

Table of Contents

1. Introduction	1
1.1 Supply Chains and Production Planning	1
1.2 Optimization	2
1.3 Components of Supply Chain Management	4
1.4 Scope of this Book.....	5
2. Optimization Modeling	7
2.1 Abstraction.....	7
2.2 Symbols	9
2.2.1 Variables, Data, Subscripts, and Math	9
2.2.2 Sets	11
2.2.3 Objective Functions and Constraints	11
2.3 Finding Solutions.....	14
2.3.1 Data.....	15
2.3.2 A Few Words About Uncertainty.....	15
2.3.3 Solvers and Model Structure	16
2.4 Implementing the Models in this Book	17
3. Starting with an mrp Model	19
3.1 An Example	19
3.2 mrp Mechanics	20
3.3 mrp Data	22
3.4 mrp Optimization Formulation	24
3.5 Discussion of mrp	26
3.5.1 Troubles	27
3.5.2 Virtues	29
4. Extending to an MRP II Model	31
4.1 MRP II Mechanics	31
4.2 MRP II Data and Constraints.....	34
4.3 Discussion of MRP II	36
4.4 Changeover Modeling Considerations	38
4.4.1 A Straightforward Modification	38
4.4.2 Production that Spans Time Buckets	39

4.4.3	Parallel Machines	40
4.4.4	Sequence Dependent Changeovers	41
4.4.5	A Few Remarks About Changeovers	42
5.	A Better Model	45
5.1	A Cost Based Objective Function	45
5.1.1	Costs	45
5.1.2	Objective Function	47
5.2	Overtime and Extra Capacity	49
5.2.1	A Simple Model	49
5.2.2	Complications	50
5.3	Allowing Tardiness	51
5.3.1	A Simple Model	52
5.3.2	Complications	53
5.4	Objective Function Issues	54
5.5	The Model	55
6.	Extensions to the Model	59
6.1	Substitutes, Multiple Routings and Subcontractors	59
6.2	Penalizing Changes to the Plan	62
6.3	End-of-horizon Effects and Minimum Inventories	64
6.4	Modeling Product Movement and Transport	66
6.4.1	Simple Product Movement and Shipping	67
6.4.2	Expedited Shipping	67
6.4.3	Fixed Costs and Consolidations	67
6.4.4	Transportation Discounts	69
6.4.5	Discussion of Transportation Modeling	70
6.5	Summarizing the Model	70
6.6	Aggregation and Consolidation	71
6.6.1	Consolidating Resources	73
6.6.2	Aggregating Parts	74
6.6.3	Discussion of Disaggregation	79
7.	Implementation Examples	81
7.1	AMPL	84
7.1.1	mrp Model	86
7.1.2	mrp Data	87
7.1.3	Results of Running mrp	88
7.1.4	MRPII Model	89
7.1.5	Data for MRPII	90
7.1.6	SCPc Model	91
7.1.7	Data for SCPc	94
7.2	GAMS	96
7.2.1	mrp and MRPII Models	98
7.2.2	SCPc Model	101

7.3	Maximal MPL	106
7.3.1	mrp Model	107
7.3.2	MRPII	109
7.3.3	SCPc	110
7.4	OPL	114
7.4.1	mrp	115
7.4.2	MRPII	118
7.4.3	SCPc	118
7.5	Xpress-Mosel	123
7.5.1	mrp Model	125
7.5.2	mrp Data	128
7.5.3	mrp Results	129
7.5.4	MRPII Model	129
7.5.5	SCPc Model	130
8.	Solutions	135
8.1	MIPs and Relaxations	135
8.2	Branch and Bound	138
8.3	Special Variable Types	141
8.3.1	Semi-continuous Variables	141
8.3.2	General Integer Variables	142
8.3.3	Special Ordered Sets	143
8.4	Heuristic Search Methods	145
8.4.1	A Brief Primer on Heuristics	146
8.4.2	Abstract Formulation and Solution Representation ...	147
8.4.3	Example of an Embedded Problem	149
8.4.4	Neighborhoods and Evaluation Functions	150
8.4.5	Simulated Annealing	154
8.4.6	Tabu Search	156
8.4.7	Genetic and Evolutionary Algorithms	157
8.5	Constraint Programming	160
9.	Some Stochastic Extensions	163
9.1	Lead Times and Congestion	164
9.1.1	The Issues	165
9.1.2	Load Dependent Lead Times	167
9.1.3	Solver Issues	170
9.1.4	Example	172
9.1.5	Complications and Discussion	173
9.2	Scenarios	174
9.2.1	The Issues	175
9.2.2	A Multi-stage Probabilistic Model With Recourse ...	178
9.2.3	Progressive Hedging	180
9.2.4	A PH based Heuristic for SCPc	184

10. Research Directions and References	187
10.1 Supply Chain Management	187
10.1.1 The Evolution of Logistics	188
10.1.2 Closed Loop Supply Chains and Reverse Logistics	191
10.1.3 The Importance of Information Technology	191
10.1.4 Supply Contracts	198
10.2 mrp, MRP II and Beyond	200
10.2.1 The Early Steps	200
10.2.2 Supply Chain Planning	201
10.3 Production Planning and Scheduling	202
10.3.1 Lot Sizing Models	202
10.3.2 Planning and Inventory Control	208
10.3.3 Machine Scheduling	211
10.3.4 Aggregation and Part Families	212
10.3.5 Load Dependent Lead Times	214
10.4 Transportation	219
10.5 Optimization	223
10.5.1 Exact Methods	225
10.5.2 Heuristic Search Methods	225
10.5.3 Progressive Hedging	229
10.5.4 Simulation	230
10.6 Modeling	231
Bibliography	233
Index	253