

McGRAW-HILL INTERNATIONAL EDITION

Brief Contents

part 1 Introduction	
1 Introduction to Operations Management	2
2 Competitiveness, Strategy, and Productivity	38
part 2 Forecasting	69
3 Forecasting	70
part 3 System Design	129
4 Product and Service Design	130
SUPPLEMENT TO CHAPTER 4: Reliability	170
5 Strategic Capacity Planning for Products and Services	184
SUPPLEMENT TO CHAPTER 5: Decision Theory	214
6 Process Selection and Facility Layout	236
SUPPLEMENT TO CHAPTER 6: Linear Programming	288
7 Design of Work Systems	320
SUPPLEMENT TO CHAPTER 7: Learning Curves	357
8 Location Planning and Analysis	368
SUPPLEMENT TO CHAPTER 8: The Transportation Model	397
part 4 quality	403
9 Management of Quality	404
10 Quality Control	456
SUPPLEMENT TO CHAPTER 10: Acceptance Sampling	499
part 5 Supply Chain Management	509
11 Supply Chain Management	509
part 6 Inventory Management and Scheduling	547
12 Inventory Management	549
13 Aggregate Planning	610
14 MRP and ERP	646
15 Lean Operations	692

Index

SUPPLEMENT TO CHAPTER 15: Maintenance	727
16 Scheduling	734
part 7 Project Management	773
17 Project Management	774
part 8 Waiting Lines	827
18 Management of Waiting Lines	828
Appendix A: Answers to Selected Problems	866
Appendix B: Tables	881
Photo Credits	889
Index	891

Contents

pa	art 1 Introduction 1	Reading:
1	Introduction to Operations	Productivity Gains Curb Inflation 51
	Management 2	Implications of Organization Strategy for
	Introduction 4	Operations Management 52
		Transforming Strategy into Action: The Balanced Scorecard 52
	Process Management 10	Productivity 53
	Reading: The Challenges of Managing Services 10	
	The Scope of Operations Management 11	Readings: Why Productivity Matters 56
	Reading:	Productivity Improvement 59
	Why Manufacturing Matters 14	Summary 59
	Why Learn About Operations Management? 15	Key Terms 60
	Operations Management and Decision Making 18	Solved Problems 60
	Reading:	
	Need a Systems Approach? 20	Discussion and Review Questions 61
	The Historical Evolution of Operations	Taking Stock 61
	Management 22	Critical Thinking Exercises 61 Problems 62
	Key Trends and Issues in Business 26	그리고 그리고 생각 경기를 가득하는 것이 되었다. 그는 그리고 있는 것이 없는 것이 없는 것이 없다.
	Reading:	Cases: An American Tragedy: How a Good
	Universities Embrace Sustainability 27	Company Died 63
	Operations Tour:	Home-Style Cookies 64
	Wegmans Food Markets 32	Hazel Revisited 66
	Summary 35	"Your Garden Gloves" 66
	Key Terms 35	Operations Tour:
	Discussion and Review Questions 35	The U.S. Postal Service 67
	Taking Stock 36	Selected Bibliography and Further Reading 68
	Critical Thinking Exercises 36	octobroa bibliography and variate modaling
	Case:	part 2 Forecasting 69
	Total Recall 36	
	Selected Bibliography and Further Reading 37	3 Forecasting 70
	0	Introduction 72
2	Competitiveness, Strategy,	Features Common to All Forecasts 73
	and Productivity 38	Elements of a Good Forecast 74
	Introduction 40	Steps in the Forecasting Process 74
	Competitiveness 40	Forecasting Accuracy 75
	Mission and Strategies 42	Reading:
	Operations Strategy 49	High Forecasts Can Be Bad News 75

Approaches to Forecasting 77 Forecasts Based on Judgment and Opinion 77 Forecasts Based on Time-Series Data 78 Associative Forecasting Techniques 94 Monitoring the Forecast 99 Choosing a Forecasting Technique 103 Using Forecast Information 105 105 Computer Software in Forecasting Operations Strategy 105

Reading:

Gazing at the Crystal Ball 106 Summary 108 Key Terms 110 Solved Problems 110 Discussion and Review Questions Taking Stock 117 Critical Thinking Exercises Problems 117

Cases:

M&L Manufacturing 126 Highline Financial Services, Ltd. 126 Selected Bibliography and Further Reading 127

part 3 System Design 129

Product and Service Design 130

Reading:

Design as a Business Strategy Introduction 132

Reading:

Product Redesign, Not Offshoring, Holds Cost Advantages for U.S. Manufacturers 133

Reading:

Dutch Boy Brushes Up Its Paints 134 The Key Questions 135

Reading:

Motorola Warms Up to Cool Phone Design 135 Legal and Ethical Considerations Sustainability 137

Readings:

Making It (Almost) New Again 139 Xerox Diverts 2 Billion Pounds of Waste from Landfills through Green Initiatives 141

Recycle City: Maria's Market 141 Other Considerations in Product and Service Design 143

Reading:

Do You Want Pickled Beets with That? 150 Phases in Product Design and Development 151

Reading:

Vlasic on a Roll with Huge Pickle Slices 152 Designing for Production 152 Quality Function Deployment 156 The Kano Model 159 Service Design 160 Operations Strategy 165 Summary 165 Key Terms 166 Discussion and Review Questions Taking Stock 166 Critical Thinking Exercises Problems 167

Operations Tour:

High Acres Landfill 168

Selected Bibliography and Further Reading 169

SUPPLEMENT TO CHAPTER 4:

Reliability 170

Strategic Capacity Planning for Products 5 and Services 184

Introduction 185

Reading:

Excess Capacity Can Be Bad News! Capacity Decisions Are Strategic 187 Defining and Measuring Capacity 187 Determinants of Effective Capacity 189

Reading:

Less Trash Leaves Landfills in a Bind Strategy Formulation 191 Forecasting Capacity Requirements 192 Additional Challenges of Planning Service Capacity 194 Do It In-House or Outsource It? 195

Reading:

My Compliments to the Chef, er, Buyer 196 Developing Capacity Alternatives 196 Constraint Management 201 Evaluating Alternatives 202 Operations Strategy 207 Summary 207 Key Terms 208

Solved Problems 208

Discussion and Review Questions 210

Taking Stock 210

Critical Thinking Exercises 210

Problems 210

Case:

Outsourcing of Hospital Services 213 Selected Bibliography and Further Reading

SUPPLEMENT TO CHAPTER 5:

Decision Theory 214

Process Selection and Facility 6 Layout 236

Introduction 238 Technology 238

Process Selection 239

Operations Tour:

Morton Salt 243

Reading:

Tour de Force 248 Process Strategy 249 Facilities Layout 249

Reading:

Designing Supermarkets 261

Designing Product Layouts: Line Balancing

Reading:

BMW's Strategy: Flexibility 270 Designing Process Layouts 270 Summary 275 Key Terms 276 Solved Problems 276

Discussion and Review Questions 280

Taking Stock 280

Critical Thinking Exercises 280

Problems 281

Selected Bibliography and Further Reading

SUPPLEMENT TO CHAPTER 6:

Linear Programming

7 Design of Work Systems 320

Introduction 321 Quality of Work Life 322

Reading:

Choosing Incentive Plans 326

Job Design 327

Methods Analysis 332

Motion Study 336

Work Measurement 339

Operations Strategy 350

Summary 350

Key Terms 351

Solved Problems 352

Discussion and Review Questions 352

Taking Stock 353

Critical Thinking Exercise 353

Problems 353

Case:

Making Hotplates 356

Selected Bibliography and Further Reading

SUPPLEMENT TO CHAPTER 7:

Learning Curves 357

8 **Location Planning and Analysis** 368

The Need for Location Decisions The Nature of Location Decisions 370 Global Locations 372

Reading:

Not-So-Clear Choices: Should You Export, or Manufacture Overseas? 374 General Procedure for Making Location Decisions 376 Identifying a Country, Region, Community, and Site 376

Reading:

Innovative MCI Unit Finds Culture Shock in Colorado Springs 377

Service and Retail Locations 383

Readings:

Where to Put the New Store? 383

Vying for Patients, Hospitals Think Location,

Location 384

Evaluating Location Alternatives 385

Summary 390

Key Terms 390

Solved Problems 391

Discussion and Review Questions 392

Taking Stock 392

Critical Thinking Exercises 392

Problems 392

Case:

Hello, Wal-Mart? 395

Selected Bibliography and Further Reading 396

SUPPLEMENT TO CHAPTER 8:

The Transportation Model 397

part 4 quality 403

9 Management of Quality 404

Introduction 405

Reading:

Whatever Happened to Quality 406

The Evolution of Quality Management 408

The Foundations of Modern Quality Management:

The Gurus 409

Insights on Quality Management 412

Readings:

The Sounds of Quality 415

Medical Mistakes Kill Almost 98,000 a

Year 418

Hyundai: Kissing Clunkers Goodbye 419

Recipe for Business Success: Quality 420

Quality Awards 422

Quality Certification 424

Quality and the Supply Chain 425

Reading:

Improving Quality and Reducing Risk in

Offshoring 426

Total Quality Management 427

Reading:

What Keeps Six Sigma Practitioners Up at

Night? 431

Problem Solving 432

Process Improvement 434

Quality Tools 435

Readings:

Continuous Improvement on the

Free-Throw Line 440

Benchmarking Corporate Web Sites of Fortune

500 Companies 447

Operations Strategy 447

Summary 448

Key Terms 448

Solved Problem 448

Discussion and Review Questions 449

Taking Stock 450

Critical Thinking Exercises 450

Problems 450

Cases:

Chick-n-Gravy Dinner Line 452

Tip Top Markets 453

Selected Bibliography and Further Reading 49

10 Quality Control 456

Introduction 457

Inspection 458

Reading:

In the Chips at Jays 461

Statistical Process Control 463

Process Capability 480

Operations Strategy 485

Reading:

Bar Codes Might Cut Drug Errors in

Hospitals 485

Summary 485

Key Terms 487

Farmers Market 604

Solved Problems 487	Rise of the 3PL 537
Discussion and Review Questions 491	Creating an Effective Supply Chain 539
Taking Stock 491	Strategy 543
Critical Thinking Exercise 492	Summary 543
Problems 492	Key Terms 543
Cases:	Discussion and Review Questions 543
Toys, Inc. 497	Taking Stock 544
Tiger Tools 497	Critical Thinking Exercise 544
Selected Bibliography and Further Reading 498	Problems 544
SUPPLEMENT TO CHAPTER 10:	Selected Bibliography and Further Reading 546
Acceptance Sampling 499	
	part 6 Inventory Management
part 5 Supply Chain Management 509	and Scheduling 547
11 Supply Chain Management 509	12 Inventory Management 548
Introduction 511	Introduction 549
Reading:	Reading:
Cadbury Schweppes Describes Its Supply	\$\$\$ 550
Chains 514	The Nature and Importance of Inventories 550
Trends in Supply Chain Management 515	Requirements for Effective Inventory
Global Supply Chains 516	Management 553
Management Responsibilities 517	Reading:
Procurement 518	Radio Frequency Identification (RFID)
Reading:	Tags 555
IBM's Supply Chain Social Responsibility 522 E-Business 522	How Much to Order: Economic Order Quantity Models 559
Readings:	When to Reorder with EOO Ordering 571
Desperately Seeking E-Fulfillment 524	How Much to Order: Fixed-Order-Interval
E-Procurement at IBM 524	Model 578
Supplier Management 525	The Single-Period Model 581
Readings:	Operations Strategy 586
CPFR: An Overview of the Model 528	Summary 586
NestléUSA and Ocean Spray Form Strategic	Key Terms 586
Operations Alliance 529	Solved Problems 588
Inventory Management 529	Discussion and Review Questions 593
Order Fulfillment 530	Taking Stock 593
Logistics 531	Critical Thinking Exercises 593
Operations Tour:	Problems 593
Wegmans' Shipping System 532	Cases:
Readings:	UPD Manufacturing 601
Springdale Farm 534	Harvey Industries 601
RFID Tags: Keeping the Shelves Stocked 535	Grill Rite 603

Active RFID vs. Passive RFID 536

Operations Tours:

Bruegger's Bagel Bakery 605

PSC, Inc. 606

Selected Bibliography and Further Reading 608

13 Aggregate Planning 610

Introduction 612

Reading:

Duplicate Orders Can Lead to Excess

Capacity 615

Basic Strategies for Meeting Uneven

Demand 618

Techniques for Aggregate Planning 621

Aggregate Planning in Services 628

Disaggregating the Aggregate Plan 630

Master Scheduling 631

The Master Scheduling Process 631

Summary 636

Key Terms 637

Solved Problems 637

Discussion and Review Questions 639

Taking Stock 640

Critical Thinking Exercise 640

Problems 640

Case:

Eight Glasses a Day (EGAD) 644

Selected Bibliography and Further Reading 644

14 MRP and ERP 646

MRP 647

An Overview of MRP 648

MRP Inputs 650

MRP Processing 653

MRP Outputs 661

Other Considerations 661

MRP in Services 663

Benefits and Requirements of MRP 663

MRP II 664

Capacity Requirements Planning 666

ERP 668

Readings:

The ABCs of ERP 669

[Condensed from] The Top Ten ERP

Mistakes 674

Tips for Successful ERP Projects 675

Operations Strategy 676

Summary 676

Key Terms 676

Solved Problems 677

Discussion and Review Questions 680

Taking Stock 681

Critical Thinking Exercise 681

Problems 681

Cases:

Promotional Novelties 687

DMD Enterprises 687

Operations Tour:

Stickley Furniture 688

Selected Bibliography and Further Reading 690

15 Lean Operations 692

Introduction 694

Reading:

Nearby Suppliers Match Ford's Mix 695

Supporting Goals 696

Reading:

To Build a Better Hospital, Virginia Mason

Takes Lessons from Toyota Plants 697

Building Blocks 699

Readings:

General Mills Turns to NASCAR to Reduce

Changeover Time 701

Pedal Pushers 704

"People" Firms Boost Profits, Study

Shows 706

Transitioning to a Lean System 717

Lean Services 719

JIT II 720

Operations Strategy 720

Summary 721

Key Terms 722

Solved Problems 722

Discussion and Review Questions 723

Taking Stock 723

Critical Thinking Exercise 723	Determining Path Probabilities 799
Problems 723	Simulation 801
Case:	Budget Control 802
Level Operations 724	Time-Cost Trade-Offs: Crashing 802
Operations Tour: Boeing 724	Advantages of Using PERT and Potential Sources of Error 805
Selected Bibliography and Further Reading	726 Critical Chain Project Management 806
SUPPLEMENT TO CHAPTER 15:	Other Topics in Project Management 806
Maintenance 727	Project Management Software 807
	Operations Strategy 808
16 Scheduling 734	Risk Management 808
Scheduling Operations 736	Summary 809
Scheduling in Low-Volume Systems 739	Key Terms 810
Scheduling Services 756	Solved Problems 810
Reading:	Discussion and Review Questions 816
Servicing Passenger Planes 758	Taking Stock 817
Operations Strategy 760	Critical Thinking Exercise 817
Summary 761	Problems 817
Key Terms 761	Cases:
Solved Problems 761	The Case of the Mexican Crazy Quilt 823
Discussion and Review Questions 765	Time, Please 825
Taking Stock 765	Selected Bibliography and Further Reading 825
Critical Thinking Exercises 766	nort 0
Problems 766	part 8 Waiting Lines 827
Case:	18 Management of Waiting Lines 828
Hi-Ho Yo-Yo, Inc. 771	Why Is There Waiting? 830
Selected Bibliography and Further Reading	772 Managerial Implications of Waiting Lines 830
part 7 Project Management 773	Reading: New Yorkers Do Not Like Waiting in Line 830
17 Project Management 774	Goal of Waiting-Line Management 831
Introduction 776	Characteristics of Waiting Lines 832
Behavioral Aspects of Project Management	nt 776 Measures of Waiting-Line Performance 836
Reading:	Queuing Models: Infinite-Source 836
Project Managers Have Never Been Mo	ore Queuing Model: Finite-Source 850
Critical 781	Reading:
Project Life Cycle 783	Hotels Exploring Easier Customer
Work Breakdown Structure 783	Check-ins 855
Planning and Scheduling with Gantt Charts	784 Constraint Management 856
PERT and CPM 784	The Psychology of Waiting 856
Deterministic Time Estimates 788	Reading:
A Computing Algorithm 789	Managing Waiting Lines at Disney World 85
Probabilistic Time Estimates 796	Operations Strategy 858

Summary 858 Key Terms 858 Solved Problems 858 Discussion and Review Questions Taking Stock 860 Critical Thinking Exercises 860 Problems 861 Case:

Big Bank 864

Reading:

Stopped at a Light? Why Not Read This, You May Have Time 864 Selected Bibliography and Further Reading

Appendix A: Answers to Selected Problems 866 Appendix B: Tables 881 Photo Credits 889 Index 891

Company Index

Adelphia, 21 Allen-Bradley, 258 Allied Signal, 429, 431 Amazon.com, 522, 538, 618 American Airlines, 758, 760 American Express, 446 Apple Computer, 377 Arrow Electronics, 426 Arthur Andersen, 21 AT&T, 377, 446

Bain & Co., 375
Barnesandnoble.com, 522
Bayer AG, 372
Bell Atlantic, 28, 377
Bell Telephone Labs, 24, 408
Binney & Smith, 240
BMW, 270, 372
Boeing Company, 3, 422, 530, 724–725
Boothroyd Dewhurst, 133
Bose Corporation, 133, 720
Boston Markets, 48
Bruegger's Bagel Bakery, 605
Burger King, 45, 51, 251, 613
Burgmaster Corp., 63

Cadbury Schweppes, 514–515
Cadillac Motor Company, 422
Camen's Confections, 517
Canon, 446
Caterpillar Inc., 139–140
Coach, 45
Coca-Cola, 45, 737
Compaq Computers, 44
CPC International, 375
Crown Audio, 407
Cummins Engine, 446
CVS, 537

DaimlerChrysler, 248
Dell Computer, 47–48, 146
Deneb Robotics, 333
Digital Equipment Corp., 377
Domino's Pizza, 719
DuPont, 431, 537

Eastman Kodak Co., 139–140, 429 Enron, 21 Ernst & Young LLP, 706 EWP Engineering, Inc., 781 Express Mail, 45, 719

Federal Express, 45, 422, 522, 719 Federated Department Stores, 522 Fingerhut, 522, 524 Firestone Tire & Rubber, 136 Florida Power and Light, 424, 446 Ford Motor Company, 136, 152, 412, 537, 695, 704 Fred Meyer, 704

Gap, 71
General Electric, 411, 429, 430, 431
General Mills, 537, 701
General Motors, 136, 145, 155, 165, 248, 550, 694
Global Crossings, 21
Globe Metallurgical, 422

Hershey Foods, 446 Hewlett-Packard, 44–45, 106, 146, 156, 446, 613 Hilton, 855 Hoechst AG, 372 Home Depot, 71 Honda, 407, 419 Honeywell, 431 Humantech Inc., 327 Hyundai Motor Co., 419–420

IBM, 45, 106, 152, 422, 522, 524–525 ImClone Systems, 21 Insight Inc., 374 ITT, 411

Jays Foods, 461–462 JCPenney, 3, 71 J.D. Power & Associates, 415, 419

Kawasaki Motors, 707 Kelo Department Store, 414 Kmart, 3 Kodak, 28, 45, 152, 446 Kohlberg Kravis Roberts & Co., 63

Leap Technologies, 431 Lexus, 45 L.L. Bean, 428, 446 Lockheed Martin Corporation, 781

Martin Company, 408
Martin Marietta, 411
Mattel, 426, 463
McDonald's Restaurant, 42, 45, 48, 150, 251, 260, 270, 470, 613
MCI Communications Corp., 377
Mercedes-Benz, 336, 372
Mercer Management Consulting, 375
Microsoft, 187, 406, 775, 807
Milliken & Company, 422
Morton Salt, 243–244
Motorola, 45, 135–136, 422, 429, 431, 482, 551, 706

NAPA Auto Parts, 704 NestléUSA, 529 Nike, 42 Nissan, 372, 407 Nokia Corp., 135–136 Nordstrom, 45, 50 NUMMI, 694

Ocean Spray, 529

Pepperidge Farms, 247 PepsiCo, 45 Photikon, 140 Pier One, 524 Procter & Gamble, 446, 537

Ralphs, 857 Ritz-Carlton Hotel Company, 422 Sam's Club. 373, 517, 857

Sam's Club, 373, 517, 857
Sears, 3
Sherwin-Williams, 134
Siemens AG, 372
Skoda, 420
Solectron, 190
Sony, 45
Southwest Airlines, 42, 45, 693
Steelcase, Inc., 132
Stickley Furniture, 688
Stryker Howmedica, 59

Target, 426
Texas Instruments, 429
3M, 45
Toshiba, 152
Toyota, 45, 149, 407, 412, 419, 446, 694–698, 701, 716
Toys "R" Us, 522
Trek Bicycle Company, 13
TriState Industries, 710

Union Carbide, 28 U.S. Postal Service, 482 University Games Corp., 374 UPS, 45, 522

Verizon, 422 Vlasic, 152–153 Volkswagen, 420 VX Corporation, 653

Wal-Mart, 3, 44, 45, 373, 374, 395, 517, 524, 535, 541, 675, 857

Wegmans Food Markets, Inc., 32–34, 511, 532–533

Wendy's, 613

Western Electric, 24

WorldCom, 21

Xerox Corp., 45, 139-141, 422, 428, 446, 706

YKK Corporation, 460

Subject Index

Page numbers followed by n indicate footnotes. A-B-C approach, 556-559 Acceptable quality level (AQL), 502 Acceptance sampling, See also Quality control acceptable quality level, 502 average quality of inspected lots, 504-505 defined 499 inspection, 258, 458-463 operating characteristic curve, 501-504 sampling plans, 500-501 Accidents, causes of, 323-324 Accounting costs, 708 forecasting and, 72 function of, 17, 519 Accuracy, in forecasting, 72, 75-77 Acquisition, of technology, 239 Activities, 785 Activity-based costing, 708 Activity-on-arrow (AOA), 785-787, 789-793 Activity-on-node (AON), 785-787, 793-795 Actual output, 188-189 Actual time, 856 Adams, Bob, 326 Adams, Scott, 260 Additive model, 90-91 Advertising and promotion, 40, 616 Affinity diagram, 444-445 Aggregate planning, 610-644. See also Inventory management concept of aggregation, 612-614 defined, 611 demand and supply, 614, 616-618 disaggregating the plan, 630 goal of, 611 inputs to, 615, 633 linear programming, 625-627 master scheduling, 612, 631-636, 650 mathematical techniques, 625-628 need for, 613-614 overview of, 614-615 planning levels, 612 in services, 628-630 simulation models, 627-628 summary of, 636 techniques for, 621-628 trial-and-error techniques, 621-625 uneven demand, strategies for meeting, 618-621 variations, 614 Agile manufacturing, 51 Agility, 27, 51 Ahire, S. L., 430n, 455 Algorithm, use in PERT, 789-796 Allison-Koerber, Deborah, 104 Allowance factor, in time studies, 342-343 Alpha risk, 467 American Production and Inventory Control Society (APICS), 17, 559

American Society for Quality (ASQ), 17, 406

American Society for Quality Control, 408 Analysis capability, 481-484 cost-profit-volume, 385-386 cost-volume, 202-206 feasibility, 151, 783 financial, 206 job. 332-336 methods, 332-336 multiple regression, 98-99 Pareto, 436, 438 process, 28, 32 sensitivity, 222-224, 306-309 supplier, 526 SWOT, 46 value, 138 waiting line, 206 Andon, 707 Angus, Robert B., 825 Ansari, Shahid, 455 Anticipation stocks, 551 AOO, 504-505 APICS, 17, 559 Applied research, 152 Appointment systems, 757 Appraisal costs, 420-421 Apte, Uday M., 169, 248, 287 AQL, 502 Argote, Linda, 367 Armony, Mor. 615 Armstrong, Larry, 419 Arrival patterns, 833-835 Ashkenas, Ronald N., 825 Assemble-to-order (ATO), 531 Assembly, 241 Assembly diagram, 650-651 Assembly line, 12, 23-24, 241, 250-251 Assembly time chart, 653-654 Assignable variation, 11, 464 Assignment model, 743-745 Associative forecasting techniques, 77, 94-99 Associative model, 77 Atkinson, Roy, 406 Attributes, 468, 472-475 Audits, of suppliers, 526 Automation advantages, 246 computer-aided manufacturing (CAM), 246 computer-integrated manufacturing, 258 defined, 245 disadvantages, 246 fixed, 246 flexible, 248, 258-259 numerically controlled (N/C), 246-247 programmable, 246 robots, 247-248 in services, 260 Autonomation, 702 Availability, 176-177, 188 Available-to-promise (ATP) inventory, 633, 635

Average, moving, 81-83, 92-93, 109 Average outgoing quality (AOQ), 504-505 Average outgoing quality limit (AOQL), 505 Average quality of inspected lots, 504-505 Averaging techniques, 80-85 Avoidance, 538 Awad, Elias M., 335 Awards, for quality, 409, 422-424 Baatz, E., 669 Bacal Robert 330n Back orders, 616 Backflushing, 663 Backward scheduling, 741 Bakke, N. A., 213 Balance delay, 265 Balance sheet approach to problem solving, 445 Balanced Scorecard, 52-53 Balanced systems, 702-703 Balancing transactions, 715 Baldrige, Malcolm, 422 Baldrige Award, 422-423 Baldwin, Carliss C., 169 Balking, 835 Ballou, Ronald H., 396, 546 Banham, Russ, 374 Bar coding, 485, 554-555 Barnes, Ralph M., 356 Bartholomew, Doug, 676 Bartlett, Christopher A., 48n, 68 Basic research, 152 Batch processing, 239-242 Batch systems, 554 Bateman, Nicola, 726 Behavioral approach to job design, 328-329 to project management, 776-782 Behavioral school, 328 Belkauoi, Ahmed, 367 Bell, Janice, 455 Benchmarking, 428, 445-446 Bender, Paul S., 546 Bennett, Wayne D., 690 Benton, W. C., 546 Bernstein, Aaron, 68 Berry, Julie, 603 Berry, Leonard L., 413n, 415n Berry, William L., 644, 690, 696, 726, 772 Best practices, of design, 134 Besterfield, Dale H., 455, 498 Besterfield, Glen, 455, 498 Besterfield-Micha, Carol, 455, 498 Besterfield-Sacre, Mary, 455, 498 Beta distribution, 796 Bias, 101, 476 Bierman, Harold, 234, 318, 402 Bill of materials (BOM), 650-653, 663 Billington, C., 540n Binding constraints, 302 Black, Cherie, 698

Black belts, 429-430

Blackburn, Joseph D., 68	factors affecting, 189-191	Centralized inspection, 462–463
Blanket purchase orders, 520	forecasting, 192-194	Centralized inspection, 462–463 Centralized inventory management, 529
Blueprint, for services, 162-164	goal of, 185	Centralized purchasing, 520–521
Blumberg, Donald F., 546	importance of, 187	Certainty, 216–217
Boenisch, Juergen, 406-407	long term, 192, 194	Certification
Bolwijn, P. T., 213	make or buy, 195-196	of employees, 17
BOM, 650-653, 663	planning service capacity, 194-195	of project managers, 782
Bonini, Charles P., 234, 318, 402	rough-cut, 632	of quality, 424–425
Bonus, 325	short term, 192	of suppliers, 526, 713
Bottleneck operation, 197-198, 207, 269,	steps in the process, 192	Chakrapani, C., 455
755–756	strategy formulation, 191-192	Chalice, Robert, 726
Bounded rationality, 215-216	volatility of demand, 194-195	Change, technological, 46, 57-58
Bovet, David, 546	Capacity requirements planning, 666-668	Change transactions, 715
Bowersox, Donald J., 546	Capacity utilization, 188-189	Changeover time, 51, 701
Bowie, Norman E., 37	Capital productivity, 55	Changes, 661
Brainstorming, 444	Cappels, Thomas, 455	Channel
Brandimarte, P., 644	Caputo, Michael, 189	defined, 832
Branding, 7	Carbone, James, 525	numbers of, 832-833
Brassard, Michael, 455	Carlisle, Brian, 356	Chapman, Chris, 825
Break-even point (BEP), 203-204	Carrying costs, 556, 560-563	Chase demand strategy, 619, 620
Breakdown maintenance, 728-729	Carvajal, Doreen, 384	Check sheet, 435-437
Breakdown programs, 731	Carville, Richard O., 140	Chen, Injazz, 546
Bribery, 374	Cascio, Wayne, 356	Chi-square goodness-of-fit test, 835
Brice, Virginia, 86n	Cases	Chopra, Sunil, 546
Bricks and mortar company, 523	An American Tragedy: How a Good	CIM, 258
Bridger, R. S., 356	Company Died, 63-64	Clark, Andrew, 440-442
B2B, 523	Big Bank, 864	Clark, Kim B., 169
Budgeting, 16	The Case of the Mexican Crazy Quilt,	Clark, Timothy, 440-442
Buffa, Elwood, 865	823-824	Classification systems, 556-559
Buffers, inventory, 530, 552	Chick-n-Gravy Dinner Line, 452	Cleland, David I., 825
Bulfin, Robert, Jr., 644	Custom Cabinets, Inc [©] , 317–318	Clements, James P., 825
Bullwhip effect, 530	DMD Enterprises, 687	Click and brick companies, 524
Burt, David N., 546	Eight Glasses a Day (EGAD), 644	Climate, impact on location decisions, 380
Bushong, J. Gregory, 772	Farmers Restaurant, 604	Closed-loop MRP, 665
Business organizations	Grill Rite, 603	Closed-loop supply chain, 539
functions within, 4, 15–16	Harvey Industries, 601-603	Closeness ratings, 273-275
trends, 26-32	Hazel, 36–37	Closs, David J., 546
Business plan, 612	Hazel Revisited, 66	Coburn, Larry, 407
Business process management (BPM), 10	Hello, Wal-Mart?, 395	Cohen, Morris A., 169, 248, 287
Business processes, 10–11	Hi-Ho Yo-Yo, Inc., 771-772	Collaborative Planning, Forecasting,
Business-to-business (B2B) commerce, 523	Highline Financial Services, Ltd., 126	and Replenishment (CPFR), 528
Butman, John, 455	Home-Style Cookies, 64-65	Column reduction, 743
Buxey, G., 644	Level Operations, 724	Colvin, Geoffrey, 37, 68
C 1 470 471	Making Hotplates, 356	Combination layouts, 254
C-chart, 472–474	Master Tag, 545	Community factors, in location decisions,
C-kanban, 711	M&L Manufacturing, 126	380-381
CAD, 155–156, 807	Outsourcing of Hospital Services, 213	Compensation, 324-327
Caldwell, Philip, 695	-Product Recall, 367	Competition, time-based, 612
Calkins, Patricia, 141	Promotional Novelties, 687	Competitive advantage, 239
CAM, 246	Son, Ltd., 317	Competitive edge, 44
Capability analysis, 481–484	Tiger Tools, 497–498	Competitiveness, 40-41
Capability index, 485	Time, Please, 825	Component commonality, 156
Capacity, 11, 185	Tip Top Markets, 453–454	Computer-aided design (CAD),
Capacity chunks, 198	Toys, Inc., 497	155-156, 807
Capacity costs, 831	UPD Manufacturing, 601	Computer-aided manufacturing (CAM), 246
Capacity cushion, 192	"Your Garden Gloves," 66	Computer applications
Capacity disposal strategies, 207	Cash flow, 206	CAD, 155-156, 807
Capacity planning, 184–213. See also Aggregate	Causal variables, 77	CIM, 258
planning	Cause-and-effect diagrams, 411, 436, 439-440	e-business, 26, 29, 522-525
airline industry, 11	Cell, 255	e-commerce, 26, 673
constraint management, 201–202, 856	Cellular layouts, 255–258. See also	e-procurement, 26, 524-525
cost-volume analysis, 202–206	Facilities layout	EDI, 524
defining and measuring, 187–189	Cellular production, 255–258	ERP, 668-676, 717
determining requirements, 193–194	Center of gravity method, 388-390	for forecasting, 105
enhancing, 196–201	Centered moving average, 92-93	GIS, 379
evaluating alternatives, 202-207	Central limit theorem, 464	linear programming, 303-306

Computer-integrated manufacturing	capacity, 831	Cycle time, 262-264, 713
(CIM), 258	carrying, 556, 560-563	Cyclical scheduling, 759-760
Computer viruses, 58	construction, 200	
Computerized numerical control (CNC), 246	distribution, 200	Danner, David L., 356
Computing algorithm, 789–796	ERP, 671-672	Darnell, Michele, 152
	excess, 582	Databases, 48
Concurrent engineering, 154–155, 699	failure, 420–421	Davenport, Tom, 690
Condit, Donald, 603	fixed, 196, 200, 202, 385–386	Davis, Mark M., 169
Condon, James D., 140	holding, 536, 556	Davis, Stanley B., 455, 498
Conformance, quality of, 417		Decentralized inventory management, 529
Constant lead time, 579	inspection, 459	Decentralized purchasing, 520-521
Constant service time, 840-841	maintenance, 728, 730	Decision making
Constant work-in-process (CONWIP), 713	opportunity, 616	capacity planning. See Capacity planning
Constrained optimization, 288	ordering, 556, 561–563	causes of poor, 215–216
Constraint management, 201-202, 856	overhead, 708	under certainty, 216–217
Constraints	prevention, 420–421	decision areas, 50
binding, 302	processing, 200	
categories of, 201	quality, 410, 412, 420-421, 484	decision trees, 219–221
defined, 201, 289	rework, 421	design and operating decisions, 13
plotting, 294-296	setup, 738	establishing priorities, 21
redundant, 300	shortage, 556, 582	ethics and, 21, 28
theory of, 755-756	total, 385-386, 671	expected monetary value criterion,
Construction costs, 200	transportation, 272-273, 373, 378,	218–219
Consumer price index (CPI), 97	515, 541, 715	expected value of perfect information,
Consumer surveys, used to forecast, 78	variable, 202, 385-386	221–222
Consumer's risk, 467, 502	Council of Supply Chain Management	hierarchical organizations, 43-44
Continual inventory system, 554	Professionals, 17	Iocation, 31
Continuous improvement, 428, 440–442,	Counting systems, for inventory, 553-555	models, 18-19, 24-25
707–708. See also Quality	Cox, Jeff, 772	process of, 214-215
Continuous processing, 241–242	Cp, 482–483	quantitative approaches, 19, 24-25
	CPFR, 528	under risk, 218–219
Continuous stocking levels, 582–583	Cpk, 483–484	sensitivity analysis, 222-224, 306-309
Contractors, independent, 617	CPM (Critical path method), 19, 784-788,	systems approach, 20-21
Contracts, long term, 527	805–806. See also PERT (Program	trade-offs, 20
Contribution margin, 203		under uncertainty, 217–218
Control, 5, 13, 75–77	evaluation and review technique)	Decision Sciences Institute, 17
Control charts	CR (critical ratio), 746, 749	Decision theory, 206, 214–215. See also
attributes, 468, 472-475	Cradle-to-grave, 137	
defined, 99, 436, 439, 465	Craft production, 22	Decision making
errors, 466-467, 502	Crainer, Stuart, 37	Decision trees, 219–221
forecasting and, 99-100	Crandall, Robert L., 758, 760	Decision variables, 289–290
mean, 468-469, 470-472	Crash	Decline phase, 144, 197
nonrandom patterns, 476, 479-480	defined, 803	Decoupling, 552
process, 465-468	project management and, 802-805	Defects, zero, 408, 411
range, 469-472	Creeping featurism, 149	Define, measure, analyze, improve, and control
run tests, 476-479	Critical activities, 786	(DMAIC), 430–431
for variables, 468-472	Critical chain project management	Delayed differentiation, 146, 541
when to use, 475-476	(CCPM), 806	Delivery time, 51
Control limits, 465, 466, 480	Critical path, 786	Dell, Michael, 47
Control process, 465	Critical path method (CPM), 19, 784-788,	Delphi method, 78
Conversion process, 5	805-806	Delurgio, Stephen, 127
Conveyance kanban, 711	Critical ratio (CR), 746, 749	Demand
CONWIP, 713	Crosby, Philip B., 411, 421	aggregate planning, 614, 616-618
Cooper, M. Bixby, 546	Cross-docking, 516, 541	common patterns, 192-193
Copacino, William C., 546	Cross training, 269, 707	dependent, 647-648
	CRP, 666–668	fluctuations in, 199
Corbett, James J., 516n, 546	Cullinane, Thomas P., 825	forecasting of, 555-556
Core competencies, 44	Culture, impact on design, 150	independent, 647-648
Corner points, 300	Cumulative lead time, 650	lumpy, 541, 648
Corrective action, 5	Cunningham, J. Barton, 356	meeting uneven, 618-621
Correlation, 97		new, 616
Cost accounting, 708	Curvilinear regression analysis, 99	seasonal, 192-193, 198-199
Cost analysis, 845–846	Customer satisfaction, 28, 32, 427, 553	
Cost-profit-volume analysis, 385–386	Customization	variations in, 614
Cost reduction, 40	degree of, 20	volatility of, 194–195
Cost-volume analysis, 202-206	mass, 146-147	Demand chain, 513
Costs	Cycle, 79–80, 94, 476	Demand fence, 666
activity based, 708	Cycle counting, 558–559	Deming, W. Edwards, 406, 409–410, 424
appraisal, 420-421	Cycle stock, 552	Deming Prize, 409, 424

Deming wheel, 433 Dependent demand, 647–648	Distribution function, 13	Environment
	Distribution requirements planning	ISO 14000, 424-425
Depth skills, 327	(DRP), 668	recycling, 141-143, 189
Derman, C., 498	Division of labor, 24	sustainability, 27, 44, 137-143, 245, 51
Design, of products and services, 130–182	DMAIC, 430-431	Environmental Protection Agency, 136
activities and responsibilities, 132. availability, 176-177, 188	Dobler, Donald W., 546	Environmental scanning, 46
best practices, 134	Dodge, H. F., 24, 408	EOQ. See Economic order quantity (EOQ
capacity. See Capacity planning	Double-sampling plans, 500	Eppen, G. D., 234
	Double smoothing, 89	Epple, Dennis, 367
component commonality, 156 computer-aided design, 155-156, 807	Downsizing, 28	Equivalent current value, 206
	DRP, 668	Equivalent interest rate, 206
concurrent engineering, 154-155, 699 cultural issues, 150	Drum-buffer-rope technique, 755	Ergonomics, 330-332
degree of newness, 149	Due date, rule for sequencing, 746	Erlang, A. K., 829
elements of, 699	Dummy activity, 786	ERP, 668-676, 717
ethical issues, 137	Duncan, A. J., 508	Errors, 75-77, 99-103, 466-467, 502
global, 150–151	Duray, Rebecca, 169 Dynamic line balancing, 269	Esain, Ann, 726
human factors, 149	Dynamic interbalancing, 209	Ethics
idea generation, 151–152	F-husiness 26 20 522 525	decision making, 21, 28
Kano model, 159–160	E-business, 26, 29, 522–525	design issues, 137
legal issues, 136–137	E-commerce, 26, 673	global, 374
life cycles. See Life cycles	E-procurement, 26, 524–525 Earliest due date (EDD), 746–751	project management, 780
mass customization, 146–147	Ease of use, 417	purchasing, 521
phases, 143–144, 151–154		quality, 421–422
production, 154–156	Eberle, Ted, 356	working conditions, 324
production requirements, 156	Ebersole, Phil, 139–140 Economic indicators, 97	European Quality Award, 423
products versus services, 161–162	Economic lot sizes, 552	Evans, James R., 413n, 498
quality, 416–417	Economic order quantity (EOQ)	Evans, P., 68
quality function deployment, 156-159	basic model, 559–564	Event management, 539
reasons for, 132–134	defined, 559	Events, 785
recycling, 141-143, 189	economic production quantity, 564–566	Exception reports, 661
redesign, 132-134	fixed-order-interval model, 578–581	Excess capacity, 11
reliability, 147-148, 170-182	in MRP, 662–663	Excess cost, 582
remanufacturing, 138-139	quantity discounts, 552, 566-571	Executive opinions, used to forecast, 77
research and development, 152	reorder points, 571–578	Expand-early strategy, 207
reverse engineering, 152	single-period model, 581–585	Expected monetary value (EMV)
robust design, 148	versus small lot sizes, 700-701	criterion, 218–219
services, 160-164	Economic production quantity	Expected value of perfect information (EVPI), 221–222
standardization, 58, 144-145, 699	(EPQ), 564–566	Experiments, design of, 148
sustainability, 137-143	Economies of scale, 22, 200	Explanatory variables, 77
systems, 7	EDD (earliest due date), 746-751	Exponential service time, 839–840
technology changes, 133	EDI, 524	Exponential smoothing, 83–85, 109
value analysis, 138	Effective capacity, 188-191	External failures, 420-421
Design capacity, 188-189	Efficiency, 20, 59, 188-189	Eyring, Veronika, 516n, 546
Design for assembly (DFA), 156	Efficiency school, 327-328	Lyring, veronika, 510n, 540
Design for disassembly (DFD), 139	Ehrsam, Fred, 375	Fabrication, 12
Design for manufacturing (DFM), 156	Eidam, Michael, 419	Facilities layout. See also Process selection
Design for recycling (DFR), 141	80/20 rule, 438	and design
Design of experiments, 148	El-Haik, Basem, 455, 726	capacity, 190
Design review, 151	Electronic commerce, 26, 673	cellular layouts, 255–258
Deterministic, 788-789	Electronic data interchange (EDI), 524	combination layouts, 254
Detroit type automation, 246	Emerson, Harrington, 23	fixed position, 250, 254
Dettmer, H. William, 201, 213	Employment, 9, 14	flexible-manufacturing systems,
DeWeaver, Mary Feeherry, 825	Empowerment, 428, 444	248, 258–259
Dewhurst, Nicholas P., 133	Energy productivity, 55	information requirements, 271–272
Differentiation, delayed, 146, 541	Engineer-to-order (ETO), 530	line balancing
Diffusion models, 86	Engineering	cycle time, 262–264
Dimensions of quality, 412-415	concurrent, 154-155, 699	defined, 262
Direct numerical control (DNC), 246	reverse, 152	flow systems, 736–737
Disaggregation, 630	Engineering changes, 699, 715	guidelines for, 266
Discounts, quantity, 552, 566-571	Englund, Randall L., 825	JIT, 702–703
Discrete stocking levels, 584-585	Enrick, Norbert L., 508	mixed model line, 270
Mseconomies of scale, 200	Enterprise resource planning (ERP),	parallel workstations, 269
Disintermediation, 541	668-676, 717. See also Material	precedence diagram, 264, 786–788
stribution costs, 200	requirements planning (MRP)	procedures, 264
Stribution decisions, 31	Enumeration approach, 300	procedures, 204

Fogarty, Donald W., 644

Facilities layout—Cont.	Following capacity strategy, 191	Ghattas, R. G., 825
need for planning, 249	Food and Drug Administration, 136	Ghoshal, Sumantra, 48n, 68
objectives of, 250	Foolproofing, 427	Gido, Jack, 825
problems with poor, 249-250	Ford, Henry, 23–24	
process layouts, 252-254, 270-275	Forecasting, 70–127	Gilbreth, Frank, 23, 24, 331, 336–337
product layouts, 250-252, 261-270	accuracy of, 72, 75–77	Gilbreth, Lillian, 23, 24, 331
service layouts, 259-260	airline industry, 11	Gillespie, Lori Ciprian, 825
transportation issues, 272–273	approaches to, 77, 108	Gilmore, James, 169
u-shaped layouts, 252		GIS, 379
Facilities location. See Location planning	associative techniques, 77, 94-99	Gispan, Jonathan, 781
Factor rating, 387–388	capacity requirements, 192–194	Gitlow, Howard S., 440, 455, 498
	choosing a technique, 103-105	Global priority rule, 746
Fail-safing, 427, 706	common features, 73	Global product design, 150-151
Failure	computers in, 105	Global strategy, 48
defined, 147	control of, 72, 75–77	Global supply chains, 27, 29, 516-517
external, 420-421	CPFR, 528	Globalization. See also International business
internal, 420-421	defined, 71	benefits, 372
Failure costs, 420-421	Delphi method, 78	disadvantages, 373
Failure rates, 172–174	demand, 555-556	location decisions, 372-376
Fazel, Farzaneh, 431n, 455	diffusion models, 86	risks, 373-374
FCFS (first come, first served), 746-751, 835	elements of good, 74	strategy, 48
Feasibility, range of, 308	errors, 75-77, 99-103	Go, no-go gauge, 475
Feasibility analysis, 151, 783	focus, 85-86	Goals
Feasible solution space, 289, 292, 297	formulas used in, 109	capacity planning, 185
Feedback, 5, 13	importance of, 72	defined, 42
Feigenbaum, Armand, 411	judgment and opinion, based on, 77-78	
Feitzinger, Edward, 169	monitoring, 99–103	of JIT, 696–698
Fences, time, 632-633	qualitative methods, 77	waiting line management, 831–832
Ferdows, Kasra, 396	quantitative methods, 77	Goetsch, David L., 455, 498
Fill rate, 539, 578	steps in the process, 74	Goldratt, Eliyahu M., 201, 213, 755n, 756, 772
Finance function, 4, 15–16, 72		806, 808n, 825
Financial analysis, 206	technology, 78	Goncalves, Marcus, 825
	time series data, based on	Gonzalez, Adrian, 537
Finite loading, 741	averaging, 80-85, 92-93, 109	Goods
Finite-source situation	cycles, 79-80, 94	defined, 4
defined, 832	defined, 77	versus services operations, 7-10, 12
queuing models, 850–856	exponential smoothing, 83-85, 109	Goods-services continuum, 6-7
Finucane, James, 377	irregular variations, 79-80	Gorman, Michael E., 169
First come, first served rule, 746-751, 835	naive method, 79-80	Gould, F. J., 234
Fishbone diagram, 411, 439	random variations, 79-80	Graham, Robert J., 825
Fisher, Marshall, 546	seasonality, 79-80, 90-93, 192-193,	Grant, Eugene L., 470, 498
Fitness, 136	198–199	Graphical linear programming
Fitness-for-use, 410, 413	trend, 79-80, 86-89	defined, 292
Fitzgerald, Kevin R., 518, 546	trend-adjusted exponential smoothing,	feasible solution space, 289, 292, 297
Fitzsimmons, James A., 37, 161n, 169	89-90	minimization, 289, 301-302
Fitzsimmons, Mona J., 37, 161n, 169	uses of data, 72-73	objective function, 289–290
5W2H approach, 446	using information, 105	objective function coefficient change,
Fixed automation, 246	Foreign locations, 372–376. See also	306–308
Fixed costs, 196, 200, 202, 385-386	International business	
Fixed-order-interval model, 578-581	Forward scheduling, 741	objective function line, 297–300
Fixed-period ordering, 663	Foster, Nicole, 545	plotting constraints, 294–296
Fixed-position layout, 250, 254. See also		procedures, 292–294
Facilities layout	Francis, Richard L., 287, 396	redundant constraints, 300
	Freivalds, Andris, 356	slack and surplus, 302-303
Fixed-quantity model, 579–580	Friedman, Norm, 213	solutions and corner points, 300-301
Flattening, of the organization, 28	Frozen, 632, 666	Graphs, used in aggregate planning, 621-625
Flexibility, 40–41, 196–197, 207	Fulfillment, of orders, 523, 530-531	Gravity method, center of, 388-390
Flexible manufacturing system (FMS),	Functional strategies, 43	Gray, Clifford F., 783, 808, 825
248, 258–259		Green, Erin H., 516n, 546
Flexible system, 697, 702	Gantt, Henry, 23, 739	Green belts, 429
Flow management, 514	Gantt charts, 23, 739-740, 778, 784	Griebenow, Allan, 535
Flow process chart, 333-335	Garvin, David A., 412n, 455	Griffin, Gale, 375
Flow-shop scheduling, 736-737	Gatekeeping, 538	Griffin, W., 865
Flow system, 736-737	GATT, 27, 372	Griffith, Gary K., 498
Flow-through distribution, 516	Gauging systems, 22	Grimshaw, David J., 396
Flowchart, 435-437	General Agreement on Tariffs and Trade	
FMS, 248, 258-259	(GATT), 27, 372	Groover, Mikell P., 169, 257, 269n, 287
Focus forecasting, 85-86	Geographical information system (GIS), 379	Gross requirements, 654–655
	Geographical information system (GIS), 3/9	Group incentive plans, 326

George, Michael L., 455

Group incentive plans, 326 Group technology, 257–258, 701

Growth phase, 143, 197 Indicators, economic, 97 centralized, 529 Growth strategies, 48 Indifference, 204 counting systems, 553-555 Gryna, Derek S., 455 Individual incentive plans, 325 cycle counting, 558-559 Gryna, Frank M., 455, 498, 508 Industrial engineering function, 13 demand forecasts, 555-556 Guide, V. Daniel, 546 Industrial Revolution, 22, 408 economic order quantity (EOO) Gundersen, Norman A., 825 Infinite loading, 741 basic model, 559-564 Infinite source models defined, 559 Hachman, Mark, 68 basic relationships, 837-839 economic production quantity, 564-566 Hall, Robert W., 733 multiple priorities, 847-850 fixed-order-interval model, 578-581 Hammer, Michael, 68 multiple servers, 841-845 in MRP, 662-663 Handfield, Robert B., 546 single server, 839-841 quantity discounts, 552, 566-571 Hard data, 77 Infinite source situation, 832 reorder points, 571-578 Hariham, Arun, 455, 726 Information technology. See Technology single-period model, 581-585 Harris, F. W., 24 Information velocity, 539 versus small lot sizes, 700-701 Harry, Mikel, 455 Ingold, Anthony, 68, 213 formulas, 587 Hausman, Warren H., 234, 318, 402 Innovation, technological, 238 importance of, 550-553 Hayes, R., 242 Input/output (I/O) control, 742-743 lead time information, 555-556, 579 Hazelwood, R. N., 851, 854 Inputs lean operations, 703-704 Hedging, 552 aggregate planning, 615, 633 objectives of, 552-553 Heijunka, 695 MRP, 650-653 ordering costs, 556, 561-563 Heineke, Janelle, 169 operations management, 5-6 perpetual system, 554, 571 Hellburg, R., 213 Inspection, 258, 458-463. See also Acceptance requirements for effective, 553-559 Hendrick, Thomas E., 213 sampling RFID, 531, 533-536, 555 Hendricks, Kevin B., 455 Institute for Operations Research and the Mansafety stock, 552, 572-573, 661-662 Hertzberg, Frederick, 24 agement Sciences, 17 service levels, 572-573, 575-578 Heskett, James L., 169 Institute for Supply Management (ISM), 17 shortages, 575-578 Heuristic rule, 264 Institute of Industrial Engineers, 17 stocking levels, 582-585 Hickey, Kathleen, 546 Interchangeable parts, 23-24, 145 stockouts, 552, 572-573, 580-581 Hierarchical organizations, 43-44 Intermediate plans, 612 two-bin system, 554, 712 High technology, 26, 238. See also Technology Intermediate-volume systems, scheduling in, Inventory models, 19 High volume systems, scheduling in, 736-738 738-739 Inventory records, 653 Hill, Terry, 68, 213, 287, 546 Intermittent processing, 252-253 Inventory turnover, 553 Hillier, Frederick S., 318, 865 Internal failures, 420-421 Inventory velocity, 529-530 Hillier, Mark S., 318 Internal rate of return (IRR), 206 Ireland, Samuel, 455 Hira, Ronald, 546 International business. See also Globalization Irregular variation, 79-80 Hiring, of workers, 616-617 design issues, 150-151 Ishikawa, Kaoru, 411 Histogram, 435-436, 438 GATT, 27, 372 Ishikawa diagram, 439 Hoerl, Roger W., 455, 726 global strategy, 48 ISO 9000, 424-425, 526 Holding costs, 536, 556 location decisions, 372-376 ISO 9001, 782 Holland, Max, 63 NAFTA, 27, 372 ISO 14000, 424-425 Holstein, William J., 68 trade agreements, 372 ISO 24700, 424-425 Hopp, Wallace J., 127, 546, 608, 644, International Ergonomics Association, 331 690, 726, 772 International Organization for Standardization, Jacobs, Robert F., 690 Hora, Michael E., 733 424-425 Japan Prize, 424 Horizontal loading, 328 Internet. See also Technology Japanese manufacturers, Horizontal skills, 327 benefits of, 58 influence of, 25 House of quality, 157-159 e-business, 26, 29, 522-525 Jeffery, Bill, 690 Housekeeping, 715-716 . e-commerce, 26, 673 Jidoka, 695, 702 Howe, Tom, 461 e-procurement, 26, 524-525 Jimenez, Alicia, 462 Human relations movement, 24 Interviewing, 445 JIT, 694, 738 Human resources, 17, 72. See also Personnel Introduction phase, 197 JIT II, 720 issues Intuitive rules, 264 Job analysis, 332-336 Hungarian method, 743 Inventory Job design, 327-332. See also Work Huse, Edgar F., 356 available-to-promise, 633, 635 measurement defined, 549 behavioral approaches, 328-329 Idle time, 265 functions of, 551-552 compensation, 324-327 Ihlwan, Moon, 419 pipeline, 552 defined, 327 Illumination, working conditions and, 322 turnover of, 553 ergonomics, 330-332 Imai, Masaaki, 697n vendor-managed, 530, 720 human relations movement, 24 Implied warranties, 136 work-in process, 551, 703, 713 methods analysis, 332-336 Incentive plans, 58, 324-326 Inventory management, 547-608 motion study, 23, 336-338 Independence, 799 80/20 rule, 438 motivation, 12, 24, 329 Independent contractors, 617 ABC approach, 556-559 specialization, 328 Independent demand, 647-648 barcoding, 485, 554-555 teams, 329-330 Independent events, 171 bullwhip effect, 530 working conditions, 322-324

carrying costs, 556, 560-563

Job enlargement, 328-329

Indexes, 91, 97

Job enrichment, 329	Leadership, 708	maturity phase, 143-144, 197
Job rotation, 329	Leading capacity strategy, 191	product, 241–242
Job shop, 239-242	Leading variable, 94	project, 776, 782-783
Job shop scheduling, 739-756	Lean operations, 692-726	Liker, Jeffrey K, 427n, 726
defined, 739	benefits of, 586	Lindsay, W. M., 413n, 498
loading, 739–745	defined, 693	Line balancing
sequence dependent setup times, 754	ERP, 668-676, 717	cycle time, 262–264, 713
sequencing, 745-754	inventory control, 703-704	defined, 262
two work centers, sequencing through,	JIT, 694, 738	flow systems, 736–737
752-753	JIT II, 720	guidelines for, 266
Job splitting, 752	kanban, 694, 711-713	JIT, 702-703
Job time, 746	level loading, 708-710	mixed model line, 270
Jockeying, 835	limited work-in-process, 713	parallel workstations, 269
Johnson, S. M., 752n	line balancing. See Line balancing	precedence diagram, 264, 786-788
Johnson's rule, 752	lot sizes. See Lot sizing	procedures, 264
Jones, Daniel T., 37, 694, 726	manufacturing cells, 701	Line functions, 4
Jorgensen, Karen, 356	manufacturing planning and control,	Linear programming, 288–318
Judgmental forecasts, 77-78	708-716	aggregate planning, 625-627
Juran, Joseph M., 410-411, 421, 455, 498, 508	versus MRP, 712-713	assignment method, 743-745
Just-in-time (JIT), 694, 738. See also Lean	obstacles, 718-719	components, 289-290
Operations	overview of, 721	computer solutions, 303-306
	personnel/organizational elements, 706-708	graphical linear programming
Kahn, Salina, 855	preventive maintenance, 251, 715-716,	defined, 292
Kaizen, 412, 428, 695, 697	728-730	feasible solution space, 289, 292, 297
Kaminsky, Philip, 523, 546	process design, 699-706	minimization, 289, 301-302
Kanban, 694, 711-713	product design, 699	objective function, 289-290
Kanbar, Vijay, 825	production flexibility, 702	objective function coefficient change,
Kano, Noriaki, 159	pull systems, 694, 710-711	306–308
Kano model, 159-160	quality improvement, 702	objective function line, 297-300
Kaplan, Robert, 52n	services, 719-720	plotting constraints, 294-296
Kapp, Karl M., 690	setup time reduction, 701, 738	procedures, 292-294
Kasibhatla, Prasad, 516n, 546	six sigma, 28, 429-430, 482-483, 717, 806	redundant constraints, 300
Katz, K. L., 865	supporting goals, 696-698	slack and surplus, 302-303
Keating, Barry, 127	Toyota approach, 694-696	solutions and corner points, 300-301
Kelly, John, 150	versus traditional, 716	models, 289-291
Kenney, Brad, 407	transitioning to, 717-719	sensitivity analysis, 222-224, 306-309
Kerzner, Harold, 825	value stream mapping, 716-717	simplex method, 303
Kilbridge, M. D., 287	vendor relationships, 713-714	transportation model, 386-387, 397-402,
Kiley, David, 415	visual systems, 711-713	626–627
Klammer, Thomas, 455	Lean process design, 245	uses for, 19
Knowledge-based pay, 326-327	Lean production, 28, 329	Linear regression, simple, 94-98
Koch, Christopher, 669, 673	Lean/six sigma, 430	Linear trend equation, 86-89, 109
Koopman, John, 375	Lean supply chains, 516	Liquid, 632
Kowalski, Bill, 431–432	Lean systems, 28–29	List reduction approach, 445
Kumpe, T., 213	Learning curves	Little's Law, 552, 713, 837
	applications of, 361–363	Load charts, 740-741
Labor factors, impact on location decisions,	concept of, 357-361	Load reports, 666-667
379–380	limitations of, 363–364	Loading, 739-745
Labor productivity, 55	Least squares line, 94-95	Local optima, 216
Labor turnover, 58	Leavenworth, Richard, 470, 498	Local priority rules, 746
Laplace, 217-218	Lee, Hau L., 169, 540n, 546	Location planning, 368–396
Larson, B. M., 865	Legal issues	decision making, 31
Larson, Erik W., 783, 808, 825	design of products/services, 136-137	evaluating location alternatives
Larson, Melissa, 825	product liability, 28, 136, 419.	center of gravity method, 388-390
Larson, R. C., 865	UCC, 136	cost-profit-volume analysis, 385-386
Latham, Bill, 690	warranties, 136	factor rating, 387–388
Latham, Hester-Ford, 690	Level capacity strategy, 619-620	transportation model, 386-387, 397-402,
Lauer, Axel, 516n, 546	Level loading, 708-710	626–627
Lawrence, Carol, 455	Liability, 28, 136, 419	factors affecting
Layoffs, 58, 616–617	Lieberman, Gerald J., 318, 865	community considerations, 380-381
Layout of facilities. See Facilities layout	Liebhaber, Richard, 377	multiple plant, 381-382
Lead time	Lientz, Bennett P., 825	regional, 378-380
constant, 579	Life cycle assessment (LCA), 137-138	site-related factors, 381
cumulative, 650	Life cycles	global locations, 372-376
defined, 16, 555–556	decline phase, 144, 197	importance of, 40, 370
stacked, 650	introductory phase, 197	location options, 371

objectives of, 370-371	Managara	
procedures for, 376	Manufacturing	safety stock, 552, 572-573, 661-662
service and retail locations, 383-384	agile, 51	in services, 663
supply chain considerations, 371	craft production, 22	updating the system, 659–660
Locational cost-profit-volume analysis,	employment, 9, 14 Japanese influence on, 25	Materials handling, 253
385–386		Mathematical decision making models, 18
Logistical transactions, 715	lean. See Lean operations	Mathematical techniques, for aggregate planning
Logistics, 512, 531–539. See also	mass production, 23 versus service, 7–10	625-628
Transportation		Mathews, Anna Wilde, 864-865
Long-range plans, 612	Manufacturing cells, 701	Matrix organization, 777–778
Long-term capacity needs, 192, 194	Manufacturing planning and control, 708–716	Matta, Nadim F., 825
Long-term contracts, 527	Manufacturing resources planning (MRP II),	Maturity stage, 143-144, 197
Long-term forecasts, 72	+ 664–665	Maximax, 217
Lot-for-lot ordering, 655–656, 662	Manufacturing systems	Maximin, 217
Lot sizing	assembly lines, 12, 23–24, 241, 250–251	Maximum line length, 847
defined, 662	automation systems, 245–249	Mayo, Elton, 24
economic, 552	cellular, 255–258	McGinnis, Leon F., Jr., 287, 396
versus EOQ, 700–701	computer-aided, 246	McGregor, Douglas, 24
large versus small, 540–541	computer-integrated, 258	McKee, Sandra L., 825
MRP, 662–663	designing for, 154–156	McMahon-Beattie, Una, 68, 213
small, 700–701	flexible, 248, 258–259	McNeil, Gordon H., 140
Lot tolerance percent defective (LTPD), 502	JIT, 694, 738	McNulty, Steven, 153
Love, Stephen, 667	job shop, 239–242	Mean, 11
Lovelock, Christopher H., 169	line balancing. See Line balancing	Mean absolute deviation (MAD), 75-77, 109
Low-level coding, 653	multiple plant location, 381–382	Mean absolute percent error (MAPE),
	robots, 247-248	76 –77, 109
Low-volume system loading, 739–745	sustainable production, 245	Mean control charts, 468-469, 470-472
	MAPE, 76–77, 109	Mean shift, 476
sequence dependent setup times, 754	Mapping, value stream, 716-717	Mean squared error (MSE), 75-77, 109
sequencing, 745–754	Markels, Alex, 377	Mean time between failures (MTBF),
two work centers, sequencing through, 752-753	Market area plant strategy, 382	172–174
	Market test, 151	Measured daywork systems, 324
Lower control limits, 100, 466	Marketing	Measurement, of capacity, 187-189
Lubbers, Sarah, 604	advertising and promotions, 40	Meczkowski, Frank, 152–153
Lumpy demand, 541, 648	forecasting, 72	Meindl, Peter, 546
Lund, Robert T., 139–140	function, 4, 16	Merchantability, 136
Lyne, Jack, 396	influence on competitiveness, 40	Meredith, Jack R., 234, 825
M/D/1, 840-841	order qualifiers/winners, 46	Mergers and acquisitions, 44-45
M/M/1, 839–840	Markets, location decisions and, 379	Methods analysis, 332-336
	Maslow, Abraham, 24	Methods Engineering Council, 344
M/M/S, 841–845	Mass customization, 146-147	Methods-time measurement (MTM), 344-345
Machine productivity, 55 Machine shop, 253	Mass production, 23	Metters, Richard, 772
MAD, 75–77, 109	Massey, Lynn, 726	Meyers, Fred E., 359
Maintenance	Master production schedule (MPS), 631-636,	Microfactory, 381
	650	Micromotion study, 337–338
breakdown, 728–729	Master schedule, 612, 630-636, 650	Milas, Gene H., 287
costs, 728, 730	Material and Information Flow Mapping, 716	Miller, Jeffrey G., 714n
defined, 727	Material requirements planning (MRP),	Milligan, Glenn W., 169
predictive, 730	. 646–690	Mills, Karen, 701
preventive, 251, 715–716, 728–730	benefits and requirements, 663-664	Minimax regret, 217-218
replacement, 731	bill of materials, 650-653, 663	Minimization, 289, 301–302
responsibility of, 13	capacity requirements planning, 666-668	MIS, 17, 72
total productive, 730	closed loop, 665	Mission, 42
Make or buy, 195–196	defined, 648	Mission statements, 42
Make-to-order (MTO), 530	dependent versus independent demand,	Mitchell, Mike, 529
Make-to-stock (MTS), 531	647–648	Mitchell, William E., 426
Makespan, 747-748	DRP, 668	Mitra, Amitava, 498
Malcolm Baldrige National Quality	ERP, 668–676, 717	Mixed model line, 270
Improvement Act, 422	inputs, 650–653	Mixed-model sequencing, 709
Management compensation, 327	inventory records, 653	Models
Management information systems	versus kanban, 712-713	additive, 90-91
(MIS), 17, 72	lot sizing, 662–663	associative, 77
Management science techniques, 24-25	master schedule, 612, 630-636, 650	benefits of using, 19
Mann, David, 726	MRP II, 664-665	decision making, 18-19, 24-25
Mann, Lawrence, Jr., 733	outputs, 661	defined, 18
Mantel, Samuel, 825	overview of, 648-649	finite source, 850–856
Manufacturability, 16, 135, 156	processing, 653-660	infinite source. See Infinite source models

Models—Cont.	Nichols, Ernest L., Jr., 546	Oppenheim, Bohdan W., 455
inventory, 19	Nichols, Karen, 781	Oppenheim, Rosa, 455, 498
Kano, 159-160	Niebel, Benjamin W., 322, 334, 337, 338,	Opportunity costs, 616
limitations of, 19	343, 356	Opportunity losses, 218
linear programming, 289-291	Noise and vibrations, working conditions and,	Optimistic time, 796-798
mathematical, 18	322-323	Optimization, constrained, 288
multiple-priority, 847-850	Nolden, Carol, 733	Order cycles, 552
multiplicative, 90-91	Nonmanufactured goods, 7	Order fulfillment, 523, 530-531
physical, 18	Nonrandom patterns, 476, 479-480	Order qualifiers, 46
project, 19	Nonrandom variation, 464	Order releases, 661
quantitative, 19, 24-25	Nonrepetitive processing, 252-254	Order winners, 46
schematic, 18	Normal distribution, 464	Ordering costs, 556, 561-563
simulation, 627-628	Normal operating conditions, 147	Orders
single-period, 581-585	Normal time, in work measurement, 341-342	back, 616
statistical, 19, 25	North American Free Trade Agreement, 27, 372	duplicate, 615
transportation, 386-387, 397-402, 626-627	Norton, David, 52n	fixed-period, 663
Modular design, 146-147, 699	Numerically controlled (N/C) machines,	process, 520
Monden, Yasuhiro, 726	246–247	Organizational strategies, 43, 52
Monroe, Joseph, 213		Organizations
Montgomery, Douglas C., 498	Objective function, 289-290, 297-300, 306-308	
Moog, Bob, 374	Objectives	accounting function, 17 centralization of, 520-521
Moore, Franklin, 213	facilities layout, 250	competitiveness and, 40–41
Moore, Jeffrey H., 234	inventory management, 552–553	finance function, 4, 15–16, 72
Morrison, Jim, 690	location decisions, 370–371	
Most likely time, 796–798	scheduling, 736	flattening, 28
Motion study, 23, 336-338	Observed time, in work measurement, 341–344	hierarchical, 43–44
Motion study principles, 336-337	OC curve, 501–504	marketing function, 4, 16
Motivation, 12, 24, 329	Occupational Health and Safety Administration,	matrix, 777–778 missions of, 42
Moving assembly line, 23	136	
Moving average, 81-83, 92-93, 109	Occupational Health Care, 323	reasons for failure, 41–42
MPS, 631–636, 650	Occupational Safety and Health Act, 324	Orlicky, Joseph, 690
MRP. See Material requirements planning (MRP)	Office layouts, 260	OSHA, 324
MRP II, 664–665	Offshoring, 425–426	Ott, Ellis, 498
MSE, 75–77, 109	Ohno, Taiichi, 412	Ouchi, William, 24
MTBF, 172–174	On-site inspection, 462–463	Output
Muda, 694		actual, 188–189
Multiple break-even points, 204	Online systems, 554 Operating characteristic (OC) curve, 501–504	examples of, 6
Multiple-channel servers, 832–833		master scheduling process, 633–636
Multiple plant location strategies, 381–382	Operational decisions, 13	MRP, 661
Multiple-priority model, 847–850	Operational processes, 10	tangible, 7
Multiple regression analysis, 98–99	Operations management	Output-based (incentive) system, 324-32
Multiple resources scheduling, 760	careers in, 17	Output constraints, 266
Multiple-sampling plans, 500	decision making and, 12, 18-21, 43-44	Outsourcing
Multiple servers, 841–845	defined, 4	defined, 29
	evolution of, 22–25	hospital services, 213
Multiple-source purchasing, 714	function, 4, 13, 519	of logistics, 537
Multiplicative model, 90–91 Mundel, Marvin E., 356	goods versus services, 7–10, 12	make or buy, 195-196
	influence on competitiveness, 40-41	quality issues, 425-426
Muther, Richard, 273n	interface with other functions, 13, 15–17	reasons for, 48, 58, 133-134
Muther grid, 273–275	Japanese influence on, 25	risks of, 196, 425-426, 515-516
NAETA 27 272	role of managers, 12-14	Overhead costs, 708
NAFTA, 27, 372	scope of, 11–15	Overtime, 617
Naive forecasts, 79–80	service operations, 7–10	Ozgur, Ceyhun, 318, 399n, 402, 865
National Association of Purchasing	transformation process, 5-7	
Management, 521	trends in, 26-32	P-chart, 472-474
National Institute of Standards and	Operations strategy, 31-32, 45, 49-51	P-kanban, 711
Technology, 422	Operations Tour	Packaging, 6
Negative exponential distribution, 834-835	Boeing, 724–725	Paired comparisons, 445
Negotiated purchasing, 361–362	Bruegger's Bagel Bakery, 605	Papadellis, Randy, 529
Net-change system, 659–660	Morton Salt, 243–244	Parallel workstations, 269
Net requirements, 654–655	PSC, Inc., 606-608	Parameter design, 148
Netting, 655	Stickley Furniture, 688–690	Parameters, 290
Network configuration, 517	U.S. Postal Service, 67-68	Parasuraman, A., 413n, 415n
Network conventions, 786–788	Wegmans Food Markets, 32-35	Pareto, Vilfredo, 438
Network (precedence) diagram, 778, 786-788	Wegmans' Shipping System, 532-533	Pareto analysis, 436, 438
	Wegmans' Shipping System, 532-533 Opinions, forecasts based on, 77-78	Pareto analysis, 436, 438 Pareto phenomenon, 21

Part time workers, 617	Dwallath	
Partnerships, 527-529	Predictive maintenance, 730	Production requirements, 156
Patents, 9	Predictor variables, 94	Production systems
Path, 786	Present value (PV), 206	craft, 22
Path probabilities, determining, 799-801	Prevention costs, 420–421	lean, 28, 329
Paulraj, Antony, 546	Preventive maintenance, 251, 715-716, 728-73	0 maintenance of, 727-733
Pay systems, 324-327	Pricing	mass, 23
Payback, 206	competitiveness and, 40	Productivity
Payoff table, 215	demand and, 616	computing, 54-57
PDSA, 433-434, 756	hedging, 552	cost and, 40
Pear, Robert, 418	shadow, 308	defined, 53
Peck, L. G., 851, 854	Primary reports, 661	factors affecting, 57-58
Pegging, 659	Priorities, establishment of, 21	growth, 56-57
Perceived time, 856	Priority rules, 746-752	human resources movement, 24
Performance-control reports, 661	Proactive planning strategies, 616	improving, 51, 58–59
Performance metrics	Probabilistic time estimates, 788, 796-798	measuring, 9
benchmarking, 428, 445-446	Probability distribution, 192–193	quality and, 419
importance of, 539	Problem solving, 432-434, 445, 708. See also	service sector, 57
	Decision making	Profiling, product or service, 245
key measures, 540	Process, 10	Profit Impact of Market State (245)
sequencing, 747–754	Process analysis, 28, 32	Profit Impact of Market Strategy (PIMS), 48
waiting lines, 836	Process capability, 480-485	Program evaluation and review technique
Periodic maintenance, 729	Process charts, 333-335	(PERT), 19, 784–788, 805–806
Periodic orders, 552	Process control, 458	Programmable automation, 246
Periodic system, 553-554	Process design, 699-706	Project, 242
Perpetual inventory system, 554, 571	Process distribution, 464	Project champion, 781
Personnel issues	Process improvement, 28, 32, 434-435	Project life cycle, 776, 782-783
hiring, 616–617	Process layouts, 252-254, 270-275. See also	Project management, 774-825. See also
human resources function, 17, 72	Facilities layout	Scheduling
independent contractors, 617	Process management, 10-11	behavioral aspects, 776-782
layoffs, 58, 616-617	Process plant strategy, location decisions and,	certification, 782
in lean operations, 706-708	382	computing algorithm, 789-796
part time workers, 617	Process selection and design. See also Facilities	crashing, 802-805
salaries/wages, 324-327	layout	critical chain, 806
PERT (Program evaluation and review tech-	automation. See Automation	determining path probabilities, 799-801
nique), 19, 784-788, 805-806	capacity planning. See Capacity planning	deterministic time estimates, 788-789
Pessimistic time, 796–798	defined, 238	ethics of, 780
Peterson, R., 608, 644	process types, 239–244	Gantt charts, 23, 739-740, 778, 784
Physical decision making models, 18	technology, 238–239	key decisions, 778–779
Physical inventory count, 553-554	Process specifications, 151	life cycle, 766, 782-783
Picking system, 259	Process technology, 26, 238	models, 19
PIMS, 48	Process variability, 463–464, 480	multiple projects, 807
Pine, B. Joseph, 169	Process variation, 11	network diagram, 778, 786-788
Pinedo, M., 740, 772		overview of, 778
Pingho, LeRoy, 377	Process yield, 57	PERT and CPM, 19, 784-788, 805-806
Pipeline inventories, 552	Processing costs, 200	probabilistic time estimates, 788, 796-798
Plambeck, Erica L., 615	Processing time, 51	project champions, 781
Plan-do-study-act (PDSA), 433-434, 756	Procurement, 518-521. See also Purchasing	project manager role, 779-780
Planned-order receipts, 654-655	Producer's risk, 467, 502	risk management, 778, 808-809
Planned-order releases, 655	Product and service technology, 26, 238	simulation, 801-802
Planned orders, 661	Product bundle, 160-161	six sigma, 806
Planning fence, 666	Product design. See Design, of products and	slack time, 617, 786, 795-796
Planning horizon, 614	services	software, 807
Planning reports, 661	Product layout, 250-252, 261-270. See also	sources of error, 805-806
Planning time, 51	Facilities layout	virtual teams, 150, 806-807
Plant layout. See Facilities layout	Product liability, 28, 136, 419	work breakdown structure, 778, 783-784
Plant locations Cast and I	Product mix, 194	Project Management Institute (PMI), 17, 780, 78
Plant locations. See Location planning	Product or service profiling, 245	Project management triangle, 780
Plotting constraints, 294–296	Product packages, 6	Project manager, role of, 779–780
Point-of-sale (POS) systems, 555	Product plant strategy, 381	Project slippage, 807
Poisson distribution, 192–193, 474, 503, 834–835	Product specifications, 151	Projected on hand, 654
Poka-yoke, 427, 695, 706	Product structure tree, 650-651	Projects, 776–778
Population source, 832	Deadusting - 4 O	Promotion, 40, 616
Postponement, 146	(POMS), 17	Prototype development 151
Powers, Richard, 374-375	Dead of a new years	Prototype development, 151
Prasad, Biren, 169	Production kanban, 711	Przanyski, Zbigniew H., 455
Precedence diagram, 264, 786-788	Design of the second of the se	Public relations function 17
Predetermined time standards, 344-346	Des dusting and the second	Public relations function, 17
	4	Pull systems, 694, 710-711

Purchase orders, blanket, 520	defined, 457	Duplicate Orders Can Lead to Excess
Purchasing	fail-safing, 427, 706	Capacity, 615
centralized versus decentralized, 520-521	formulas, 486	Dutch Boy Brushes Up Its Paints, 134-135
e-procurement, 26, 524-525	inspection, 258, 458-463	E-Procurement at IBM, 524-525
ethics, 521	Kaizen, 412, 428, 695, 697	Excess Capacity Can Be Bad News!, 186
goals of, 519	lean operations and, 696, 699	Gazing at the Crystal Ball, 106-108
importance of, 518-519	process capability, 480-485	General Mills Turns to NASCAR to Reduc
interfaces, 519-520	six sigma, 28, 429-430, 482-483, 717, 806	Changeover Time, 701
in a JIT system, 714	statistical process control. See Statistical	High Forecasts Can Be Bad News, 75
multiple source, 714	process control (SPC)	Hotels Exploring Easier Customer Check-in
negotiated, 361-362	TQM, 28, 32, 427–434	855–856
responsibility of, 13, 30	Quality function deployment (QFD),	Hyundai: Kissing Clunkers Goodbye,
Purchasing cycle, 519-520	156-159	419–420
Push systems, 710	Quality of conformance, 417, 463	IBM's Supply Chain Social Responsibility,
Pyke, D.F., 644	Quality of design, 416–417	522
Navaras has a stema	Quality of work life, 322–327	Improving Quality and Reducing Risk in
QFD, 156–159	Quality transactions, 715	Offshoring, 426
Qualitative approaches, to forecasting, 77	Quantitative approach	Innovative MCI Unit Finds Culture Shock i
Quality, 404-455. See also Quality control	to decision making, 19, 24-25	Colorado Springs, 377
awards for, 409, 422-424	to forecasting, 77	Less Trash Leaves Landfills in a Bind, 189
Baldrige Award, 422–423	Quantity discounts, 552, 566-571	Making It (Almost) New Again, 139-140
benefits of good, 418	Queue discipline, 835–836	Managing Waiting Lines at Disney World,
certification for, 424-425	Queuing techniques, 19	857
consequences of poor, 418-420	Queuing theory, 829	Medical Mistakes Kill Almost 98,000 a Ye
cost of, 410, 412, 420-421, 484	Quick response, 40	418
defined, 405	D 150 400 400	Motorola Warms Up to Cool Phone Design
determinants of, 416–417	R-charts, 469-472	135–136
dimensions of, 412–415	Radford, G. S., 408	My Compliments to the Chef, er, Buyer, 19
ethics and, 421–422	Radio frequency identification	Nearby Suppliers Match Ford's Mix, 695
evolution of, 408–409	(RFID), 531, 533–536, 555	Need a Systems Approach?, 20
gurus of, 409–412	Ragsdale, Cliff T., 318	NestléUSA and Ocean Spray Form Strategi
ISO, 424–425, 526, 782	Rajan, Murli, 447	Operations Alliance, 529
problem solving, 432–434	Random number table, 348	New Yorkers Do Not Like Waiting in Line. 830
process improvement, 434–435	Random variations, 11, 79–80, 463–464	
responsibility for, 417–418 of services, 9, 12, 41, 413–415	Range control chart, 469–472 Range of feasibility, 308	Not-So-Clear Choices: Should You Export, or Manufacture Overseas?, 374–376
supply chain, 425–426	Range of insignificance, 308	Pedal Pushers, 704–705
tools	Range of optimality, 307	"People" Firms Boost Profits, Study Shows
affinity diagram, 444–445	Raw materials, location decisions and, 378	706
benchmarking, 428, 445-446	Rea, Kathryn P., 825	Product Redesign, Not Offshoring,
brainstorming, 444	Reactive planning strategies, 616, 620-621	Holds Cost Advantage for U.S.
cause-and-effect diagrams, 411, 436,	Readings	Manufacturers, 133–134
439-440	\$\$\$, 550	Productivity Gains Curb Inflation, 51
check sheets, 435-437	The ABCs of ERP, 669-673	Productivity Improvement, 59
control charts. See Control charts	Active RFID vs Passive RFID, 535-536	Project Managers Have Never Been More
5W2H approach, 446	Bar Codes Might Cut Drug Errors in	Critical, 781-782
flowcharts, 435-437	Hospitals, 485	Radio Frequency Identification (RFID) Tag
graphical, 443-444	Benchmarking Corporate Web Sites of	555
histograms, 435-436, 438	Fortune 500 Companies, 447	Recycle City: Maria's Market, 141-143
interviewing, 445	BMW's Strategy: Flexibility, 270	RFID Tags: Keeping the Shelves Stocked, 5
pareto analysis, 436, 438	To Build a Better Hospital, Virginia Mason	Rise of the 3PL, 537
quality circles, 411, 444-445	Takes lessons From Toyota Plants,	Servicing Passenger Planes, 758
run charts, 442	697–698	The Sounds of Quality, 415
scatter diagrams, 436, 438-439	Cadbury Schweppes Describes Its Supply	Springdale Farm, 534
zero defects, 408, 411	Chains, 514-515	Stopped at a Light? Why Not Read This, You
Quality at the source, 428, 463	Challenges of Managing Services, 10	May Have Time, 864-865
Quality-based strategy, 50	In the Chips at Jays, 461-462	Tips For Successful ERP Projects, 675-676
Quality circles, 411, 444-445	Choosing Incentive Plans, 326	The Top 10 ERP Mistakes, 674-675
Quality control, 455-498	Continuous Improvement on the Free-Throw	Tour de Force, 248-249
acceptance sampling. See Acceptance	Line, 440–442	Universities Embrace Sustainability, 27
sampling	CPFR: An Overview of the Model, 528	Vlasic on a Roll with Huge Pickle Slices,
airline industry, 12	Curb Inflation, 51	152-154
approaches to, 458	Design as a Business Strategy, 132	Vying for Patients, Hospitals Think Location
autonomation, 702	Designing Supermarkets, 261	Location, 384
continuous improvement, 428, 440-442,	Desperately Seeking E-Fulfillment, 524	What Keeps Six Sigma Practitioners Up at
707–708	Do You Want Pickled Beets With That?, 150	Night?, 431–432

Whatever Happened to Quality?, 406-407	Ross, S. M., 498	Called to the second
Where to Put the New Store?, 383	Rothrock, Dorothy, 14	Schlesinger, Leonard A., 169
Why Manufacturing Matters, 14	Rough-cut capacity planning, 632	Schmidt, C. P., 234
Why Productivity Matters, 56	Row reduction, 743	Scholz, Alan, 704–705
Xerox Diverts 2 Billion Pounds of Waste, 141	Rowe, G., 127	Scholz, Hanz, 705
Receiving function, 519	Roy, David M., 455, 726	Schragenheim, Eli, 201, 213, 546, 690
Record keeping, 586	Run, 477	Schroeder, Richard, 455
Recycling, 141-143, 189	Run chart, 442	Science of management, 22-24
Reddy, Ram, 106-108	Run size, of jobs, 738	Scientific management, 22-24, 328, 408
Redesign of products, 132-134. See also Design,	Run tests, 476-479	Scott, Gerald, 248, 249
of products and services	Rusche, Chris, 604	Scrap rates, 58
Reduce, 138	Rush, 746	Seasonal demand patterns, 192-193, 198-199
Reduced transaction processing, 714-715	Rusii, 740	Seasonal indexes, 91
Redundancy, 171	S/O (Shalt	Seasonal inventories, 552
Redundant constraints, 300	S/O (Slack per operation) rule, 746, 751	Seasonal relative, 91-93
Redundant systems, 809	Sabolik, Jerome, 377	Seasonal variations, 79-80, 90-93, 192-193
Reengineering, 725	Safety, 58, 323–324	Seasonality, 79-80, 90-93
Regenerative system, 659-660	Safety stock, 552, 572-573, 661-662	Sebastianelli, Rose, 447
Regional factors, location decisions and, 378–380	Salaries/wages, 324–327	Secondary reports, 661
Regression, 94–99	Salegna, Gary, 431n, 455	Self-directed teams, 329-330
Regret (opportunity loss), 218	Sales and operations planning, 611. See also	Sensitivity analysis, 222-224, 306-309
	Aggregate planning	Sequence dependent setup times, 754
Relative costs, 745	Sales systems, point-of, 555	Sequencing, 745-754, 745-754
Reliability, 147-148, 170-182	Salesforce opinions, used to forecast, 78	Sequential decisions, 219
Remanufacturing, 138-139	Sampling, 325, 346-350. See also Acceptance	Sequential relationships, 786
Reneging, 835	sampling	Servers, numbers of, 832–833
Reorder points, 571–578	Sampling distribution, 464	Service, 160
Repetitive processing, 240–242, 250–252	Sampling plans, 500-501	Service blueprint, 162-164
Replacement maintenance, 731	Samuel, Donna, 726	Service delivery system, 160
Requisition, 520	Sasser, W. Earl, Jr., 169	Service design, 160-164. See also Design,
Research and development (R&D), 152	Scanning, environmental, 46	of products and services
Reservation systems, 757	Scatter diagrams, 436, 438-439	Service layouts, 259–260
Response time, 51, 541-542	Schardt, David, 261	Service level, 572–573, 575–578
Retail sector	Schedule chart, 741-742	Service package, 161
layout, 259	Scheduled receipts, 654	Service patterns, 833–835
location planning, 383-384	Scheduling, 734-772	
Return on investment (ROI), 550	airline industry, 12	Service profiling, 245 Service technology, 238
Return on quality, 421	appointment system, 757	
Returns, management of, 537-539	assignment model, 743-745	Serviceability, 135
Reuse, 138-139	backward, 741	Services
Revenue management, 28, 32	benefits, 736	aggregate planning, 628-630
Reverse engineering, 152	cyclical, 759–760	airline industry, 11–12
Reverse logistics, 538	defined, 735	capacity planning, 194-195
Rework costs, 421	flow-shop, 736–737	challenges, 10
RFID, 531, 533-536, 555	forward, 741	defined, 4
Rich, Nick, 726		designing for, 160–164
Right-hand side (RHS) change, 308-309	Gantt charts, 23, 739-740, 778, 784	employment in, 9, 14
Right-sized equipment, 256	high-volume systems, 736–738	ERP, 674
Risk	Hungarian method, 743	facilities layout, 259-260
decision making under, 218-219	intermediate volume systems, 738–739	inspection points, 460-461
defined, 216	job shops/low-volume system	in lean operations, 719-720
globalization, 373–374	loading, 739–745	location planning, 383-384
management of, 516, 778, 808-809	sequence dependent setup times, 754	versus manufacturing, 7–10
of outcoursing 106 426 426 515 516	sequencing, 745-754	measuring productivity in, 9
of outsourcing, 196, 425–426, 515–516 Risk management, 542	two work centers, sequencing through,	MRP, 663
	752–753	operations activities, 11-12
Ritter, Diane, 455	master, 612, 630-636, 650	outsourcing, 213
Roach, Stephen, 68	multiple resources, 760	productivity, 57
Robinson, Alan, 446	objectives of, 736	quality of, 9, 12, 41, 413-415
Robot, 247-248	problems with, 191, 737, 754-755	scheduling of, 756-760
Robust design, 148	reservation system, 757	SERVQUAL, 415
Rodrigues, Jorge Nascimento, 697n	service-systems, 756-760	Setrakian, Scott, 375
ROI, 550	theory of constraints, 755-756	Setup costs, 738
Rolling horizon, 614, 659	time fences, 632-633, 666	Setup time
Romig, H. G., 25, 408	workforce, 758-759	reduction of, 701, 738
Roos, Daniel, 37, 694, 726	yield management, 28, 72, 630, 757	sequence dependent, 754
Ross, D. F., 68	Schematic decision making models, 18	Shadow price, 308
Ross, Joel E., 455	Scherkenbach, W. W., 455	Shafer, Scott M., 825
		WANTED WANTED THE OLD

		20 CO
Sheffi, Yossi, 546	Spreadsheets, used in aggregate planning,	organizational, 43, 52 quality-based, 50
Shewhart, Walter, 25, 409, 465	621-625	reasons for failure, 48
Shewhart cycle, 433	SPT (shortest processing time), 746-751	technology changes and, 46, 57–58
Shingo, Shigeo, 412, 701, 726	Stacked lead time, 650	time-based, 50–51
Shinn, Sharon, 37	Stalk, George, Jr., 68	Strengths, weaknesses, opportunities, and threa
Shipping, evaluating alternatives, 536-537	Standard deviation, 11	(SWOT), 46
Short-range plans, 612	Standard elemental times, 344	
Short-term capacity needs, 192	Standard error of estimate, 96-97	Structural variation, 11
Short-term forecasts, 72	Standard parts, 699	Subcontracting, 618
Shortage costs, 556, 582	Standard time, 339, 341-343	Suboptimization, 215–216
Shortages, 575–578	Standardization, 23-24, 58, 144-145, 699	Substitutability, of parts, 156
Shortest processing time (SPT), 746–751	Standards, 191	Summers, Donna, 433, 455, 498
	Stanley, Linda L., 37	Supplier forums, 527
Shulman, L. E., 68	Stanton, Steven, 68	Supplier-managed inventory, 530, 720
Silver, E. A., 608, 644	Starling, Stephen, 546	Supplier relationship management, 527
Silverstein, Judith, 524, 546	States of nature, 214	Suppliers
Simchi-Levi, David, 523, 546	Static sequencing, 746	analysis of, 526
Simchi-Levi, Edith, 523, 546	Statistical models, 19, 25	audits, 526
Simo chart, 338	Statistical process control (SPC), 463-480	certification of, 526, 713
Simple linear regression, 94-98	control charts	JIT systems, 713-714
Simplex method, 303	attributes, 468, 472–475	management of, 525-529
Simulation, project management and,	defined, 99, 436, 439, 465	partnerships with, 527-528
801-802		quality and, 428
Simulation models, 627-628	errors, 466–467, 502	relationships with, 527, 713-714
Simultaneous chart, 338	forecasting, 99–100	selection of, 520, 525-526
Simultaneous development, 154	mean, 468-469, 470-472	sole source, 714
Singhal, Vinod R., 455	nonrandom patterns, 476, 479-480	tiers of, 714–715
Single-channel servers, 832-833	process, 465-468	world class, 526
Single-minute exchange of die (SMED),	range, 469-472	
255-256, 701	run tests, 476-479	Supply chain
Single-period model, 581-585	for variables, 468-472	capacity planning and, 191
Single-sampling plans, 500	when to use, 475-476	closed loop, 539
Single server	control process, 465	defined, 4, 511
constant service time, 840–841	defined, 463	global, 27, 29, 516-517
exponential service time, 839–840	process variability, 463-464, 480	quality and, 425-426
Sipper, Daniel, 644	Statistical quality control, 409	Supply chain management, 510-546. See al.
Site related location factors, 381	Steinberg, Neil, 461-462	Purchasing
Six sigma, 28, 429–430, 482–483, 717, 806	Step costs, 204	challenges, 540-542
	Stevens, Tim, 704-705	CPFR, 528.
Slack, 302-303, 786, 808	Stevenson, William J., 234, 318, 399, 402, 455,	creating effective, 539-542
Slack per operation rule, 746, 751	825, 865	defined, 512
Slack time, 617, 786, 795–796	Stocking levels, 582–585	e-business, 26, 29, 522-525
Slater, Derek, 669, 690	Stockouts, 552, 572–573, 580–581	electronic data interchange, 524
Slushy, 632	Stokes, Andrew, 249	elements of, 30-31
Small business, 542	Stopwatch time study, 339–344	global, 27, 29
SMED, 255–256, 701		goals of, 513-514
Smith, Adam, 24	Storage, 703–704	importance of, 29-30
Smith, Bernard T., 85, 86n	Storage layouts, 259	location planning, 371
Smith-Daniels, Dwight, 825	Straight piecework, 325	logistics, 512, 531–539
Smoothing, exponential, 83-85, 109	Strategic buffering, 530	management responsibilities, 517-518
Snee, Ronald D., 455, 726	Strategic partnerships, 529	outsourcing. See Outsourcing
Snook, David M., 139-140	Strategic sourcing, 539	purchasing and, 519–520
Sodhi, ManMohan S., 455, 726	Strategies	requirements for success, 539-540
Sodhi, Navdeep S., 726	Balanced Scorecard, 52-53	
Soft information, 77	comparison of, 49	reverse logistics, 538
Sole source suppliers, 714	defined, 43	RFID, 531, 533–536, 555
Solutions and corner points, 300-301	examples of, 45	strategy alignment, 517
Sourcing, strategic, 539	external factors, 46	supplier management, 525-529
Sower, Victor E., 772	formulation of, 44-48	trends, 515-516
S&P Index, 423	functional, 43	value chains, 513
Span-of-control, 216	global, 48	Supply chain visibility, 539
SPC. See Statistical process control (SPC)	goals, 42	Supporting processes, 10
Secondary Mark I 127 608 644 600	growth, 48	Surplus, 302-303
Spearman, Mark L., 127, 608, 644, 690,	implications of, 52	Surveys, consumer, 78
726, 772	internal factors, 46–47	Sustainability, 27, 44, 137-143, 516
Special variation, 464	marketing, 40	Sustainable production, 245
Specialization, 328	mission, 42	Sutton, Margaret, 825
Specifications, 151, 480	operations, 31–32, 45, 49–51	Swank, Cynthia Karen, 726
Spence, Randy, 153	operations, 31-32, 13, 13 31	

SWOT analysis, 46	The 1 of 20 to 20 to 1	
System, 20	Time reduction, 28, 32, 50–51	Uneven demand, meeting, 618-621
System design, 13. See also Process selection	Time series, 78	Uniform Commercial Code, 136
and design	Time series data, forecasting using	U.S. China Trade Relations Act, 372
System nervousness, 666	averaging, 80–85, 92–93, 109	Universal Product Code (UPC), 554
System operation, 13	cycles, 79–80, 94	Upper control limits, 100, 466
System utilization, 837	defined, 77	Upper-management processes, 10
Systems approach, to decision making, 20–21	exponential smoothing, 83-85, 109	Upton, David, 213, 287
eystems approach, to decision making, 20-21	irregular variations, 79-80	Utilization, capacity, 188-189
Tactical decisions, 13	naive method, 79-80	
Tactics, 43	random variations, 79-80	Value-added, 6-7
Taghizadegan, Salman, 455, 726	seasonality, 79-80, 90-93, 192-193,	Value analysis, 138
Taguchi, Genichi, 148, 412, 484	198–199	Value chains, 513
Taguchi cost function, 484–485	trend, 79-80, 86-89	Value stream mapping, 716-717
Taguchi loss function, 412	trend-adjusted exponential smoothing,	Van Wassenhove, Luk N., 546
Takt time, 702-703	89–90	Vargus, Vicente, 772
Talbott, John C., 772	Time-series forecasts, 77	Variability, 463-464, 480, 541
Tamimi, Nabil, 447	Time studies, 339–344	Variable costs, 202, 385-386
	Time-to-market, 40	Variable demand, 579
Tangible output, 7	Time value of money, 206	Variables
Tariffs, 27	Timing, 194	causal, 77
Taxes, impact on location decisions, 380	Tippett, L. H. C., 25	charts for, 468-472
Taylor, Bernard W., 234, 318	Tolerances, 480	decision, 289–290
Taylor, Frederick Winslow, 22-23, 328,	Total-cost curve, 567-569	defined, 468
331, 408	Total cost of ownership (TCO), 385-386, 671	explanatory, 77
Teams	Total productive maintenance, 730	leading, 94
benefits of, 330	Total quality management (TQM), 28, 32,	
forms of, 329–330	427-434. See also Quality	predictor, 94 Variations
keys to success, 330	Toyota approach, 694-696	
problem solving and, 428	Toyota Production System (TPS), 407, 705	assignable, 11, 464
for process improvement, 695	Toyota Way Principles, 427	in demand, 614
self managed/directed, 329-330	TQM, 28, 32, 427–434	irregular, 79–80
virtual, 150, 806-807	Tracking capacity strategy, 191	nonrandom, 464
Technological innovation, 238	Tracking signal, 101–103, 109	process, 11
Technology. See also Internet	Trade agreements, 372	random, 11, 79-80, 463-464
acquisition of, 239	Trade-offs, 20, 540–541	seasonal, 79-80, 90-93, 192-193
changes in, 46, 57-58	Traffic management 524	Velocity, 529-530
competitive advantage, 239	Traffic management, 531	Vendor analysis, 526
defined, 26, 238	Training, 269, 707	Vendor-managed inventory (VMI), 530, 720
forecasting, 78	Transaction processing, reduction of, 714–715	Ventilation, 322
kinds of, 238–239	Transformation process, 5-7	Vertical loading, 329
management of, 26-27	Transportation	Vertical skills, 327
product design, 133	costs, 272-273, 373, 378, 515, 541, 715	Vicente, Kim, 169
productivity improvements and, 57–58	cross-docking, 516, 541	VICS, 528
Temperature and humidity, 322	facilities layout, 272–273	Villa, A., 644
Temporary workers, 856	logistics, 512, 531–539	Virtual project teams, 150, 806-807
Tenby, Susan, 331	model, 386-387, 397-402, 626-627	Vision statements, 42
Teplitz, Charles T., 367	Transportation table, 628	Visual inspection, 258
Ternicko, John, 169	Trend, 79-80, 86-89	Visual systems, 711–713
	Trend-adjusted exponential smoothing,	Volatility, of demand, 194-195
Terrorism, 373	89-90	Vollman, Thomas E., 644, 690, 696, 714n, 726,
Theory of constraints, 755-756	Trend patterns, 475	752n, 772
Theory X, Y, Z, 24	Trial-and-error techniques, 621-625	
Therbligs, 337	Trust, in management, 329	Wages/salaries, 324-327
Third-party logistics, 537	Turban, Efraim, 234	Wait-and-see strategy, 207
Three-sigma, 483	Turnover	Waiting lines, 828–865
Throughput, 756	of inventory, 553	analysis of, 206
Time-based competition, 612	of labor, 58	arrival and service patterns, 833-835
Time-based strategy, 50-51	Two-bin system, 554, 712	characteristics of, 832–836
Time-based system, 324–325	Two work centers, sequencing jobs through,	constraint management, 856
Time buckets, 653	752–753	cost analysis, 845–846
Time estimates	Type I error, 466-467, 502	finite-source models, 850–856
deterministic, 788-789	Type II error, 467, 502	goals of management of, 831–832
probabilistic, 788, 796-798		infinite source models
Time fences, 632-633, 666	U-shape layouts, 252	
Time horizon, 73	UCC, 136	basic relationships, 837–839
Time-ordered plot, 465	Ulrich, Karl T., 169	multiple priorities, 847–850
Time-phased requirements, 653	Uncertainty, 216, 217-218, 541	multiple servers, 841–845
		single server, 839-841

Waiting lines-Cont. managerial implications of, 830 maximum line length, 847 performance measures, 836 psychology of, 856-857 queue discipline, 835-836 queuing systems, 832-833 queuing theory, 829 reasons for, 830 Ward, Stephen, 825 Ware, Norman, 644 Warehousing, 259 Warranties, implied, 136 Waste, in JIT, 697 Weatherford, Larry R., 234 Webster, Scott, 546 Weighted average, 83 Weightman, Clive, 674-675 Weinstein, Bob, 781 Wester, L., 287 Wheatley, Malcolm, 690 Wheeler, John, 273n Wheelwright, S., 242 White, John A., 287, 396 White noise, 80

Whitney, Eli, 23

Whybark, D. Clay, 644, 690, 696, 726, 772 Wicks, Jim, 136 Wiesenborn, Gary, 377 Wight, Oliver W., 690 Wilkerson, Ella Mae, 154 Wilson, J. Holton, 104, 127 Winebrake, James J., 516n, 546 Wisner, Joel D., 37 Womack, James P., 37, 694, 726 Woolsey, Gene, 550 Work breakdown structure (WBS), 778, 783-784 Work breaks, 323 Work design, 320-327 behavioral approaches, 328-329 compensation, 324-327 ergonomics, 330-332 human relations movement, 24 methods analysis, 332-336 motion study, 23, 336-338 motivation, 12, 24, 329 specialization, 328 teams. See Teams working conditions, 322-324 Work-in-process inventory, 551, 703, 713

Work measurement. See also Job design defined, 339 predetermined time standards, 344-346 standard elemental times, 344 standard time, 339, 341-343 stopwatch time study, 339-344 Work sampling, 325, 346-350 Work system design. See Job design Worker-machine chart, 335 Workers, as assets, 706 Workforce scheduling, 758-759 Working conditions, 322-324 Workstation, 262, 269, 745 World class suppliers, 526 Wright, G., 127 x-bar chart, 468-469

Yang, Kai, 455 Yeoman, Ian, 68, 213 Yield management, 28, 72, 630, 757

Zeithhaml, Valarie A., 413n, 415n Zero defects, 408, 411 Zipkin, Paul H., 608, 726 Zucco, James, 377