

SECOND EDITION

NUREDOİN KIRKAVAI

1997

**MANUFACTURING
FACILITIES**

Location, Planning, and Design

Dileep R. Sule

Louisiana Tech University



PWS Publishing Company

Boston

Contents

Preface xi

CHAPTER 1	Introduction	I
	1.1 Nature and Scope of Part I	1
	1.2 Nature and Scope of Part II	3
	1.3 The Role of a Facility Planner	5
	1.4 Computer Programs	6
	<i>Suggested Readings</i>	7

PART I

Planning and Design

9

CHAPTER 2	Product Development	II
	2.1 Market Research	11
	2.2 Quality Function Deployment (QFD)	20
	2.3 Forecasting	24
	2.4 Design	33
	2.5 Design for Manufacture	34
	2.6 Drawings	38
	2.7 Computer-Aided Design	42
	2.8 Computer Program Description	45
	<i>Summary</i>	45
	<i>Problems</i>	46
	<i>Suggested Readings</i>	48

CHAPTER 3	Manufacturing Processes	51
	3.1 Processes Used to Change the Shape of Material	52
	3.2 Processes Used for Machining Parts to a Fixed Dimension	58
	3.3 Processes for Obtaining a Surface Finish	65
	3.4 Processes Used for Joining Parts or Materials	69
	3.5 Processes for Changing Physical Properties	71
	3.6 Plastic Processing	72
	3.7 Economic Evaluation of Processes	75
	<i>Summary</i>	78
	<i>Problems</i>	79
	<i>Suggested Readings</i>	80

CHAPTER 4	Automation	81
4.1	Sensing Methods	81
4.2	Bar Codes	83
4.3	Radio Frequency Identification System	99
4.4	Machine Vision	100
4.5	Voice Input	110
4.6	Programmable Logic Controllers	110
4.7	Numerically Controlled Machines	119
4.8	Industrial Robots	125
	<i>Summary</i>	129
	<i>Problems</i>	130
	<i>Suggested Readings</i>	133

CHAPTER 5	Production Charts and Systems	135
5.1	Production Charts	135
5.2	Production Systems	145
5.3	Cell Formation in Group Technology	150
5.4	Labor Assignments	163
5.5	Computer Program Description	175
	<i>Summary</i>	180
	<i>Problems</i>	182
	<i>Suggested Readings</i>	185

CHAPTER 6	Requirements and Selection of Machines and Labor	187
6.1	Machine Selection	187
6.2	Labor Requirement and Selection	202
6.3	Machine Coupling	207
6.4	Total Personnel Requirement	212
	<i>Summary</i>	214
	<i>Problems</i>	215
	<i>Suggested Readings</i>	217

CHAPTER 7	Building, Organization, Communications, and Selected Support Requirements	219
7.1	Building	219
7.2	Organization	222
7.3	Communications	227
7.4	Support Facilities and Requirements	229
	<i>Summary</i>	240
	<i>Problems</i>	241
	<i>Suggested Readings</i>	242

CHAPTER 8	Material Handling: Principles and Equipment Description	243
8.1	Definition of Material Handling	243
8.2	Objectives of Material Handling	244
8.3	Material-Handling Equipment Types	245
8.4	Degrees of Mechanization	248
8.5	The Unit Load Concept	249
8.6	Principles of Material Handling	249
8.7	Material-Handling Cost	252
8.8	Relationship between Material Handling and Plant Layout	253
8.9	Material-Handling System Design	253
8.10	Dilemma of an Analyzer	254
8.11	Specifications of the Design	255
8.12	Analyzing an Existing Material-Handling System	256
8.13	Productivity Ratios	259
8.14	Equipment Used for Material Handling	261
	Summary	280
	Problems	281
	Suggested Readings	282

CHAPTER 9	Material Handling: Equipment Selection	283
9.1	Basics of Equipment Selection	283
9.2	Robots in Material Handling	297
9.3	Automated Guided Vehicle (AGV) in Material Handling	305
9.4	A Simulation of an AGV Material-Handling System	308
	Summary	318
	Problems	319
	Suggested Readings	321

CHAPTER 10	Material Handling: Flow Lines, Grouping, and Packaging	323
10.1	Flow Pattern in Assembly Lines	323
10.2	Machine Grouping in Cellular Manufacturing with Reduction of Material Handling as the Objective	345
10.3	Machine Placement in Job Shop or Cellular Manufacturing	358
10.4	Packaging	365
10.5	Reducing Packaging Costs	374
10.6	Designing a Packaging Area	375
10.7	Computer Program Description	376
	Summary	377
	Problems	379
	Suggested Readings	383

CHAPTER 11	<i>Storage and Warehousing</i>	385
	11.1 Warehouse Ownership	386
	11.2 Storage/Warehouse Location	386
	11.3 Building	387
	11.4 Material Requirement Planning (MRP)	391
	11.5 Storage/Warehouse Functions	399
	11.6 Storage and Warehouse Operations	400
	11.7 Accessories	405
	11.8 Stock Location	409
	11.9 Automated Storage and Retrieval	410
	11.10 Loading Docks	416
	11.11 Dock Doors	421
	11.12 Computer Program Description	422
	<i>Summary</i>	428
	<i>Problems</i>	430
	<i>Suggested Readings</i>	433

CHAPTER 12	<i>Plant and Office Layout: Conventional Approach</i>	435
	12.1 Procedure	435
	12.2 Detailed Layout	450
	12.3 Materials Used in Plant Layout Illustrations	453
	12.4 Developing and Analyzing Plant Layouts	453
	12.5 Presenting the Layout	457
	12.6 Office Layout	458
	12.7 Office Landscaping	464
	12.8 Plot Planning	465
	12.9 Evaluating and Implementing the Layout	465
	12.10 Planning Activities	467
	12.11 Computer Program Description	468
	<i>Summary</i>	477
	<i>Problems</i>	479
	<i>Suggested Readings</i>	481

CHAPTER 13	<i>Computer-Aided Plant Layout</i>	483
	13.1 Characteristics of the Problem	484
	13.2 Data Requirements	484
	13.3 Approaches and Types of Procedures	485
	13.4 Mathematical Programming	486
	13.5 Heuristics	488
	13.6 Probabilistic Approaches	497
	13.7 Graph Theory	500
	13.8 Facility Design	500
	13.9 Comments	501
	13.10 Departmental and Layout Shapes	502
	13.11 Scale Effect	504
	13.12 Selection Procedures	506
	13.13 Placement	507
	13.14 Criticisms Concerning Computer-Aided Plant Layout	509
	13.15 Data Guide to Computer Programs	510
	<i>Summary</i>	510
	<i>Problems</i>	511
	<i>Suggested Readings</i>	512

CHAPTER 14	<i>Simultaneous Development of Plant Layout and Material Handling</i>	515
14.1	An Algorithm for MH Equipment Selection	516
14.2	Illustrative Example 1	525
14.3	An Iterative Process for Layout and Optimum MH Development	538
14.4	Illustrative Example 2	542
14.5	Comparison of the Analytical and Heuristic Approaches for Material-Handling System Development	544
14.6	Computer Program Description	545
	Summary	545
	Problems	546
	Suggested Readings	548

CHAPTER 15	<i>Plant Site Selection and Service (Support) Considerations</i>	549
15.1	Plant Site Selection	549
15.2	Utilities Specifications	556
15.3	Insurance	578
15.4	Safety	582
15.5	Americans with Disabilities Act of 1990	588
15.6	Taxes	591
15.7	Financial Statements	594
15.8	Computer Program Description	594
	Summary	601
	Problems	603
	Suggested Readings	604

CHAPTER 16	<i>Computer-Integrated Manufacturing Systems</i>	607
16.1	Systems and Files	608
16.2	Components of CIMS	610
16.3	Benefits and Deficiencies of CIMS	616
16.4	Planning for CIMS	617
16.5	System Providers	619
	Problems	620
	Suggested Readings	620

PART II

Facility Location

621

CHAPTER 17	<i>Basic Facility Location Problems</i>	623
17.1	Single-Facility Placement Problem	623
17.2	Multiple-Facility Placement Problem	625
17.3	Brute Force Approach	625
17.4	Heuristic Method for Problems Involving Facilities with Unlimited Capacities	628
17.5	Other Methods	632
17.6	Computer Program Description	633
	Summary	634
	Problems	634

CHAPTER 18	<i>Location Analysis with Fixed Costs</i>	637
18.1	Heuristic Method for Solving Problems with Fixed Costs	638
18.2	Application	640
18.3	Unassignable Location	644
18.4	Computer Program Description	648
	<i>Summary</i>	651
	<i>Problems</i>	651
	<i>Suggested Readings</i>	653

CHAPTER 19	<i>Continuous Facility Location</i>	655
19.1	Single-Facility Locations	656
19.2	Multiple Facilities	660
19.3	Multiple Facilities of the Same Type	664
19.4	Computer Program Description	667
	<i>Summary</i>	668
	<i>Problems</i>	668
	<i>Suggested Readings</i>	670

APPENDIX A	<i>Engineering Economy Formulas</i>	671
APPENDIX B	<i>Quality Assurance Manual, Spring Controls, Inc.</i>	673
APPENDIX C	<i>Queuing Results</i>	683
APPENDIX D	<i>Mathematical Formulation for Material Equipment Selection (Chapter 14)</i>	685
APPENDIX E	<i>Samples of Americans with Disabilities Act of 1990 Checklists</i>	687
APPENDIX F	<i>Case Studies</i>	699
APPENDIX G	<i>Manufacturing Facilities: Computer Programs</i>	709
	<i>Index</i>	715