

Table of Contents

List of Acronyms and Symbols	ix
Abstract	xiii
Deutsche Kurzzusammenfassung	xv
1 Introduction	1
1.1 Motivation	1
1.2 Research Topic Overview	4
1.3 Contribution and Outline of the Thesis	11
2 Background and Preliminaries	15
2.1 Concepts from Industry 4.0	15
2.2 Production Scheduling	17
2.3 Petri Nets	21
2.4 Model Predictive Control	22
2.5 Summary	25
3 Modeling of the Flexible Manufacturing System	27
3.1 Framework Overview	27
3.2 The Job Shop with Multi-Purpose Machines and Sequence Flexibility	30
3.3 Automatic Petri Net Generation for the JMPMSF	37
3.4 Summary	53
4 Model Predictive Control for Flexible Job Shop Scheduling	55
4.1 MPC Formulation without Terminal Cost	55
4.2 MPC Formulation with Terminal Cost	68
4.3 Completion of the Production Problem	69
4.4 Discussion	71
4.5 Summary	81
5 Numerical Examples	83
5.1 Nominal Case	84
5.2 Machine Breakdowns	87
5.3 Summary	88

Table of Contents

6 Conclusion	89
6.1 Summary	90
6.2 Discussion and Outlook	92
A Proof of the Properties of the Automatically Generated Petri Net	101
Bibliography	105