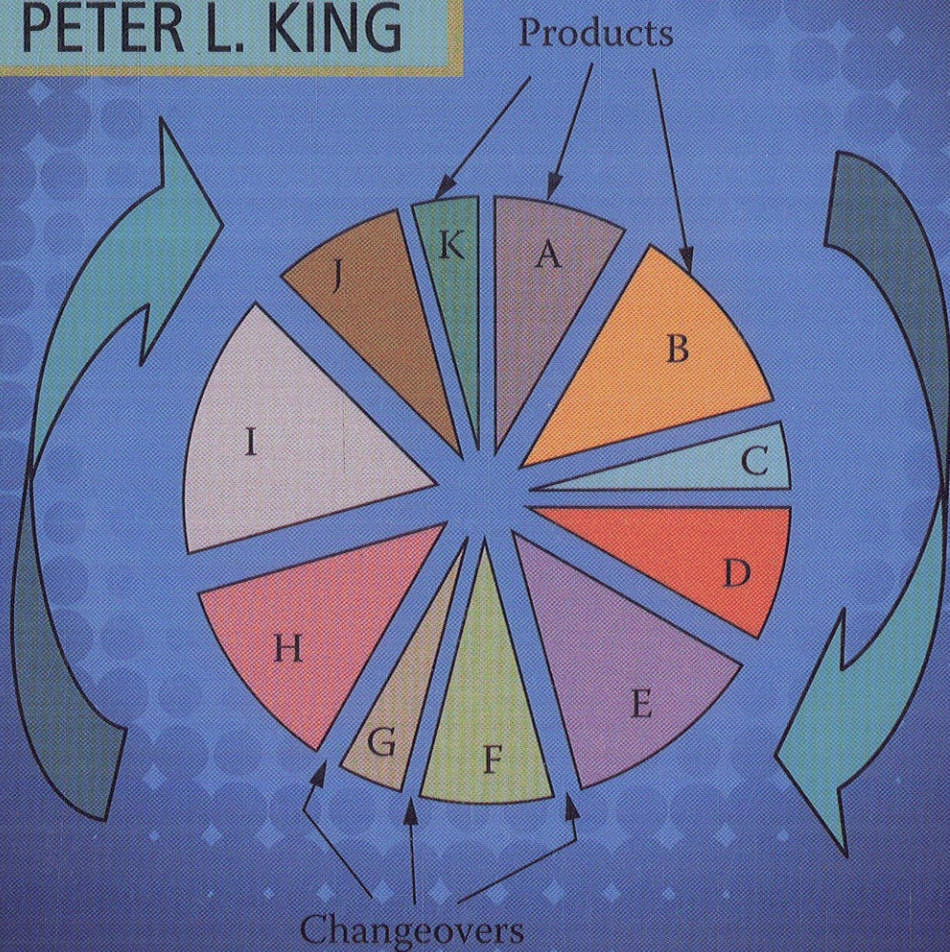


Lean for the Process Industries

Dealing with Complexity

PETER L. KING



CRC Press
Taylor & Francis Group

A PRODUCTIVITY PRESS BOOK

Contents

Acknowledgments	xv
Introduction.....	xvii

PART I Lean and the Process Industries

Chapter 1 Lean Overview: Principles and Tools	3
Origins of Lean	3
TPS Becomes the New Production Paradigm.....	6
Essence of Lean.....	8
Fourteen Lean Tools.....	11
Lean Tool 1: Value Stream Mapping (VSM).....	11
Lean Tool 2: Takt Time	11
Lean Tool 3: Kaizen	12
Lean Tool 4: 5S.....	12
Lean Tool 5: Jidoka	12
Lean Tool 6: Single Minute Exchange of Dies (SMED)	13
Lean Tool 7: Poka-Yoke.....	13
Lean Tool 8: Five Whys.....	13
Lean Tool 9: Standard Work	13
Lean Tool 10: Total Productive Maintenance (TPM).....	14
Lean Tool 11: Cellular Manufacturing	14
Lean Tool 12: Heijunka.....	14
Lean Tool 13: Just-In-Time (Pull).....	15
Lean Tool 14: Kanban	15
Further Information	15
Lean Today	16
Summary	17
 Chapter 2 Distinguishing Characteristics of Process Industry Manufacturing.....	19
Process Industries versus Assembly Operations.....	19

Characteristics That Distinguish the Process	
Industries	21
The Three Vs: Volume, Variety, and Variability	21
Capital Intensive versus Labor Intensive.....	22
Throughput Is Limited by Equipment Rather Than by Labor	23
Equipment Is Large and Difficult to Relocate.....	24
Processes Are Difficult to Stop and Restart	24
Product Changeover Issues Are Complex.....	24
Finished Product Inventory versus WIP.....	25
Hidden WIP	26
Material Flow Patterns in Assembly and Process Plants (SKU Fan Out).....	26
Examples of “V” Type Process in Process Plants	28
Product Differentiation Points.....	32
Summary	33

Chapter 3 The Seven (or Eight, or Nine) Wastes in the Process Industries	37
Value and Waste	37
Waste of Overproduction	38
Waste of Time on Hand (Waiting)	40
Waste in Transportation.....	42
Waste of Processing Itself.....	43
Waste of Stock on Hand (Inventory).....	44
Capacity Differences: Rate Synchronization.....	45
Bottleneck Protection.....	46
Campaign Sizes.....	46
Inappropriate Product Differentiation	46
Tank Heels	47
Waste of Movement.....	47
Waste of Making Defective Parts.....	48
Waste of Human Creativity	49
Time as a Waste	50
Necessary versus Unnecessary Waste	51
Summary	52

PART II Seeing the Waste

Chapter 4	Value Stream Mapping the Process Industries	57
	Introduction to Value Stream Mapping	57
	Benefits of a Value Stream Map	58
	Generating the Map	59
	Direction of Flow	60
	Product Families	60
	Takt and Cycle Time	61
	Takt Time	61
	Cycle Time	62
	Takt Rate versus Takt Time	63
	Units of Production	63
	Where to Begin	66
	Level of Detail	66
	Process Box	68
	Data Boxes	69
	Customer Data Box	69
	Process Step Data Box	70
	Inventory Data Box	73
	Transportation Data Box	74
	Supplier Data Box	75
	Information Flow	75
	The Timeline	78
	An Example VSM	81
	Additional VSM Best Practices	81
	Parallel Equipment	81
	Logical Flow versus Geographic Arrangement	84
	Summary	88
Chapter 5	Reading and Analyzing the Current State Value Stream Map	89
	Analyzing the Current State Map	89
	Voice of the Customer	90
	Waste	90
	Non-Value-Adding Activities	91

Flow and Bottlenecks	91
Variability	92
Other Opportunities	92
Learning from Material Flow	93
Learning from Information Flow.....	98
Tools to Get to Root Cause.....	101
The Five Whys (5W).....	101
Detailed Process Mapping.....	102
The Ishikawa Diagram.....	102
Cross-Functional Process Mapping	102
Creating the Future State VSM.....	104
Summary	107

PART III

Lean Tools Needing Little Modification

Chapter 6	Total Productive Maintenance	111
	TPM and Lean Synergy	112
	TPM in the Process Industries	113
	TPM and Reliability-Centered Maintenance	114
	The Benefits of TPM.....	114
	TPM Measures	114
	Overall Equipment Effectiveness.....	115
	Availability.....	115
	Performance	115
	Quality.....	116
	Uptime	116
	Calculation of OEE and Uptime	118
	Calculation of OEE.....	118
	Calculation of Uptime	120
	VSM Data Boxes: OEE or Uptime	120
	Summary	121
Chapter 7	Setup Reduction and SMED	123
	SMED and Its Origins	123

SMED Concepts.....	124
Product Transitions in the Process Industries	126
A Changeover Where All Tasks Are Completely Manual	127
A Changeover Completely in Chemistry and/or Physics	128
A Changeover That Includes a Combination of Manual Tasks and Chemistry/Physics	128
SMED beyond Product Changes.....	130
A Non-Manufacturing Example	131
Summary	132

Chapter 8 Visual Management	135
Introduction to the Visual Plant	135
Visual Work Area	137
Visual Displays.....	138
Visual Scheduling.....	139
Andons.....	144
Metrics	144
Management by Sight and Frequent Communication.....	145
Process Industry Challenges.....	145
Summary	147

Chapter 9 Kaizen Events	149
Kaizen by Specific Events.....	149
Quality Circles versus Kaizen Events	151
Steps in the Kaizen Event Process.....	151
Planning.....	152
Conducting the Event	153
Following-Up.....	154
Appropriate Event Scope Areas.....	154
Kaizen Dangers: The Root Causes of Kaizen Failures	155
Process Industry Unique Requirements	157
Kaizen Events as Six Sigma Projects.....	158
Summary	160

PART IV
Lean Tools Needing a Different Approach

Chapter 10	<i>Finding, Managing, and Improving Bottlenecks</i>	163
	Bottlenecks in Process Plants	163
	Moving Bottlenecks	165
	Recognizing Covert Bottlenecks	167
	The Root Causes of Bottlenecks	168
	Bottleneck Management: Theory of Constraints.....	171
	Widening the Bottleneck: Lurking Bottlenecks.....	174
	Summary	175
Chapter 11	Cellular Manufacturing in the Process Industries	177
	The Process Layout (Pre-Cellular Manufacturing in Assembly Plants)	177
	The Product Layout (Cellular Manufacturing in Assembly Plants)	178
	Cell Application in the Process Industries	180
	Typical Process Plant Equipment Configurations.....	181
	Virtual Cells	185
	Case Study: Virtual Cell Implementation in a Synthetic Rubber Production Facility.....	189
	The Result: Synthetic Rubber Virtual Work Cells	193
	Steps in Virtual Work Cell Design.....	195
	Step 1: Start with the Current State Value Stream Map ..	195
	Step 2: Determine Preliminary Asset Groups or Virtual Cells	196
	Step 3: Determine Preliminary Product Groupings (Group Technology)	196
	Step 4: Assign Each Product Group to a Manufacturing Cell.....	196
	Step 5: Define a Few Swing Products	198
	Step 6: Review the Plan	198
	Step 7: Document Virtual Cell Arrangements, Flow Patterns, Product Lineups, and Operating Rules.....	199
	Step 8: Mark Each Cell Visually	199

Step 9: Modify Scheduling Processes Accordingly.....	199
Step 10: Ensure that Appropriate Managing Processes Are in Place.....	199
Summary.....	201

Chapter 12 Product Wheels: Production Scheduling, Production Sequencing, Production Leveling	203
Solutions in Assembly Processes.....	203
Process Industry Challenges.....	205
A Process Industry Solution: The Product Wheel Concept.....	206
Product Wheel Design.....	209
Step 1: Determine Which Process Steps Should Be Scheduled by Product Wheels	211
Step 2: Analyze Product Demand Variability.....	212
Step 3: Determine the Optimum Sequence.....	215
Step 4: Calculate Shortest Wheel Time Possible (Available Time Model)	216
Step 5: Estimate Economic Optimum Wheel Time (the EOQ Model)	217
Step 6: Determine the Wheel Time (Making the Choice)	219
Step 7: Calculate Inventory Requirements.....	222
Step 8: Fine-Tune the Design.....	224
Step 9: Revise the Current Scheduling Process	225
Step 10: Create a Visual Display	225
Benefits of Product Wheels.....	226
Some Additional Points.....	227
Summary.....	228

Chapter 13 Postponement in the Process Industries:	
Finish to Order	229
Finish to Order.....	230
Examples of Finish to Order: FTO in Assembly.....	230
FTO in the Process Industries.....	232
FTO within Process Plants.....	232

The Benefits of FTO	233
Example of FTO in a Process Plant	234
A Further Example: Bond to Order	237
Summary	240
Chapter 14 Pull Replenishment Systems.....	241
What Is Pull?.....	241
Pull in Assembly.....	243
Difficulties in Process Plants.....	245
Push–Pull Interface.....	246
ConWIP	250
Development of Pull on the Sheet Goods Process.....	254
Visual Signals.....	258
When to Start Pulling: The Sequence of Implementation	260
Creating Pull.....	261
Value Stream Focus.....	263
Traditional Pull Strategies and Signals	265
Push in Real Life.....	266
Summary	267
Chapter 15 Supermarket Design.....	269
Understanding the Supermarket Concept.....	270
Inventory Types and Supermarkets	271
Inventory Components Defined: Cycle Stock and Safety Stock	272
Calculating Cycle Stock.....	275
Calculating Cycle Stock: Fixed Interval Replenishment Model	275
Calculating Cycle Stock: Fixed Quantity Replenishment Model	278
Calculating Safety Stock.....	281
Variability in Demand	281
Variability in Lead Time.....	283
Combined Variability.....	284
Cycle Service Level and Fill Rate.....	284
Example: The Product Wheel for Forming Machine 1	286

Alternatives to Safety Stock	290
Signaling Methods	291
<i>The Role of Forecasting</i>	292
Summary	293

Chapter 16 The Importance of Leadership and Robust

Business Processes	295
Business Practices and Targets	296
ABC Classification.....	296
Customer Lead Times.....	297
Customer Service Levels.....	298
MTS, MTO, and FTO	298
Demand Variability Analysis.....	298
Protection (Safety Stock or Contingency Processes)	299
SKU Rationalization.....	299
Integrated Business and Operations Planning.....	300
Poor Business Practices	300
Dictating Low Safety Stock Levels	300
Expecting Abnormally Short Lead Times.....	300
Expecting Perfect Customer Service.....	301
Reducing Inventory at Year End.....	301
Pulling Next Quarter's Sales Ahead.....	301
Obsessing over Cost Reduction	302
Inappropriate Use of Metrics.....	302
Summary	303

PART V Appendices

Appendix A: Determination of Appropriate Raw Material Inventory.....	307
Appendix B: References.....	311
Index.....	313
About the Author.....	333