

Contents

1 Introduction	1
<i>David Bradley and David W. Russell</i>	
1.1 Background	1
1.2 What Is Mechatronics?	1
1.2.1 Mechatronics and Design Innovation	4
1.2.2 Mechatronics and Manufacturing	5
1.2.3 Mechatronics and Education	7
1.3 Mechatronics and a Sustainable Future	9
1.3.1 Sustainability	9
1.3.2 Mechatronics and Sustainability	11
1.4 The Book	13
References	14
2 Consumption to Contribution: Sustainable Technological Development Through Innovation	19
<i>John H. Millbank</i>	
2.1 Introduction	19
2.2 The Interpretation of Meaning for Sustainability and Innovation	20
2.3 Deconstructing Technological Innovation as a Driving Force for Sustainable Engineered Systems	21
2.4 Forecasting, Foresight and Technology Assessment	23
2.5 The Influence and Impact of Information and Communication Technologies	24
2.6 Consumption, Obsolescence and Moves Towards Future Proofing	26
2.7 Complexity Paradigms Within a Sustainability Context	28
2.8 Rationalising Material Selection and Processing	29
2.9 Conclusion – From Responsible Design to Resource Recovery	31
References	34
3 The “Revolution”: a Small Company Revived	43
<i>David Dawson</i>	
3.1 Some History of the UK Industry-Academic Link, the “KTP”	43
3.2 Some Observations on the Acceptance of Computer-aided Engineering (CAE) in Smaller Companies.....	44
3.3 The Ducker Engineering Case Study	45
3.3.1 Problem or Opportunity?.....	45

3.3.2	The “Revolution”	49
3.3.3	Further Benefits Demonstrated in the CAE Application	51
3.4	Conclusions	53
	References	54
4	A Mechatronic Design Process and Its Application	55
	<i>Xiu-Tian Yan and Rémi Zante</i>	
4.1	Introduction to Mechatronic Design	55
4.2	Mechatronic Design Process Model	55
4.3	A Mechatronic Case Study	59
4.3.1	Mechatronic System Design Problem Description	59
4.3.2	Design Concept Development	59
4.3.3	Detailed Design	61
4.3.4	Electronic Control Unit.....	67
4.4	Conclusions	69
	References	70
5	A Mechatronic Design of a Circular Warp Knitting Machine	71
	<i>Memiş Acar</i>	
5.1	Introduction	71
5.2	Warp Knitting Cycle.....	72
5.3	Circular Warp Knitting Machine Concept.....	73
5.4	The Needle Reciprocating Mechanism.....	75
5.5	The Patterning Mechanism.....	75
5.5.1	Servo Motor Selection	76
5.6	The Prototype	78
5.6.1	Servo-controlled Needle Motion	79
5.6.2	The Yarn Feed Mechanism.....	80
5.6.3	Truncated-cone Optimisation	80
5.7	Conclusions	80
	Acknowledgements.....	81
	References	81
6	Mechatronics and the Motor Car	83
	<i>Derek Seward</i>	
6.1	Background.....	83
6.1.1	Vehicle Mechatronic Systems	83
6.1.2	Drivers for Change	86
6.2	Engine Basics	88
6.3	The Mechanical Solution for Ignition Timing and Fuel Delivery	89
6.3.1	Traditional Mechanical Ignition Timing.....	89
6.3.2	Fuel Delivery – the Carburettor	90
6.4	The Mechatronic Solution to Engine Management	92
6.4.1	Sensors.....	92

6.4.2	Actuators	93
6.4.3	Processing.....	94
6.5	Anti-lock Braking System (ABS).....	97
6.5.1	Background to the Theory of Braking	97
6.5.2	ABS Components	99
6.5.3	ABS Diagnostics	101
6.6	Conclusions	101
	References	101
7	Multi-mode Operations Marine Robotic Vehicle – a Mechatronics Case Study	103
	<i>Daniel Toal, Edin Omerdic, James Riordan and Sean Nolan</i>	
7.1	Introduction	104
7.2	MPPT Ring System Overview	105
7.2.1	Main Features	105
7.2.2	The Virtual Underwater Laboratory	107
7.2.3	Architecture and Implementation	108
7.2.4	Imaging Sonar Simulator.....	110
7.2.5	Laboratory Configuration.....	111
7.3	University of Limerick (UL) Thrusted Pontoon/ROV	112
7.3.1	Base Vehicle.....	112
7.3.2	High-resolution Imaging Tool Skid.....	114
7.3.3	Onboard Electronics and Computer Control	114
7.3.4	Fault Tolerant Thruster Control.....	115
7.3.5	Autotuning of Low-level Controllers	116
7.3.6	High Frequency Sonar Enabling at Seabed Operation	117
7.3.7	Interchangeable Inshore and Deep Water Winch System.....	118
7.4	System Testing	118
7.5	Conclusions	118
	References	119
8	Wireless Communication Technology for Modular Mechatronic Controllers	121
	<i>Glen Bright, Nkgatho S. Tlale and Christopher M. Kumile</i>	
8.1	Introduction	121
8.2	Modular Mechatronic Controllers	122
8.3	Communications Technology.....	124
8.4	Model-based Mechatronic Controllers	125
8.5	Wireless Mechatronic Controller for the Camera Platform.....	128
8.5.1	Requirements for the Wireless Mechatronic Controller	129
8.6	Modelling of the Camera Platform.....	130
8.7	Results	132
8.7.1	Performance of the System.....	133
8.8	Conclusions	134
	References	134

9 The Utility Function Method for Behaviour Selection in Autonomous Robots	135
<i>Mattias Wahde</i>	
9.1 Introduction	135
9.2 Behaviour Selection.....	136
9.3 The Concept of Utility	137
9.3.1 A Biological Example	139
9.4 The Utility Function Method.....	141
9.4.1 Motivation	141
9.4.2 Method.....	141
9.4.3 Optimisation Procedure	146
9.4.4 Application Example – a Transportation Task	151
9.5 Ongoing Work.....	154
9.5.1 Extended UF Method.....	154
9.5.2 Data Preprocessing and Artificial Emotions.....	154
References	155
10 Force Sensing in Medical Robotics.....	157
<i>Kaspar Althoefer, Hongbin Liu, Pinyo Puangmali, Dinusha Zbyszewski, David Noonan and Lakmal D Seneviratne</i>	
10.1 Background.....	157
10.2 Force Sensing Techniques in Medical Robotics.....	159
10.3 The Use of Force Sensing in Medical Robotics.....	163
10.3.1 Haptic Feedback During Robotic Surgery	163
10.3.2 Soft Tissue Diagnosis Through Tissue Mechanical Property Identification	164
References	171
11 Intelligent Prostheses – a Biomechatronics Approach.....	173
<i>Abbas Dehghani</i>	
11.1 Introduction	173
11.2 Biomechatronics and Biological Systems.....	174
11.2.1 Biomechatronics	174
11.2.2 The Human Body.....	175
11.3 Prosthetics	175
11.3.1 Human Locomotion	177
11.3.2 Current Prosthetics	179
11.3.3 Future Prosthetics	191
11.4 Conclusions	193
References	193

12 Education in Mechatronics	197
<i>Vladimir V. Vantsevich</i>	
12.1 Introduction and Background	197
12.2 The Development of the Master of Science in Mechatronics Systems Engineering at Lawrence Technological University	203
12.2.1 Rational for Course Development	203
12.2.2 Programme Structure and Implementation	206
12.3 Summary	216
References	217
13 Mechatronics Education	219
<i>Job van Amerongen</i>	
13.1 Introduction	219
13.2 Historical Context.....	220
13.3 Curriculum	222
13.3.1 Mechatronic Designer Programme	223
13.3.2 BSc Curriculum	224
13.3.3 MSc Curriculum	228
13.4 Modelling of Mechatronic Systems.....	229
13.4 Conclusions	231
References	232
14 A Personal View of the Early Days of Mechatronics in Relation to Aerospace	235
<i>Bill Scarfe</i>	
15 Mechatronic Futures	241
<i>David Russell and David Bradley</i>	
15.1 Introduction	241
15.2 Challenges	242
15.3 Home Based Technologies	243
15.4 Medicine and eHealth.....	244
15.5 Transportation	245
15.6 Manufacturing, Automation and Robotics	246
15.7 Communications.....	247
15.8 Nanotechnologies	247
15.9 Advanced Algorithms.....	248
15.10 Artificial Intelligence	248
15.11 Conclusions	249
References	249
Authors	251