
Contents

Preface	ix
Introduction	xi
Chapter 1. Impacts and Challenges of Industry 4.0	1
1.1. Employment and training	2
1.2. The industrial digital transition	5
1.3. Scientific research	8
1.4. A global strategy	12
1.5. Business models	14
1.6. Data transformation	16
Chapter 2. New Functionalities	19
2.1. “Preparation” category	20
2.1.1. Operations	21
2.1.2. Simulation	22
2.2. “Supervision” category	23
2.2.1. Flexibility	24
2.2.2. Control	25
2.2.3. Personalization	27
2.2.4. Responsiveness	27
2.2.5. Portability	28
2.2.6. Quality	29
2.3. “Cross-functional” category	30
2.3.1. Prediction	30
2.3.2. Cybersecurity	31
2.3.3. Environment	32
2.3.4. Human dimension	33

2.3.5. Data	34
2.3.6. Scalability	35
Chapter 3. Fundamental Concepts	37
3.1. Data lake	37
3.2. Cyber-physical manufacturing system	40
3.3. Industrial Internet of Things	42
3.4. Industrial cyber-physical system	44
3.5. Dynamic supervision	46
3.6. Intelligent computing	47
Chapter 4. Concepts, Models and Architectures	51
4.1. General concepts.	53
4.1.1. Lina et al.'s concept	53
4.1.2. Gorecky and Weyer's concept	54
4.1.3. Benfriha et al.'s concept	55
4.1.4. Conclusion.	57
4.2. Reference model	58
4.3. Generic architecture	60
4.4. Transition approaches	62
4.4.1. Horizontal and vertical integration	62
4.4.2. Hybrid approach	65
Chapter 5. Platform 4.0.	71
5.1. Design and development	72
5.1.1. Scientific challenges	74
5.1.2. New design approach.	78
5.1.3. Physical layer	82
5.1.4. Software and control layer	84
5.1.5. IoT layer	85
5.2. Communication architecture	87
5.2.1. Connection architecture	88
5.2.2. Communication protocols	92
5.3. Generated data	94
5.3.1. Data classification	94
5.3.2. Examples	95
5.4. Case study	97
5.4.1. Introduction to Quality 4.0	98
5.4.2. Technology used	99
5.4.3. General approach	100
5.4.4. Experimentation.	105
5.5. Conclusion	108

Chapter 6. Production Control	111
6.1. Functional architecture	112
6.1.1. Digital continuity	112
6.1.2. Business flows	113
6.2. Control systems	116
6.2.1. Planning	118
6.2.2. Modularity	119
6.2.3. Production plan	120
6.2.4. Control	122
Chapter 7. Digital Twins	133
7.1. Principles	134
7.1.1. Maturity levels	134
7.1.2. Categorization	135
7.1.3. Operating modes	136
7.2. Design approach	137
7.3. Needs identification phase	139
7.3.1. Identification of industrial objectives	139
7.3.2. Identification of evaluation criteria	139
7.3.3. Identification of necessary data	140
7.3.4. Writing of the specifications document	141
7.4. DT design phase	142
7.4.1. Modification of the physical system	142
7.4.2. Design of the digital module	143
7.4.3. Development of the communication module	143
7.4.4. Integration of functionalities	145
7.4.5. Design of the decision-making module	145
7.4.6. Synthesis	146
7.5. Deployment and verification phase	147
7.5.1. Experimentation platform	147
7.5.2. Specifications document	148
7.5.3. Design of the DT	150
7.5.4. Validation	157
Chapter 8. Clouds for Industry	161
8.1. The main clouds for industry	162
8.1.1. Cloud manufacturing	162
8.1.2. Cloud outsourcing	163
8.1.3. Cloud computing	165
8.1.4. Methodologies and frameworks	165
8.2. Integration methodology	169
8.2.1. Identification of industrial needs	170

8.2.2. Adaptation of the workshop's IT infrastructure	170
8.2.3. Classification and categorization of data	171
8.2.4. Data aggregation and data lake construction	175
8.2.5. Analysis in the cloud and creation of specific processes	177
8.2.6. Deployment of the methodology	178
8.3. Deployment framework	179
8.4. Synthesis	182
Chapter 9. Digital Optimization	185
9.1. Introduction to the problem	186
9.1.1. Evolution of industrial optimization.	186
9.1.2. Characterization of the problem	187
9.2. Optimization phases	188
9.2.1. Modeling.	189
9.2.2. Data and IT infrastructure	191
9.2.3. Data analysis algorithm in the cloud	192
9.2.4. Results and interpretation	194
9.3. Conclusion	199
Conclusion	201
References.	205
Index.	209