reading	86
	Criteria Questions	86
	Appendix	87

CHAPTER 7

Method Study - Record

7.1	Data Collection	95
7.2	Symbols and Charts	96
7.3	Tabular Presentation	96
7.4	Symbols	98
7.4.1	Process Chart Symbols	98
7.4.2	Some Variations in the Process Chart Symbols	98
7.4.3	Therbligs	99

7.5	Charts used in Work Study	99
7.5.1	Charts Indicating the Process Sequence	99
7.5.2	Charts Using a Time Scale	99
7.5.3	Diagrams Indicating Movements	99
7.6	Outline Process Charts	100
7.7	Flow Process Chart	102
7.8	Differences between the Outline Process Chart and the Flow Process Chart	104
7.9	Two Handed Process Charts	105
7.10	SIMO Charts	105
7.11	Multiple Activity Chart	108
7.12	Flow Chart	110
7.13	Computer Process Flowchart Symbols	111
7.14	Flow Diagram	112
7.15	String Diagram	112
7.16	Travel Chart	113
7.17	Cyclograph	114
7.18	Chronocyclograph	114
7.19	Memo Motion Photography	115
7.20	Time-Lapse Camera Video	115
7.21	Conclusion	115
	Further Reading	116
	Criteria Questions	116

CHAPTER 8

Examine and Develop

8.1	Significance of Generating Alternative Solutions	117
8.2	Requirements for Examining and Developing	117
8.3	Significance of Creativity in Examining an Operation	118
8.4	Creative Methodology	119
8.5	The Principles of Creativity	119
8.5.1	Divide and Conquer	119
8.5.2	Set Quotas and Deadlines for Yourself	119
8.5.3	Let Loose Your Mind	119
8.5.4	Blue Sky Thinking	120
8.5.5	Two Heads are Better than One	121
8.5.6	Question Each and Every Detail	121
8.6	Brainstorming	122
8.6.1	When to Use Brainstorming?	122
8.6.2	Freewheeling vs Round Robin	122
8.6.3	Techniques of Brainstorming	122

8.7	Six Thinking Hats	123
8.8	Other Continuous Improvement Techniques	124
8.9	Primary and Secondary Questions	124
8.10	Checklist for Operation Examination	124
8.11	Develop	126
8.12	Some Quotations on Change	127
8.13	Conclusion	127
	Further Reading	128
	Criteria Questions	128

CHAPTER 9

Method Study - Define, Install and Maintain

9.1	Define	129
9.2	Standard Operating Procedure	129
9.2.1	Definitions on Standard Operating Procedure	130
9.2.2	Objectives of Standard Operating Procedure	130
9.2.3	Linking SOPs to Quality	131
9.2.4	Categories of SOP	131
9.2.5	Benefits of SOPs	131
9.3	Install	132
9.3.1	The 4 Steps of Installing a Proposed Method	132
9.4	Importance of Training	133
9.4.1	Guidelines for Training of the Operatives	133
9.5	Maintain	134
9.6	Conclusion	134
	Further Reading	134
	Criteria Questions	135

CHAPTER 10

Method Study as a Necessary Tool for Productivity

Important - a Case Study

10.1	Introduction	137
10.2	The Case Study	138
10.2.1	Brief Details of the Operations	138
10.2.2	Select	139
10.2.3	Record	139
10.2.4	Examine & Develop	139
10.2.5	Critical Questioning	140
10.2.6	Capital Investment for the Attachment	141

10.2.7	Savings Effected	141
10.2.8	Define, Install & Maintain	141
10.3	Other Case Studies on Application of Creativity	142
10.4	Conclusion	144
	Further Reading	144
	Criteria Questions	144

CHAPTER 11

Kaizen and Continuous Improvement

11.1	What is Kaizen's Role in Productivity Improvement?	145
11.2	Kaizen and Creativity	145
11.3	Kaizen vs Innovation	146
11.4	Why Continuous Improvement?	147
11.5	Significance of Kaizen in Continuous Improvement	147
11.6	How does Kaizen Improve Productivity?	148
11.7	Juran's Methodology	148
11.8	Illustrations of Kaizen Application	148
11.9	Umbrella of Kaizen	149
11.10	Industrial Engineering Principles vs Kaizen Principles	150
11.11	Conclusion	150
	Further Reading	150
	Criteria Questions	150

CHAPTER 12

Terminology used in Japanese Management Practices

12.1	Introduction	151
12.2	Some of the Terminologies Cited in this Chapter	152
12.3	History of Development of Japanese Management Practices	152
12.4	Kaizen	153
12.5	Quality Circles	153
12.6	Genchi Genbutsu	154
12.7	Nemawashi	154
12.8	Heijunka	154
12.9	3 Mu Checklists	155
12.10	4M Checklist	155
12.11	Four Wives and One Husband	157
12.12	CREW	157
12.13	5 Management Objectives of Factory Management	158
12.14	5 Zu's	158

(xvi) **Contents**

12.15	Poka Yoke	158
12.16	Andon and Hanedashi	158
12.17	Jidhoka	159
12.18	Chaku Chaku	159
12.19	5 S	159
12.19.1	SEIRI (Straighten up)	159
12.19.2	SEITON (Put things in order)	160
12.19.3	SEISO (Clean up)	160
12.19.4	SEIKETSU (Personnel cleanliness)	160
12.19.5	SHITSUKE (Discipline)	160
12.19.6	Shitsuke is the Foundation for 5S	160
12.19.7	An easy way of Remembering the 5S Terms	161
12.20	Six Sigma	161
12.21	Gemba Walk	162
12.22	Warusa Kagen	162
12.23	Single Minute Exchange of Die	162
12.24	Just in Time	162
12.25	Kanban	163
12.26	Hoshin Kanri	163
12.27	Nichijo Kanri	164
12.28	Kata	164
12.29	Total Productive Maintenance	164
12.30	Pecha-Kucha	164
12.31	Dakara Nani	165
12.32	Kanso, Shizen and Shibumi	165
12.33	Okya Kusoma	165
12.34	Conclusion	165
	Further Reading	165
	Criteria Questions	166
	Appendix	166

CHAPTER 13

Principles of Motion Economy

13.1	Introduction	169
13.2	Basic Body Movements per Frank Gilbreth	169
13.3	Categories of Motion Economy Principles	170
13.3.1	Principles related to the use of Human Body	170
13.3.2	Principles related to the Arrangement of the Workplace	170
13.3.3	Principles related to the Design of Tools and Equipment	172
13.3.4	Principles related to Time Conservation	173

13.4	Limitations of Motion Economy Principles of Gilbreth	173
13.5	Therbligs	173
13.6	Effective and Ineffective Classification of Basic Motion Elements	175
13.7	Objectives of Therbligs	175
13.8	Some Definitions of Therbligs	175
13.9	Conclusion	176
	Further Reading	176
	Criteria Questions	177

CHAPTER 14

Work Measurement

14.1	Introduction	179
14.2	Definitions on Work Measurement	180
14.3	Objectives of Work Measurement	181
	14.3.1 Comparison Purpose	181
	14.3.2 Capacity Assessment	181
	14.3.3 Estimating Purpose	181
	14.3.4 Wage Payment Process	181
14.4	Principal Techniques for Work Measurement	182
14.5	Stopwatch Time Study	182
14.6	Equipment Required for Stopwatch Time Study	182
	14.6.1 Stopwatch	182
	14.6.2 Observation Sheet	183
	14.6.3 Observation Board	183
	14.6.4 Other Equipment Used	184
14.7	Methods of Stopwatch Timing	185
	14.7.1 Pros and Cons of the 2 Methods	185
	14.7.2 The Requirements for Effective Time Study Are	186
14.8	Elemental Breakdown	186
	14.8.1 Objectives for the Elemental Identification	186
	14.8.2 Guidelines for Breaking an Operation into Elements	187
	14.8.3 Types of Elements	187
14.9	Number of Cycles to be Timed	189
14.10	Performance Rating	190
14.11	Time Study Data Sheet	190
14.12	Operational Standard Times	191
	14.12.1 Terms Used in Determining the Operational Standard Time	192
14.13	Operational Budgeted Time	194
14.14	Standard Time Declaration Form	194
14.15	Method Improvement is a Continuous Process	194
14.16	Computer Software for Work Measurement	196

(xviii) **Contents**

14.17 Conclusion	197
Further Reading	197
Criteria Questions	197

CHAPTER 15

Micro Motion Study

15.1 Introduction	199
15.2 Predetermined Motion Time Standards	200
15.3 Objectives of PMTS	200
15.4 Advantages and Limitations of PMT Systems	201
15.4.1 Advantages	201
15.4.2 Limitations	201
15.5 Categories of PMTS	201
15.6 Methods-Times Measurement	202
15.7 MTM2	202
15.8 Maynard Operation Sequence Technique (MOST)	203
15.9 Benefits of MTM Systems	203
15.10 Time Measurement Unit.....	204
15.11 Conclusion	204
Further Reading	204
Criteria Questions	205

CHAPTER 16

Ergonomics and Work Study

16.1 Introduction	207
16.2 Aims of Ergonomics	208
16.3 History of Ergonomics	208
16.4 Definitions on Ergonomics	209
16.5 Operative's Posture at Work	210
16.6 The Three Major Domains of Ergonomics	210
16.7 Man-Machine System	210
16.8 Ergonomic Design of the Work Place	212
16.9 Ergonomic Design of Machine Controls	212
16.10 Ergonomic Design of Assembly Work Place	213
16.11 Ergonomic Design of Bins for Picking up Small Components (Fig.16.5)	214
16.12 Ergonomics at Office Work (Fig.16.5a)	214
16.13 Ergonomics for Computer Operation	215
16.14 Display Panels on Machinery	216
16.15 Management Responsibility for Optimal Ergonomics	216
16.16 Benefits of an Optimized Ergonomic Process	217

16.17	Limitations of Ergonomics	217
16.18	Software for Ergonomics	218
16.19	Conclusion	218
	Further Reading	219
	Criteria Questions	219

CHAPTER 17

Work Sampling

17.1	Principle of Work Sampling	221
17.2	Production Study vs. Work Sampling	222
17.3	Definitions on Production Study	222
17.4	Objectives of Production Study	222
17.5	What is Work Sampling?	223
17.6	Definitions on Work Sampling	223
17.7	Categories of Work Sampling	224
17.8	History of Work Sampling	224
17.9	Why Work Sampling?	224
17.10	Characteristics of Work Sampling Study	225
17.11	Objectives of Work Sampling	225
17.12	Procedure for Work Sampling	226
17.13	Statistical Theory behind Work Sampling	227
17.14	Random Timing	229
17.15	Number of Observations to be Made	229
17.16	Use of Nomographs for Determining Sample Size	230
17.17	Advantages of Work Sampling	230
17.18	Limitations of Work Sampling	230
17.19	Applications of Work Sampling	232
17.20	Performance Sampling	232
17.21	Computer Software for Work Sampling	232
17.22	Conclusion	233
	Further Reading	233
	Criteria Questions	233

CHAPTER 18

Value Analysis

18.1	What is Value Analysis?	235
18.2	Definitions of Value Analysis	236
18.3	History of Value Analysis	237
18.4	What is Value?	237

(xx) **Contents**

18.5	Value Analysis	238
18.6	Objectives of Value Analysis	238
18.7	Typical Benefits of Value Analysis Projects	238
18.8	Functions of a Product as the Customer Sees	239
18.9	Functional Value of a Product	239
18.10	Methodology of Value Analysis	240
18.10.1	General Phase	240
18.10.2	Information Phase	240
18.10.3	Function Phase	240
18.10.4	Investigation and Creative Phases	241
18.10.5	Evaluation Phase	242
18.10.6	Recommendation and Follow-up Phases	242
18.10.7	Darsiri Methodology for Value Analysis	242
18.11	Function Analysis System Technique (FAST)	242
18.12	Case Study	242
18.13	Conclusion	248
	Further Reading	248
	Criteria Questions	249

CHAPTER 19

Material Layout Planning

19.1	Introduction	251
19.2	Significance of Material Layout Planning	251
19.3	Material Layout Planning Applied to Shearing Operations	252
19.4	Bill of Materials (BOM)	253
19.5	Case Study for Material Layout Planning	253
19.5.1	Bill of Materials	253
19.5.2	The Bucket Production Process	254
19.5.3	Existing Operation Sequence for Producing the Blanks	254
19.5.4	Recommended Material Layout and the Process	254
19.5.5	Summary of Results Achieved	258
19.6	Conclusion	258
	Further Reading	259
	Criteria Questions	259

CHAPTER 20

Work Study on Clerical Operations

20.1	Introduction	261
20.2	Organisation & Methods	261
20.3	Definition of Organization and Methods (O & M)	262

20.4 Application of Work Study in Office	263
20.4.1 Select	263
20.4.2 Record	263
20.4.3 Evaluate	264
20.5 Obstacles to Administrative Reforms	265
20.6 Avoid Cluttering of Office Desk	265
20.7 Conclusion	266
Further Reading	266
Criteria Questions	266

CHAPTER 21**Resistance to Change**

21.1 Improvement vs. Resistance	267
21.2 Types of Changes that Generally meet Resistance	268
21.3 Effect of Worker Representation on Productivity	268
21.4 Reasons for Resistance	269
21.5 Some Criticisms Generally Encountered in the Process of Change	269
21.6 Employee Involvement strategies	270
21.7 Abilities of Man vs Machine	270
21.8 Maslow's Theory of Hierarchy of Basic Needs	271
21.9 Theory X, Theory Y and Theory Z	272
21.10 How to Successfully Implement a Change?	273
21.11 Empowerment	273
21.12 Benefits of Employee Involvement	274
21.13 Total Employee Involvement	274
21.14 Recognition and Rewards	274
21.15 Forms of Recognition and Rewards	275
21.16 Criteria for Effective Recognition of Employees	275
21.17 Advantages of Effective Rewarding Systems	276
21.18 Case Study	276
21.19 Conclusion	277
Further Reading	277
Criteria Questions	278

CHAPTER 22**Industrial Engineer's Role as a Consultant**

22.1 Who is a Consultant?	279
22.2 Key Features of Consultancy	279
22.3 Why are Consultants used?	279
22.4 Requirements of a Consultant	280

22.5	Attributes of a Consultant	280
22.6	Qualities of Consultants as per P.W. Shay	280
22.7	External and Internal Consultants	281
22.8	Consultants' Responsibility to the Clients	281
22.9	Sample Codes of Ethics	283
22.10	Data vs Information	283
22.11	Characteristics of Management Information Systems	284
22.12	Computerization of MIS	284
22.13	Report Writing and Work Study Engineer	285
22.14	Basic Steps of Project Report Writing	287
22.14.1	Data Collection	287
22.14.2	Recording and Presentation of Data	287
22.14.3	Forms of Reports Submitted	287
22.14.4	Tips for Personal Discussions	287
22.15	Basic Communication Skills	288
22.15.1	What is Communication?	288
22.15.2	Elements of Communication	288
22.15.3	Barriers of Communication	288
22.16	Case Study - Consultancy Requirements of a Medium Scale Industry of Chennai in the Indian Context	289
22.17	Conclusion	290
	Further Reading	290
	Criteria Questions	290

Work Study Syllabi from the Indian Universities and Professional Bodies	291
Summarised Syllabi- Foreign Universities	301
Bibliography	303
Index	311