# Table of Contents

Preface .................................................................................................................................................. xv  

Acknowledgment .................................................................................................................................. xxiii

## Section 1
### Supervisory Control in FMS

#### Chapter 1
Nonblocking Supervisory Control of Flexible Manufacturing Systems based on State Tree Structures .......................................................... 1  

*Wujie Chao, Xi’an Jiaotong University, China  
Yongmei Gan, Xi’an Jiaotong University, China  
W. M. Wonham, University of Toronto, Canada  
Zhaoan Wang, Xi’an Jiaotong University, China*

#### Chapter 2
Petri Net Supervisory Method for Linear Constraints and its Applications to Flexible Manufacturing Systems ............................................... 20  

*Jiliang Luo, Huaqiao University, China*

#### Chapter 3
Distributed Maximally Permissive Nonblocking Control of Flexible Manufacturing Systems .......... 36  

*Renyuan Zhang, Xi’an Jiaotong University, China  
Yongmei Gan, Xi’an Jiaotong University, China  
W. M. Wonham, University of Toronto, Canada  
Zhaoan Wang, Xi’an Jiaotong University, China*

#### Chapter 4
A Computationally Improved Control Policy for FMS Using Crucial Marking/Transition-Separation Instances ......................................................... 61  

*Yi-Sheng Huang, National Ilan University, Taiwan, R.O.C.  
Yen-Liang Pan, Air Force Academy, Taiwan, R.O.C.*
Section 2
Production Planning and Scheduling

Chapter 5
Hybrid Optimization Techniques for Industrial Production Planning .......................................................... 84
Pandian Vasant, University Technology Petronas, Malaysia

Chapter 6
MDA-Based Methodology for Verifying Distributed Execution of Embedded Systems Models ..... 112
Anikó Costa, Universidade Nova de Lisboa, Portugal
Paulo E. S. Barbosa, Universidade Estadual da Paraíba, Brazil
Filipe Moutinho, Universidade Nova de Lisboa, Portugal
Fernando Pereira, Instituto Politécnico de Lisboa, Portugal
Franklin Ramalho, Universidade Federal de Campina Grande, Brazil
Jorge C. A. Figueiredo, Universidade Federal de Campina Grande, Brazil
Luis Gomes, Universidade Nova de Lisboa, Portugal

Chapter 7
A Resource-Oriented Petri Net Approach to Scheduling and Control of
Time-Constrained Cluster Tools in Semiconductor Fabrication ................................................................. 136
NaiQi Wu, Guangdong University of Technology, China
MengChu Zhou, New Jersey Institute of Technology, USA & Tongji University, China

Chapter 8
Real-Time Scheduling and Control of Single-Arm Cluster Tools with Residency Time
Constraint and Activity Time Variation by Using Resource-Oriented Petri Nets ............................................ 178
Yan Qiao, Guangdong University of Technology, China
NaiQi Wu, Guangdong University of Technology, China
MengChu Zhou, New Jersey Institute of Technology, USA & Tongji University, China

Chapter 9
Intelligent Computation for Manufacturing ..................................................................................................... 211
Ashraf Afify, King Saud University, Saudi Arabia & Zagazig University, Egypt

Chapter 10
Feasible Dynamic Reconfigurations of Petri Nets .......................................................................................... 247
Jia Feng Zhang, Xidian University, China
Olfa Mosbah, University of Carthage, Tunisia
Mohamed Khalgui, University of Carthage, Tunisia & National Council of Research, Italy
Atef Gharbi, University of Carthage, Tunisia
Section 3
Deadlock Prevention and Net Analysis Techniques

Chapter 11
A Critical-Siphon Approach to Fastest Deadlock Controller for $S^3PR$ .................................................. 269
Daniel Yuh Chao, National Cheng Chi University, China

Chapter 12
Iterative Deadlock Control for Petri Net Models of Automated Manufacturing Systems:
Algorithms and Case Studies .................................................................................................................. 296
Anrong Wang, Xidian University, China
MengChu Zhou, New Jersey Institute of Technology, USA & Tongji University, China

Chapter 13
Design of Optimized Petri Net Supervisors for Flexible Manufacture Systems
Based on Elementary Siphons ............................................................................................................. 322
Mingming Yan, University of Electronic Science and Technology of China, China

Chapter 14
Deadlock Control in Generalized Petri Nets .......................................................................................... 343
Mi Zhao, Shihezi University, China
Yifan Hou, Xidian University, China

Chapter 15
Deadlock Prevention for Automated Manufacturing Systems with Uncontrollable and
Unobservable Transitions: A Petri Net Approach ................................................................................. 367
Meng Qin, Xidian University, China

Chapter 16
Solving Siphons with the Minimal Cardinality for Deadlock Control .................................................. 388
Shaoyong Li, Lanzhou University of Technology, China

Chapter 17
Composition of Functional Petri Nets .................................................................................................. 404
Dmitry A. Zaitsev, International Humanitarian University, Ukraine

Compilation of References .................................................................................................................. 465
About the Contributors ......................................................................................................................... 495
Index .................................................................................................................................................... 504