Full Contents

Preface **vii**

1 Introduction **1**

1.1 SPS and Programmable Manufacturing Advisor . . 2

1.2 Goals and Contents of the Book 4

1.3 Intended Audience and Prerequisites 6

1.4 Relationship of PMA-based SPS with Industry 4.0 . 8

1.5 Preview: A Brief Demonstration of PMA-based SPS 11

1.6 Chapter 1 Takeaway 23

2 Production System Types, Machine and Buffer Parameters, and Performance Metrics **25**

2.1 Production System Types 26

2.2 Machine and Buffer Parameters 30

2.3 Evaluating Machine Parameters using Factory Floor Measurements 36

2.4 Production Systems Performance Metrics 43

2.5 Evaluating Induced Accuracy of Calculated Analytically Performance Metrics 45

2.6 Chapter 2 Takeaway 48

3 Mathematical Modeling of Production Systems 51

3.1 Mathematical Models: Components and Process of Development 52

3.2 Asynchronous Serial Line with Cycle Overrun: Automotive Transmission Case Machining Line 55

3.3 Asynchronous Serial Line with Infinite Buffers: Electronic Board Production System 59

3.4 Synchronous Assembly System: Automotive Ignition Control Module Assembly System 61

3.5 Asynchronous Multi-Job Production System: Automotive Underbody Assembly System 65

3.6 Serial Line with Infinite Buffers: Galvanization Plant 68

3.7 Closed Serial Line with Bernoulli Machines: Automotive Paint Shop System 69

3.8 Chapter 3 Takeaway 75

4 Fundamentals of Production Systems Engineering 77

4.1 PSE General Characterization 78

4.2 PSE Analytics for Performance Metrics Evaluation . 79

4.3 PSE Analytics for Management Concepts 89

4.4 Bottleneck Machine 89

4.5 Intermittent Bottleneck Machine 97

4.6 Bottleneck Buffer and Buffering Potency 102

4.7 Quality Bottleneck 104

4.8 Closed Lines Impediment 108

4.9 Production Lead Time Analysis and Control 114

4.10 Lean Buffering 118

4.11 Product-Mix Performance Portrait of Multi-Job Production Systems 120

4.12 Qualitative Laws of Production Systems 123

4.13 Chapter 4 Takeaway 126

5 PSE Toolbox-assisted Design of Continuous Improvement Projects 129

5.1 PSE Toolbox Homepage 130

5.2 Illustration of PSE Toolbox Operation 132

5.3 Procedure for PSE Toolbox-assisted Design of Continuous Improvement Projects 139

5.4 Examples of PSE Toolbox-assisted Design of Continuous Improvement Projects 142

5.5 Chapter 5 Takeaway 157

6 PMA-enabled Design of Continuous Improvement Projects 159

6.1 PMA and PMA-based SPS Architectures 160

6.2 PMA-based SPS Modes of Operation, Regimes, and Data Structures 163

6.3 PMA-based SPS Homepage and Workflow 166

6.4 Illustration of PMA-based SPS Operation 169

6.5 Procedure for PMA-enabled Design of Continuous Improvement Projects 183

6.6 Examples of PMA-enabled Design of Continuous Improvement Project with Static Data Structure . . . 184

6.7 Example of PMA-enabled Design of Continuous Improvement Project with Dynamic Data Structure . . 195

6.8 Steps of PMA-based SPS Deployment 201

6.9 Chapter 6 Takeaway 202

7 Smart Transmission Case Machining Line 205

7.1 Preliminaries 206

7.2 The System and Its Mathematical Model 207

7.3 System Health & Improvement Considerations . . . 209

7.4 Improvement Scenarios and Resulting Continuous Improvement Projects 211

7.5 Facilitating Managerial Approval: Summary of the Designed Improvement Projects 220
7.6 Chapter 7 Takeaway 224

8 Smart Electronic Board Production System 227
8.1 The System and its Mathematical Model 228
8.2 System Health & Improvement Considerations . . . 229
8.3 Improvement Scenarios and Resulting Continuous Improvement Projects 234
8.4 Chapter 8 Takeaway 244

9 Smart Ignition Control Module Assembly System 247
9.1 The System and Its Mathematical Model 248
9.2 System Health & Improvement Considerations . . . 250
9.3 Improvement Scenarios and Resulting Continuous Improvement Projects 252
9.4 Facilitating Managerial Approval: Summary of the Designed Improvement Projects 261
9.5 Chapter 9 Takeaway 266

10 Smart Underbody Assembly System 269
10.1 The System and its Mathematical Model 270
10.2 System Health & Improvement Considerations . . . 272
10.3 Improvement Scenarios and Resulting Continuous Improvement Projects 278
10.4 Chapter 10 Takeaway 284

Epilogue 287

Acknowledgements 289

References 291

Acronyms and Notations 295

Index 299