Contents

Preface to the first Indian edition v

PART A	. PRODU	CTIVITY	AND	WORK	STUDY
--------	---------	---------	-----	------	-------

1. Prod	luctivity concept and definitions 3					
1.1	Introduction 3					
1.2	Definitions of productivity 3					
1.3	Productivity measurement at national, industrial and enterprise level					
1.4	Benefits of higher productivity 6					
2. Prod	uctivity in the individual enterprise 8					
2.1	Introduction 8					
2.2	Productivity measurement approaches at the enterprise level 9					
2.3						
2.4	Productivity of land, buildings, machines and manpower 12					
2.5	Factors contributing to productivity improvement 13					
3. Tech	niques for productivity improvement 17					
3.1	Introduction 17					
3.2	Work content and ineffective time 17					
3.3	Improving productivity by reducing work content 19					
3.4	Improving productivity by reducing ineffective time 24					
3.5	Management of productivity 27					
4. Wor	k Study 28					
4.1	Introduction 28					
4.2	Definition 28					
4.3	Basic procedure 29					
4.4	Prerequisites of conducting a work study 32					
5. The	human factor in the application of work study 33					
5.1	Introduction 33					
5.2	Management and supervisor: Their roles in work study 33					
5.3	The works study man 35					
6. The	influence of working conditions on work study 38					
6.1	Introduction 38					

6.2 6.3 6.4 6.5 6.6 6.7 6.8 6.9	Noise and vibration 49 Ergonomics 54	
	Conclusion 59	
PART B	. METHOD STUDY	
7. Intro	eduction to method study and the selection of job 63	
7.1	Introduction 63	
7.2	Definition and objectives of method study 63	
7.3	Procedure 64	
7.4	Selection of job 66	
8. Reco	rd, examine, develop 70	
8.1	Introduction 70	
8.2	Examine critically: The questioning technique 83	
8.3	Develop the improved method 88	
9. Flow	and handling of materials 91	
	Introduction 91	
9.2	Plant layout 91	
9.3	Developing the new layout 94	
9.4	The handling of materials 104	
10. Tool	s for recording the movement of workers 110	
10.1	Introduction 110	
10.2	String diagram 111	
	Flow process chart: Man type 115	
10.4	Travel chart 120	
10.5	Multiple activity chart 125	
10.6	Conclusion 130	
11. Meth	nods and movements at the workplace 131	
11.1	Introduction 131	
11.2	The principles of motion economy 132	
11.3	Classification of movements 135	
11.4	1 ,	
11.5	Notes on the design of jigs, tools and fixtures 137	
11.6	Machine controls and displays of dials 138	
11.7	The two-handed process chart 139	
11.8	Reorganisation of a workplace by means of a two-handed process chart	143
11.9	Micromotion study 149	
	The simo chart 149	
	The use of films in methods analysis 151	
	2. Other recording techniques 152	
	The development of improved methods 153 The methods laboratory 154	
	·	
	ne, install, maintain 156 Introduction 156	
12.1	INTRODUCED 130	
12.2	Obtaining approval for the improved method 156	

	12.3	Defining the improved method 157
	12.4	5 1
	12.5	
	12.6	Maintaining the new method 162
	12.7	Conclusion 162
PA	RT C.	WORK MEASUREMENT
13.		ral remarks on work measurement 165
		Introduction 165
		Definition 165
		Purpose of work measurement 166
	13.4	Where work measurement can be applied 167
	13.5	The basic procedure 168
	13.6	The techniques of work measurement 168
		a 4=4
14.		Sampling 171
		Introduction 171
		Basic concepts and definition 171
	14.3	
		Determination of sample size 175
		Procedure for selecting random observations 177
	14.6	. 0
		Conducting the work sampling study 181
	14.8	Uses of work sampling 184
	m·	4.1. 4
15.		study: the equipment 185
		Introduction 185
		Time study equipment 185
	15,3	Time study forms 189
16	Time	study: Selecting and timing the job 196
10.	16.1	
	16.2	
	16.3	
	16.4	·
	16.5	· · · · · · · · · · · · · · · · · · ·
	16.6	
	16.7 16.8	<i>5 5</i>
	16.9	Determination of sample size 203 Timing elements by stop-watch 204
	10.9	Tilling elements by stop-water 204
17.	Time	study: Rating-Determination of basic time from observed time 207
	17.1	Introduction 207
	17.2	The qualified worker 208
	17.3	The 'average' worker 209
	17.4	Standard rating and standard performance 211
	17.5	Comparing the observed rate of working with the standard 215
	17.6	Rating of effort 216
	17.7	Factors affecting the rate of working 217
	17.8	
	17.9	5
		Recording the rating 221

18.		study: From study to standard time 223
		Introduction 223
	18.2	
		Preparing the study summary sheet 224
		Extension: The calculation of basic time 225
		The selected time 226
		Completing the study summary sheet 232
	18.7	Number of elements and cycles to be studied 233
		The analysis of studies sheet 234
		Work content 236
		Allowances 236
		Calculation of allowances 238
		Relaxation allowances 238
		Other allowances 240
		The standard time 243
	18.15	Example 244
19.	Settin	g time standards for man-machine systems 246
	19.1	Introduction 246
	19.2	
		Basic definitions pertaining to a man-machine system 249
		Determination of cycle time 252
		Determining the standard time 253
	19.6	Conclusion 260
20.	Exam	ple of a time study 265
21.	Prede	termined time standards (PTS) 286
	21.1	Introduction 286
		Definition 286
		Advantages of PTS systems 287
		Criticisms of PTS systems 288
		Different forms of PTS systems 289
		Use of PTS system 291
	21.7	Application of PTS systems 297
22.	Stand	ard data 307
	22.1	Introduction 307
		Major Considerations 307
		Developing the standard data 308
	22.4	Use of PTS systems to develop standard data 315
23.	The u	ses of time standard 323
	23.1	Introduction 323
	23.2	Technical set-up and work specification 323
	23.3	The uses of time standard 326
	23.4	Conclusion 329
PA:	የተ ከ	TWO INTEGRATED EXERCISES
1 (1)	KI D.	INO MILOWILD EALWOLD
24.		ntegrated exercises 333
	24.1	Introduction 333
	24.2	Exercise 1: Manpower planning 333
	24.3	Exercise 2: Production planning 337

PART E. FROM ANALYSIS TO SYNTHESIS: NEW FORMS OF WORK ORGANISATION

25.	Combined	methods and	tacker	New	forms	of work	organisation	341
43.	Comonica	memous and	LUSAS	new	mus	or work	orvanisation	.741

- 25.1 Method study and work measurement: basic tools for job design 341
- 25.2 Design of individual work roles
- 25.3 Design of group work in production 348
- 25.4 Design of product-oriented organisations
- 25.5 Criteria of good work organisation: Some concluding remarks

PART F. APPENDICES

- 1. Glossary of terms used 373
- Check-list of questions which may be of use in applying the questioning sequence in method study 2. 385
- 3. Example of tables used to calculate relaxation allowances
- 4. Conversion factors 405
- 5. Selected bibliography

FIGURES

- 1. Role of the management in coordinating the resources of an enterprise
- How manufacturing time is made up 2.
- 3. Work content due to the product and processes 21
- Ineffective time due to shortcomings on the part of management and workers 4.
- 5. How management techniques can reduce excess work content
- 6. How management techniques can reduce ineffective time
- 7. Work study
- 8. Four basic stratagies to control occupational hazards
- 9. Mounting of general lighting units
- 10. Need for general lighting
- Maximum recommended spacing for industrial type units 45 11.
- Factors influencing the degree of glare produced by a given diffusing fitting (or a bare fluorescent 12. lamp unit) 45
- 13. Relative cost of incandescent and fluorescent lighting
- 14. Recommended ranges of reflection factor for main interior surfaces
- 15. Distance at which the normal voice can be heard against background noise
- 16. Temporary hearing threshold shift in dB as a function of duration of exposure to wideband noise 52
- 17. Ergonomic display design 55
- 18. Ergonomic design of controls
- 19. Optimal use of physical effort
- 20. Method study
- 21. Switch rotor assembly 74
- 22. Outline process chart: switch rotor assembly
- 23. Some charting conventions
- 24. Flow process chart: engine stripping, cleaning and degreasing
- 25. Flow process chart — material type: engine stripping, cleaning and degreasing (original method) 82
- 26. Flow diagram: engine stripping, cleaning and degreasing 87
- 27. Flow process chart — material type: engine stripping, cleaning and degreasing (improved method) 89
- 28. Types of layout
- 29. Example of various types of flow between work stations, including flow in a multi-storey building 95
- 30. Flow diagram: inspecting and marking incoming parts (original method) 97
- 31. Flow process chart: inspecting and marking incoming parts (original method)
- 32. Flow diagram: inspecting and marking incoming parts (improved method)

- XII CONTENTS Flow process chart: inspecting and marking incoming parts (improved method) 102 33. Developing the flow for a number of products, using the cross chart 34. 35. Different types of material-handling equipment 36. Different possibilities of handling the same object 108 37. A string diagram 112 38. Simple movement study sheet 39. String diagram storing tiles (original method) 114 40. String diagram storing tiles (improved method) 41. Flow diagram serving dinners in a hospital ward 118 Flow process chart-man type dinners in a hospital ward 42. 119 43. Travel chart: movements of messenger in office Simple study sheet 123 44. 45. Travel chart material 46. Multiple activity chart: inspection of catalyst in a converter (original method) 47. Multiple activity chart: inspection of catalyst in a converter (improved method) 128 Multiple activity chart: 129 48. 49. Normal and maximum working areas 50. Assembling an electric meter 137 51. Two-handed process chart cutting glass tubes (original method) 52. Two-handed process chart cutting glass tubes (improved method) 53. Example of workplace layout (original method) 54. Example of workplace layout (improved method) 146 55. Right- and left-handed activity charts: assembly of power motor starting winding to core Two-handed process charts: assembly of power motor starting winding to core between 149-150 56. 57. A simo chart 151 58. Standard practice sheet 159 59. A typical learning curve 161 60. Method study 169 Work measurement 170 61. Proportional distribution of 'heads' and 'tails' 62. Distribution curve showing probabilities of combinations when large samples are used 173 63. 64. Curve of normal distribution 174 Example of a simple work sampling record sheet 183 65. Work sampling record sheet showing machine utilisation and distribution of idle time 66. 67. Work sampling record sheet showing distribution of time on ten elements of work performed by a group of four workers 183 68. Decimal-minute stop-watch Time study boards 69.
 - 70. Layout of a typical general purpose Time Study Top Sheet
 - 71. Layout of a typical general purpose continuation sheet
- Layout of a typical short Cycle Time Study Form 72.
- 73. A typical Time Study summary sheet layout
- 74. A typical layout of study sheet 194
- 75. Distribution of times taken by workers to perform a given job
- 76. Effect of ineffective time on performance 214
- 77. Effect of a payment-by-results incentive on the time taken to perform an operation
- 78. Effect of extension on the time of an element 227
- 79. A graphical method of selecting basic time
- 80. Cumulative average basic times for a constant element 234
- 81. Allowances 235
- 82. How the standard time for a simple manual job is made up
- 83. Pump diagram
- 84. 251 Machine interference
- 85. Four operations with machine elements
- 86. Explanatory diagram of machine time

- 87. Card giving details of elements and break points 266
- 88. Sketch of part and of workplace layout 267
- 89. Time study top sheet 268
- 90. Time study continuation sheet 270
- 91. Second continuation sheet 272
- 92. Working sheet 274
- 93. Study summary sheet 276
- 94. Extract from the analysis of studies sheet 278
- 95. Calculation of relaxation allowance 280
- 96. Final calculation of relaxation allowance 282
- 97. Calculation and issue of the standard time 284
- 98. Overall cycle time 285
- 99. PTS data levels: basic motions 289
- 100. Base assembly 298
- 101. Base assembly workplace layout 299
- 102. MTM-2 analysis sheet, base assembly 301
- 103. Restricted walking 311
- 104. Base times for cross-cutting wood of varying width and thickness 312
- 105. Base curve for cross-cutting wood of 2 cm thickness and of varying width 313
- 106. Factor curve for cross-cutting wood of varying width and thickness 314
- 107. Sequence of elements 317
- 108. Basic elements of power press work 318
- 109. Power press work: example of TRANSPORT elements and distances 319
- 110. Power press work: example of standard data determined by MTM-2 (tabular presentation) 320
- 111. Power press work: example of standard data determined by MTM-2 (algorithmic presentation) 321
- 112. Power press work: standard data application form 322
- 113. Machine-paced line 350
- 114. Man paced line 351
- 115. Automated process 352
- 116. Concentrated operation 353
- 117. Service group 354
- 118. Construction group 355
- 119. Assembly of motor car engines 356
- 120. Line grouping and parallel grouping 358
- 121. Schematic diagram of a flow-oriented group 36
- 122. Flow group for the manufacture of pump axles 361
- 123. Layout for a heat exchanger unit 364
- 124. Some examples of the building of buffer stock in manufacturing operations 365
- 125. Manufacture of electric motors 366

TABLES

- 1. Direct means of raising productivity 31
- 2. Recommended levels of illumination for different categories of work with modifications suggested for particular circumstances 43
- 3. A qualitative variation of suggested illumination level with the age of the worker 43
- 4. Recommended maximum lighting intensity ratios 44
- 5. Average values of metabolic rate during different activities 48
- 6. Calculation of noise level obtained by removing a source of noise from the background noise 53
- Duration of continuous noise exposure which should not be exceeded to ensure the prevention of occupational deafness amongst the majority of workers 53
- 8. Typical industrial problems and appropriate method study techniques 67
- 9. The most commonly used method study charts and diagrams 71
- 10. Classification of movements 135

XIV CONTENTS

26.

11.	Therbligs 150
12.	Proportional distribution of 'heads' and 'tails' 173
13.	Table of random numbers 178
14.	Determining the sequence of time for random observations 179
15.	Table 15 180
15a.	Conventional standard of number of recommended cycles for time study 204
16.	Specimen performance distribution 211
17.	Examples of various rates of working on the principal rating scales 220
18.	Components of a basic PTS 287
19.	Scope of application of PTS System 290
20.	MTM-2 data card 291
21.	Fitting a nut and washer on a stud 299
22.	Methods-Time Measurement application data in tmu 302
23.	Restricted walking 310
24.	Base times for cross-cutting wood of varying width and thickness 311
25.	Standard data elements in light engineering and assembly work 315

Minimum data required for work measurement and labour control records 330