## Contents

Foreword ................................................................. xxv
Preface ................................................................. xxvii
Preface to First Edition ........................................... xxix
Acknowledgments ...................................................... xxxiii
Prologue: A Day in the Life—May 10, 2020 ................... xxxv
  Bill, Mechanic at Delta Ray, Inc., No Planning ............... xxxv
  Sue, Supervisor at Zebra, Inc., No Planning .................. xxxvii
  Juan, Welder at Alpha X, Inc., Has Planning ................. xxxvii
  Jack, Planner at Johnson Industries, Inc. ..................... xxxviii
  Charles, Predictive Maintenance Technician  
    at Beta X, Inc., No Scheduling .............................. xxxix

1 The Business Case for the Benefit 
   of Planning (Why Do Planning?) .............................. 1
  Company Vision ..................................................... 1
  Why Improvement Is Needed in Maintenance ................. 3
  What Planning Mainly Is and What It Is Mainly Not 
    (e.g., Parts and Tools) ........................................... 4
  Increase Your Workforce Without Hiring ..................... 7
    Case Study: The Practical Result of Planning 
      Is Freed-Up Technicians ....................................... 8
    “World Class” Wrench Time ..................................... 8
    The Specific Benefit of Planning Calculated 
      for Labor Only .................................................. 11
    The Specific Benefit of Planning Calculated 
      beyond Labor: The Ultimate Benefit ....................... 12
  Plant Staffing Level .............................................. 14
  Why Does This Opportunity Exist? ............................ 15
  Quality and Productivity: Effectiveness and Efficiency .... 20
  Planning Mission .................................................. 21
  Frustration with Planning ....................................... 22
  W. Edwards Deming ................................................ 22
  Peter F. Drucker ................................................... 24
  Summary ............................................................ 24
Overview of the Chapters and Appendices .................... 24
## Contents

### 2 Planning Principles (What Makes Planning So Frustrating and What Makes It Work?)
- The Planning Vision: The Mission ........................................... 29
- Principle 1: Separate Group .................................................. 31
  Illustrations ................................................................. 35
- Principle 2: Focus on Future Work ........................................ 36
  Institutionalizing Plant Knowledge ...................................... 41
  Emergencies ...................................................................... 42
  Case Study: Insist on Using the Job Plan Module .................. 42
  Illustrations ..................................................................... 43
- Principle 3: Component Level Files ....................................... 44
  Illustrations ..................................................................... 48
  Caution on Computerization .............................................. 50
- Principle 4: Estimates Based on Planner Expertise ............... 51
  Illustrations ..................................................................... 58
- Principle 5: Recognize the Skill of the Crafts ....................... 60
  Illustrations ..................................................................... 67
- Principle 6: Measure Performance with Work Sampling ......... 69
  Illustrations ..................................................................... 72
- W. Edwards Deming ............................................................ 73
- Peter F. Drucker ................................................................. 76
- Planner Liability ............................................................... 77
- Summary ......................................................................... 79
- Case Study: Plant with Only Planning .................................. 80

### 3 Scheduling Principles (Why Do We Have to Do Scheduling and What Makes It Work?)
- Why Maintenance Does Not Assign Enough Work ............. 83
- Advance Scheduling Is an Allocation ................................... 87
- Principle 1: Plan for Lowest Required Skill Level ............... 90
  Illustrations ..................................................................... 93
- Principle 2: Schedules and Job Priorities Are Important ....... 94
  Illustrations ..................................................................... 95
  Case Study: New Supervisor ............................................. 96
  Case Study: Honoring the Schedule .................................. 97
- Principle 3: Schedule from Forecast of Highest Skills Available ................................................................. 98
  Illustrations ..................................................................... 101
- Principle 4: Schedule for Every Work Hour Available ....... 102
  Illustrations ..................................................................... 105
- Principle 5: Crew Leader Handles Current Day's Work ....... 106
Peters and Waterman, *In Search of Excellence*, "Tight and Loose" ............................... 110
Illustrations ........................................ 110
Principle 6: Measure Performance with Schedule Compliance .................. 111
Illustrations ........................................ 116
W. Edwards Deming .................................. 117
Peter F. Drucker .................................... 118
Summary .............................................. 119
Case Study: Plant with Planning Plus Scheduling ................................. 120

4 **Success Only After Dealing with Reactive Maintenance**  
(What If Something Breaks?) ........................................ 121
Proactive versus Reactive Maintenance ..................................... 122
Extensive versus Minimum Maintenance ................................... 127
What Kind of Job Plan Is That!?! ..................................... 128
Case Studies Illustrating Actual Industry Successes ......................... 129
  Case Study: Electric Utility ..................................... 129
  Case Study: Chemical Plant ..................................... 132
  Case Study: Food Processing ..................................... 136
  Case Study: Facilities 1 ..................................... 138
  Case Study: Facilities 2 ..................................... 139
  Case Study: Paper Mill ..................................... 140
  Case Study: Wastewater Treatment Plant ................................ 141
W. Edwards Deming ........................................ 142
Peter F. Drucker ........................................ 142
Summary .............................................. 142

5 **Basic Planning (Let's Plan a Work Order)** ................................. 145
A Day in the Life of a Maintenance Planner ................................ 145
Work Order System ........................................ 148
Planning Process ........................................ 151
Work Order Form ........................................ 153
Coding Work Orders ......................................... 155
Using and Making a Component Level File ................................ 158
Scoping a Job .............................................. 160
Troubleshooting ........................................... 161
  Performance Testing or Engineering ................................ 162
  Illustrations ............................................ 163
Engineering Assistance or Reassignment .................................. 164
Developing Planned Level of Detail, Sketching and Drawing ................ 165
## Contents

W. Edwards Deming and Peter F. Drucker on Quotas, Benchmarks, and Standards ........................................... 264
Summary .............................................................................. 267

### 7 Daily Scheduling and Supervision
(What Should the Supervisor Be Doing?) ................................ 269
A Day in the Life of a Maintenance Supervisor .................. 269
Assigning Names .............................................................. 273
Coordinating with the Operations Group ...................... 280
Handing Out Work Orders ............................................... 282
During Each Day ............................................................ 284
Avoiding Common Pitfalls That Wreck the Schedule .... 286
W. Edwards Deming and Peter F. Drucker on Supervision .. 287
Summary .............................................................................. 288

### 8 Forms and Resources Overview (Tools That Planners Use) .... 289
Forms ............................................................................. 290
   Deficiency Tags ........................................................... 291
Resources ......................................................................... 300
   Component Level Files—Minifiles ............................... 300
   Equipment History Files
      (Including System Files and Minifiles) .................. 304
   Technical Files ............................................................. 307
   Attachment Files .......................................................... 308
   Vendor Files ................................................................. 308
   Equipment Parts Lists .................................................. 309
   Standard Plans .............................................................. 309
   Lube Oil Manual ............................................................ 312
   MSDS ........................................................................ 312
   Plant Schematics .......................................................... 313
   Rotating or Critical Spares Program ........................... 313
Security of Files ............................................................... 315
Summary .............................................................................. 315

### 9 The Computer in Maintenance
(How Computers Can Help and Hinder Planning) ............ 317
A Day in the Life of a Maintenance Planner (Using a CMMS) . 318
The Planner Must Use the CMMS Job Plan Module .......... 322
What Type of Computerization ....................................... 324
   Software Already in Use .............................................. 324
   Single User or Larger Network ................................... 325
Creating versus Purchasing a Commercial CMMS .................. 325
Interfacing a CMMS with a Company Financial System ........ 326
Benefits with the CMMS ........................................... 326
Standardizing Work Processes ................................... 327
Inventory Control ................................................. 327
Information for Metrics and Reports .............................. 328
Finding Work Orders ............................................. 328
Linking Information to Equipment ................................. 330
Common Database .................................................. 330
Scheduling ........................................................... 330
PM Generation ....................................................... 330
Problem Diagnosis and Root Cause Analysis Support .......... 331
Cautions with the CMMS .......................................... 331
Faulty Processes .................................................... 331
Reliability and Speed .............................................. 332
Data Protection ..................................................... 332
Improper Costing ................................................... 333
Employee Evaluations ............................................ 333
Goldfish Bowl ....................................................... 333
Unnecessary Metrics ................................................ 334
Eliminate Paper? .................................................... 334
Jack of All Trades, Master of None ............................... 335
Artificial Intelligence .............................................. 336
Templates ........................................................... 336
User Friendly ......................................................... 336
Cost and Logistics .................................................. 337
Selection of a CMMS ................................................. 338
Team ................................................................. 338
Process ............................................................... 338
Specific Planning Advice to Go Along with a CMMS ........... 340
Advanced Helpful Features for Planning and Scheduling .... 341
Summary ............................................................. 342

10  How Planning Interacts with Preventive Maintenance,
    Predictive Maintenance, and Project Work ................. 343
Preventive Maintenance and Planning ............................. 343
Predictive Maintenance and Planning ........................... 348
Project Work and Planning ....................................... 350
    Taking Over Contractor Project Work ....................... 350
    Helping Engineering Without Losing Planning ............ 351
11 Control (How Do We Control Planning Itself and What Are Associated KPIs for Planning and Overall Maintenance?) ................................................................. 353
Organization Theory 101: The Restaurant Story ........................................ 353
Selection and Training of Planners ............................................................ 356
Key Process Indicators (KPIs) .................................................................. 358
  Overall Plant Performance ................................................................. 358
  Proactive versus Reactive ................................................................. 360
  Reactive Work Hours ....................................................................... 361
  Work Type ....................................................................................... 362
  Six Sigma Application of “Function Reasoning” ................................. 363
KPIs for Scheduling (Is Scheduling Working?) ........................................ 364
  Schedule Compliance (or Success) and Labor Forecast .................... 365
  Wrench Time ..................................................................................... 369
  Work Orders Completed ................................................................... 370
  Backlog Management ....................................................................... 370
  Backlog Work Hours ....................................................................... 371
  Case Study: Backlog Management .................................................... 372
KPIs for Planning (Is Planning Working?) ................................................ 374
  Planned Coverage ........................................................................... 374
  Minifiles Made ................................................................................. 375
  Defect Work Orders That Wreck Planning ....................................... 376
  Helpful Feedback ............................................................................. 377
Summary ............................................................................................... 378

12 Shutdown, Turnaround, Overhaul, and Outage Management .............. 379
Different Types of Outages .................................................................... 380
The Changing Nature of Outages over Time as Reliability Improves .... 381
Planning Individual Work Orders for Outages ....................................... 382
Moving from Weekly Maintenance to Outage Maintenance ................. 382
Accuracy of Task Estimates .................................................................. 383
Cycle of Improvement: The Outage Report .......................................... 385
  Good Libraries ................................................................................. 386
  Notebooks and Checklists ............................................................... 386
  Meetings and Critiques .................................................................. 387
  Project Closeout Reports ............................................................... 387
Controlling the Scope of Outages ......................................................... 388
  Knowing Purpose ............................................................................ 388
  Outage Strategies .......................................................................... 389
When to Start Planning Outages .................... 390
Handling Discovery Work ......................... 391
Beware Routine Rebuilds ......................... 392
Preventive Maintenance Tips .................... 393
Tool: Work Breakdown Structure ................ 393

Elements of the Outage Organization .......... 394
Essentials of the Shutdown Manager Role ........ 394
Processes Needing Identification and Mistakes to Avoid .... 394
Contractors .................................... 395
Computerized Maintenance for Outages ......... 396
Maintenance Crew Supervisors .................. 397
Planners ...................................... 397
Operations .................................... 398

Defining Outage Success ......................... 398

13 Conclusion: Start Planning .................... 401
Why Do Companies Need Maintenance Planning? .... 401
WIIFM (What’s in It for Me?) .................... 403
What’s in It for Me if I’m a Technician? ........ 403
What’s in It for Me if I’m a Supervisor over a Crew? ... 404
What’s in It for Me if I’m a Maintenance Manager? ... 404
What’s in It for the Company? ................... 405

Bill, Mechanic at Delta Ray, Inc. .................. 407
Sue, Supervisor at Zebra, Inc. .................... 408
Juan, Welder at Alpha X, Inc ...................... 409
Jack, Planner at Johnson Industries, Inc .......... 410
Charles, Predictive Maintenance Technician at Beta X, Inc .... 411

A Planning Is Just One Tool; What Are the Other Tools Needed? ... 413
Work Order System ............................. 416
Equipment Data and History ..................... 420
Leadership, Management, Communication, Teamwork (Incentive Programs) ... 422
Qualified Personnel ............................. 428
Classification ................................ 429
Hiring ...................................... 430
Training .................................... 430
B The People Side of Planning ........................................... 455

The People Rules of Planning ......................................... 456

Rule 1: The Planning Program Is Not Trying to
Give Away the Plant's Work to Contractors .................. 456
Rule 2: Planners Cannot Plan the Perfect Job .......... 456
Rule 3: Planning Is Not Designed to Take the Brains
Out of the Technicians ............................................ 457
Rule 4: The Technicians Own the Job after the Supervisor
Assigns It to Them ................................................. 457
Rule 5: Planners Cannot Make the Perfect Time Estimate 458
Rule 6: Management Cannot Hold Technicians Accountable
to Time Estimates for Single Jobs ............................. 458
Rule 7: Showing What Is Not Correct Is Often as Important
as Showing What Is Correct .................................... 459
Rule 8: Planners Do Not Add Value if They Help
Jobs-in-Progress ......................................................... 459
Rule 9: Everyone Is an Adult ..................................... 459
Rule 10: Everyone Should Enjoy Their Work .......... 460
Rule 11: Everyone Should Go Home at the End of
Each Day Knowing if They Have Won or Lost .......... 461
Rule 12: Wrench Time Is Not Strictly under the Control
of the Technicians .................................................. 462
Rule 13: Schedule Compliance Is Not Strictly under
the Control of the Crew Supervisors ............... 462
Rule 14: It Is Better to Train Employees and Lose Them
Than to Not Train Them and Keep Them .............. 463
Rule 15: Modern Maintenance Needs to Do Less with Less 463

Summary ................................................................. 464

C What to Buy and Where ............................................. 465

Minifile Folders ....................................................... 465
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Minifile Labels</td>
<td>465</td>
</tr>
<tr>
<td>4</td>
<td>Miscellaneous Office Supplies</td>
<td>466</td>
</tr>
<tr>
<td>4</td>
<td>Equipment Tags</td>
<td>466</td>
</tr>
<tr>
<td></td>
<td>Recommended Tag Sizes and Colors</td>
<td>467</td>
</tr>
<tr>
<td>4</td>
<td>Wire to Hang Tags on Equipment</td>
<td>468</td>
</tr>
<tr>
<td>4</td>
<td>Deficiency Tags</td>
<td>468</td>
</tr>
<tr>
<td>4</td>
<td>Shop Ticket Holders</td>
<td>468</td>
</tr>
<tr>
<td>4</td>
<td>Open Shelf Files</td>
<td>469</td>
</tr>
<tr>
<td>4</td>
<td>CMMS</td>
<td>469</td>
</tr>
<tr>
<td>5</td>
<td>Sample Forms and Work Orders</td>
<td>471</td>
</tr>
<tr>
<td>6</td>
<td>Overview of Duties for Planners and Others</td>
<td>499</td>
</tr>
<tr>
<td></td>
<td>Maintenance Planner</td>
<td>499</td>
</tr>
<tr>
<td></td>
<td>New Work Orders</td>
<td>499</td>
</tr>
<tr>
<td></td>
<td>Before Job Scheduling</td>
<td>500</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance Scheduler</td>
<td>504</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance Planning Clerk</td>
<td>505</td>
</tr>
<tr>
<td>6</td>
<td>Operations Coordinator or Gatekeeper</td>
<td>505</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance Purchaser or Expediter</td>
<td>506</td>
</tr>
<tr>
<td>6</td>
<td>Crew Supervisor</td>
<td>506</td>
</tr>
<tr>
<td>6</td>
<td>Planning Supervisor</td>
<td>507</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance Manager</td>
<td>508</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance Planning Project Manager</td>
<td>508</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance Analyst</td>
<td>508</td>
</tr>
<tr>
<td>7</td>
<td>DIY (Do It Yourself) Wrench Time Study, Quick and Easy In-House</td>
<td>509</td>
</tr>
<tr>
<td></td>
<td>How Not to Measure Wrench Time</td>
<td>512</td>
</tr>
<tr>
<td></td>
<td>Setting Up the In-House Study</td>
<td>513</td>
</tr>
<tr>
<td></td>
<td>Determining a Representative Period with Enough Observations</td>
<td>514</td>
</tr>
<tr>
<td></td>
<td>Making Observations and Respecting the Workforce</td>
<td>515</td>
</tr>
<tr>
<td></td>
<td>Organizing Data Collection</td>
<td>516</td>
</tr>
<tr>
<td></td>
<td>Example Observations</td>
<td>516</td>
</tr>
<tr>
<td></td>
<td>Interpreting the Results</td>
<td>516</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>519</td>
</tr>
<tr>
<td>8</td>
<td>Sample Work Sampling (Wrench Time) Study: “Ministudy”</td>
<td>521</td>
</tr>
<tr>
<td></td>
<td>Executive Summary</td>
<td>522</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>523</td>
</tr>
</tbody>
</table>
Category Definitions ........................................ 523
Collection of Observation Data ........................... 526
Analysis ....................................................... 527
Conclusions .................................................. 527
Recommendations ............................................ 528
Attachment A: Procedure for Measuring Workforce  
Productivity by Work Sampling .......................... 536
Attachment B: Work Sampling Calculations .............. 541

H Sample Work Sampling (Wrench Time) Study: Full-Blown Study  . 543
Executive Summary ......................................... 544
Introduction ............................................... 545
Category Definitions ....................................... 546
Collection of Observation Data ............................ 549
Analysis ...................................................... 549
Conclusions .................................................. 604
Recommendations ............................................ 609
Attachment A: Procedure for Measuring Workforce  
Productivity by Work Sampling .......................... 609
Attachment B: Work Sampling Calculations .............. 613

I Special Factors Affecting Productivity .................... 615
Wrench Time in Exceptional Crafts and Plants .......... 615
Blanket Work Orders ........................................ 616
Empowering versus Scheduling ............................ 617
  Definitions and Details ................................... 618
  Empowered to Do What? .................................. 618
  Proper Empowered Responsibility between  
    Planning and Crew Supervision ....................... 620
  The Result of Proper Empowerment ..................... 621
Schedule Compliance ....................................... 623
  Major Causes ............................................. 624
Overloaded Schedule ...................................... 625
  Crew Not Making It ...................................... 627
Schedule Breakers ........................................ 627
  Low Producing Crews .................................... 631
Priority Systems ........................................... 635
  Major Causes ............................................. 635
Choice ....................................................... 638
  No Priority System in Reality ........................... 639
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization and Interfaces</td>
<td>730</td>
</tr>
<tr>
<td>Planners</td>
<td>732</td>
</tr>
<tr>
<td>Workspace Layout</td>
<td>736</td>
</tr>
<tr>
<td>Management and Control</td>
<td>737</td>
</tr>
<tr>
<td>Redirecting or Fine-Tuning an Existing Planning Group</td>
<td>737</td>
</tr>
<tr>
<td>Considerations</td>
<td>739</td>
</tr>
<tr>
<td>Older Facilities versus Newer Facilities</td>
<td>739</td>
</tr>
<tr>
<td>Facilities under Construction</td>
<td>739</td>
</tr>
<tr>
<td>Centralized versus Area Maintenance Considerations</td>
<td>739</td>
</tr>
<tr>
<td>Traditional versus Self-Directed Work Teams</td>
<td>740</td>
</tr>
<tr>
<td>Aids and Barriers Overview</td>
<td>740</td>
</tr>
<tr>
<td>Major Areas of Planning Management</td>
<td>743</td>
</tr>
<tr>
<td>Organize—Establish a Planning Group</td>
<td>743</td>
</tr>
<tr>
<td>Plan—Plan Enough Jobs for One Week</td>
<td>746</td>
</tr>
<tr>
<td>Schedule—Schedule Enough Jobs for One Week</td>
<td>750</td>
</tr>
<tr>
<td>Execute—Execute Scheduled Jobs and Give Feedback</td>
<td>752</td>
</tr>
<tr>
<td>Ongoing—Keep Planning and Scheduling Ongoing</td>
<td>754</td>
</tr>
<tr>
<td>Key Aids and Barriers</td>
<td>757</td>
</tr>
<tr>
<td>Management Support—Sponsor a P&amp;S System</td>
<td>757</td>
</tr>
<tr>
<td>Supervisor Support—Follow a P&amp;S System</td>
<td>759</td>
</tr>
<tr>
<td>Technician Support—Follow a P&amp;S System</td>
<td>761</td>
</tr>
<tr>
<td>Right Planner—Create Positions and Select the Right Planners</td>
<td>763</td>
</tr>
<tr>
<td>Planner Training—Have Trained Planners</td>
<td>765</td>
</tr>
<tr>
<td>Urgent Breakdowns—Utilizing P&amp;S in a Reactive Environment</td>
<td>767</td>
</tr>
<tr>
<td>Technician Interruptions—Deal with Planner Distractions</td>
<td>768</td>
</tr>
<tr>
<td>Equipment Tags—Have Tags on Equipment</td>
<td>770</td>
</tr>
<tr>
<td>Files—Have Effective Files</td>
<td>772</td>
</tr>
<tr>
<td>Purchasing—Buy Timely Nonstock Parts</td>
<td>774</td>
</tr>
<tr>
<td>Work Order System—Have an Effective Foundation</td>
<td>775</td>
</tr>
<tr>
<td>CMMS—Have a Helpful Computer System</td>
<td>777</td>
</tr>
<tr>
<td>Special Circumstances</td>
<td>779</td>
</tr>
<tr>
<td>Improve Existing Planning—Turn Around an Existing Group</td>
<td>779</td>
</tr>
<tr>
<td>New Plants or Units—Establish Effective Planning</td>
<td>781</td>
</tr>
<tr>
<td>Self-Directed Teams—Use Planning and Scheduling</td>
<td>783</td>
</tr>
<tr>
<td>Summary</td>
<td>784</td>
</tr>
<tr>
<td>R Concise Text of Missions, Principles, and Guidelines</td>
<td>829</td>
</tr>
<tr>
<td>Maintenance Planning Mission Statement</td>
<td>829</td>
</tr>
<tr>
<td>Maintenance Planning Principles</td>
<td>829</td>
</tr>
<tr>
<td>Maintenance Scheduling Principles</td>
<td>830</td>
</tr>
<tr>
<td>Guidelines for Deciding if Work Is Proactive or Reactive</td>
<td>831</td>
</tr>
<tr>
<td>Guidelines for Deciding if Work Is Extensive or Minimum Maintenance</td>
<td>831</td>
</tr>
<tr>
<td>Guidelines for Deciding Whether to Stage Parts or Tools</td>
<td>832</td>
</tr>
<tr>
<td>Guidelines for Craft Technicians to Provide Adequate Job Feedback</td>
<td>833</td>
</tr>
<tr>
<td>Glossary</td>
<td>835</td>
</tr>
<tr>
<td>Bibliography</td>
<td>839</td>
</tr>
<tr>
<td>Index</td>
<td>843</td>
</tr>
</tbody>
</table>