

Cambridge University Press

978-1-107-07639-6 - Robotic Industrialization: Automation and Robotic Technologies for Customized Component, Module, and Building Prefabrication

Thomas Bock and Thomas Linner

Table of Contents

[More information](#)

Contents

<i>Acknowledgements</i>	<i>page</i> ix
<i>Glossary</i>	xiii
1 Introduction	1
1.1 OEM Model and Manufacturing Strategy	2
1.2 Analysis Framework	4
1.3 Organization of this Volume	5
2 Automation and Robotics in Building Component Manufacturing	7
2.1 Brickwork- and Ceramics-Based Components	8
2.1.1 History and Techniques of Brick and Ceramic Parts Production	8
2.1.2 Keys and Figures	9
2.1.3 Classification of Ceramic Construction Elements and Brickwork Products	9
2.1.4 Manufacturing Methods	10
2.1.5 Possibilities for Industrial Customization	12
2.1.6 End-Effectors and Automated Processes	12
2.1.7 Factory Layouts	20
2.1.8 Emerging Techniques in the Field	22
2.1.9 End-of-Life Strategies	24
2.2 Concrete-Based Components	25
2.2.1 History and Techniques of Concrete Prefabrication	26
2.2.2 Keys and Figures	27
2.2.3 Classification of Precast Concrete Products	28
2.2.4 Manufacturing Methods for Precast Concrete	30
2.2.5 Possibilities for Industrial Customization	32
2.2.6 Equipment and End-Effectors for Automated Production	33

Cambridge University Press

978-1-107-07639-6 - Robotic Industrialization: Automation and Robotic Technologies for Customized Component, Module, and Building Prefabrication

Thomas Bock and Thomas Linner

Table of Contents

[More information](#)

vi

Contents

2.2.7	Factory Production Layouts	36
2.2.8	Emerging Techniques in the Field	36
2.2.9	End-of-Life Strategies	43
2.3	Wood-Based Components	43
2.3.1	History and Techniques of Wood/Timber Construction and Prefabrication	43
2.3.2	Keys and Figures	44
2.3.3	Classification of Products	44
2.3.4	Manufacturing Methods	46
2.3.5	Possibilities for Industrial Customization	47
2.3.6	End-Effectors and Automated Processes	49
2.3.7	Factory Production Layouts	52
2.3.8	Emerging Techniques in the Field of Timber Prefabrication	52
2.3.9	End-of-Life Strategies	54
2.4	Steel-Based Components	54
2.4.1	History and Techniques of Steel Production	54
2.4.2	Keys and Figures	55
2.4.3	Classification of Products	55
2.4.4	Manufacturing Methods: Steel Elements	57
2.4.5	Possibilities for Industrial Customization	60
2.4.6	End-Effectors and Automated Processes	61
2.4.7	Factory Production Layouts	62
2.4.8	Emerging Techniques in the Field	63
2.4.9	End-of-Life Strategies	63
3	Building Module Manufacturing	66
4	Comparison of Large-Scale Building Manufacturing in Different Countries	72
4.1	Germany	73
4.1.1	Wood-Based Housing Prefabrication in Germany	73
4.1.2	Steel-Based Building Prefabrication in Germany	76
4.2	United Kingdom	82
4.2.1	History	82
4.2.2	General Overview	83
4.2.3	Companies	84
4.2.4	Manufacturing Methods	87
4.2.5	Conclusion	87
4.3	Spain	88
4.3.1	History	88
4.3.2	General Overview	88
4.3.3	Companies	88
4.3.4	Manufacturing Methods	88
4.3.5	Conclusion	89
4.4	China	89
4.4.1	History	89

Cambridge University Press

978-1-107-07639-6 - Robotic Industrialization: Automation and Robotic Technologies for Customized Component, Module, and Building Prefabrication

Thomas Bock and Thomas Linner

Table of Contents

[More information](#)

	<i>Contents</i>	vii
4.4.2 General Overview	89	
4.4.3 Companies	89	
4.4.4 Manufacturing Method	91	
4.4.5 Conclusion	92	
5 Large-Scale Building System Manufacturing in Japan	93	
5.1 Background, Development, and Strategy of the Industry	94	
5.1.1 Overview Companies (Turnover, Output, Employees, Prices, Factories)	94	
5.1.2 Japan's Prefabrication Industry Today and Tomorrow	96	
5.1.3 Karakuri Technology Diffusion in Japan	98	
5.1.4 Influences of Local and Cultural Specifics and Disasters	99	
5.1.5 Roots in Chemicals, Electronics, and the Automotive Industry	101	
5.1.6 Drivers for Prefabrication in Japan	103	
5.1.7 First Approaches to Mass Production: Premos Home	104	
5.1.8 Sekisui Heim's M1	107	
5.1.9 From Japan's Traditional Organizational Culture towards TPS and Toyota Home	109	
5.1.10 Automated and Robotized Production as Sales Argument	110	
5.1.11 Sekisui Heim – ERP Systems for the Control of Increasing Complexity	111	
5.1.12 Timeline of Evolution of Prefabrication in Japan	112	
5.2 Robot-Oriented Design and Management Strategies Used in the Japanese Prefabrication Industry	116	
5.2.1 The Idea of Robot-Oriented Design and Management	116	
5.2.2 Complementarity as a Key Element in the Success of Automated Prefabrication in Japan	116	
5.2.3 Robotic Logistics-Oriented Design	117	
5.2.4 Robotic Assembly-Oriented Design	118	
5.2.5 Degree of Structuring/Automation of Off-Site and On-Site Environments	119	
5.2.6 OEM-like Integration Structure	121	
5.2.7 Modular Coordination	121	
5.2.8 Control of Variation by Platform- and Same-Parts Strategies	121	
5.2.9 Linking of Customer and Manufacturing System	122	
5.2.10 Innovation and R&D Capability as Key Elements of the Business Strategy	125	
5.2.11 Performance Multiplication Effect	126	
5.3 The Manufacturing Process	128	
5.3.1 Product Variety and Types of Prefabrication	129	
5.3.2 Production Process Explained by Sekisui's and Toyota's Unit Method	129	
5.3.3 Factory Layouts and Process Design Strategies	135	

Cambridge University Press

978-1-107-07639-6 - Robotic Industrialization: Automation and Robotic Technologies for Customized Component, Module, and Building Prefabrication

Thomas Bock and Thomas Linner

Table of Contents

[More information](#)

viii

Contents

5.4	Analysis of Selected Companies and Their Manufacturing Systems	148
5.4.1	Sekisui House (Fully Panelized Steel Kit)	149
5.4.2	Daiwa House (Steel Frame Combined with Panels)	159
5.4.3	Pana Home (Steel Panels Combined with Steel Components)	162
5.4.4	Sanyo Homes Corporation (Steel Frame Combined with Panels)	166
5.4.5	Asahi Kasei – Hebel House Homes (Steel Frame Combined with Aerated Concrete Panels)	168
5.4.6	Misawa Homes Sub- and Mini-Assembly Units (Wood Panels)	171
5.4.7	Mitsui Home (Wood Panels)	174
5.4.8	Tama Home (Wooden Frame Combined with Panels)	176
5.4.9	Muji House (Wooden Frame Combined with Panels)	181
5.4.10	Sekisui Heim (Steel Units)	185
5.4.11	Toyota Home (Steel Units)	198
5.4.12	Misawa Homes Hybrid (Steel Units)	201
5.4.13	Sekisui Heim Two-U Home (Wood Units)	206
5.5	Evolving Tendencies in the Evolution of the Japanese Prefabrication Industry	207
5.5.1	Advanced Product Service Systems	208
5.5.2	Prefabrication Industry as Part of a Large-Scale Disaster Management Strategy	211
5.5.3	Extending the Value Chain through the Development of Prefabricated, Sustainable High-Tech Settlements	216
5.5.4	Reverse Innovation: Mass-Customized Housing Production as a Prototype for Future Manufacturing Systems	222
	<i>References</i>	225
	<i>Index</i>	233