

Contents

1	Introduction	1
1.1	Research Background	1
1.2	Engineering Education in Southern Africa	4
1.3	Africa-UK Partnership for Development	6
1.4	Regional Macroeconomic Situations and Policies	8
1.5	Engineering Skills Development and Training	10
1.6	Academia-Industry Collaborations	11
1.7	Synopsis and Scope of the Book	13
1.8	Significance and Contributions to Knowledge	17
1.9	Summary and Outline of the Book	18
2	Engineering Doctoral Training in Southern Africa	21
2.1	Introduction	21
2.2	Systems Thinking and Heuristics in Modelling	23
2.2.1	Systems Thinking Philosophy	24
2.2.2	Heuristics in Engineering Education and Training	27
2.3	SWOT Analysis	29
2.3.1	Engineering Education in Southern Africa	30
2.3.2	Detailed Analysis of the TWOS Matrix	32
2.4	Mapping of Skills and Qualifications	34
2.5	Industry-Academia Engagements in Southern Africa	36
2.6	Global Engineering Education	37
2.7	Conclusion	39
3	Royal Academy of Engineering Interventions	41
3.1	Introduction	41
3.2	Background to the Initiatives and Interventions	43
3.2.1	Operational Challenges	43
3.2.2	Royal Academy of Engineering Projects	44
3.3	Enriching Engineering Education Program	46

3.4	Higher Education Partnerships for Sub-Saharan Africa	48
3.4.1	HEP SSA Phase 1	48
3.4.2	HEP SSA Phase 2	50
3.5	Other Interventions by the Royal Academy of Engineering	55
3.5.1	Industry Academia Partnership Program	55
3.5.2	Transforming Systems Through Partnerships	56
3.5.3	Africa Catalyst	57
3.5.4	Africa Prize for Engineering Innovation	57
3.6	Conclusion	57
4	Industry–Academia Engagements: UK Perspective	59
4.1	Introduction	59
4.2	Progression of Academic Staff and Students	61
4.3	Research Grants and Projects	62
4.4	Postgraduate Training	65
4.5	Industry-Academia Collaborations	66
4.6	Continuing Engineering Education and Training	70
4.7	Benchmarking UK Experiences in Southern Africa	72
4.8	Conclusion	74
5	Centres for Doctoral Training: UK Perspective	75
5.1	Introduction	75
5.2	Origins and Evolution of Doctoral Training in the United Kingdom	76
5.2.1	Introduction	76
5.2.2	Pre-World War II and Post-World War II	77
5.2.3	Expansion in UK Higher Education: 1970s–2003	78
5.2.4	Doctoral Training in the Twenty-First Century	79
5.2.5	Status of Doctoral Training in the United Kingdom in 2021	82
5.2.6	EPSRC Review of Doctoral Training	84
5.3	Key Features of Centres for Doctoral Training	86
5.4	Centre for Innovative Metal Processing	87
5.4.1	Partnerships with Industry	89
5.4.2	External Relations and Collaborations	91
5.4.3	Governance	91
5.5	Digital Transformation of Metals Industry	92
5.5.1	DigitalMetal Teams and Partnerships	95
5.5.2	Financial Commitments	96
5.5.3	Institutional Strengths and Logistics	96
5.6	Manufacturing Technology Centre: Coventry, UK	97
5.6.1	Bridging the Gap Between Research and Manufacturing	98
5.6.2	MTC Operations and Activities	98

5.7	Sheffield Water Centre	98
5.7.1	Socio-economic Dimensions of Water.	99
5.7.2	Groundwater Protection and Restoration.	99
5.7.3	Pennine Water	99
5.8	Diversification and Possible Collaborations with Southern Africa	100
5.9	Conclusion	101
6	Secondments and Industry Role in Engineering Training	103
6.1	Introduction	103
6.2	Access to Modern Equipment and Technology	106
6.3	Provision of Skilled Staff by Industry	109
6.3.1	Professorial Chairs.	110
6.3.2	Adjunct or Visiting Professorships	112
6.3.3	Motivation and Mentorship	114
6.4	Outcome-Based Engineering Education	116
6.4.1	Outcome-Based Learning	117
6.4.2	Problem-Based Learning	118
6.4.3	Industry-Based Learning	119
6.5	Commercialisation of Research.	120
6.5.1	Innovation Hubs and Industrial Parks	121
6.5.2	Intellectual Property and Patenting	123
6.5.3	Technology and Knowledge Transfer	124
6.6	Conclusion	125
7	Case Studies: Potential Areas of Research and Doctoral Training.	127
7.1	Introduction	127
7.2	Water Provision and Quality Control.	128
7.2.1	Background and Objectives	129
7.2.2	Community Areas of Research and Methodology.	131
7.2.3	Contributions to Research and Knowledge	132
7.3	Lean Manufacturing and Management	133
7.3.1	Background and Objectives	134
7.3.2	Case Study Company and Methodology	135
7.3.3	Contributions to Research and Knowledge	136
7.4	Cementitious Materials for Road Construction	137
7.4.1	Background and Objectives	137
7.4.2	Research Case Study Companies and Methodology	140
7.4.3	Contributions to Research and Knowledge	143
7.5	Food Processing Technology: Alternative Food Varieties	144
7.5.1	Background and Objectives	144
7.5.2	Methodology and Case Study Company	145
7.5.3	Contributions to Research and Knowledge	146

7.6	Other Potential Areas of Research	147
7.6.1	Renewable Energy: Provision of Green Solutions.	147
7.6.2	Industrial and Process Automation	149
7.6.3	Mineral Processing and Beneficiation	150
7.6.4	Transportation	151
7.7	Conclusion	153
8	Internationalisation and Partnerships	155
8.1	Introduction	155
8.2	Collaborative Research	157
8.3	Internationalisation of Engineering Education	159
8.4	Coopetition in Higher Education	160
8.5	Southern Africa Engineering Education Network	163
8.5.1	Membership and Obligations	166
8.5.2	Intellectual Property Rights	167
8.5.3	Administration of the Network	169
8.5.4	Financial Management	170
8.5.5	Other Considerations	170
8.6	Conclusion	171
9	Doctoral Training Centres Framework for Southern Africa	173
9.1	Introduction	173
9.2	Doctoral Training Centres Committee	175
9.2.1	Composition	176
9.2.2	Roles and Responsibilities	176
9.3	Available and Required Infrastructure	177
9.4	Phased Implementation	180
9.4.1	Readiness Analysis	180
9.4.2	Time Frames	180
9.4.3	Number of Students	181
9.4.4	Logistical Arrangements and Collaborations	182
9.5	Campaign and Marketing Strategy	183
9.6	Fitness Test for Potential DTCs	185
9.6.1	Skills Mapping	185
9.6.2	Core Group of Senior Academics	189
9.7	Budgeting and Cost Estimation	189
9.7.1	Recurrent Budget	190
9.7.2	Capital Budget	191
9.7.3	Financial Resourcing	192
9.8	Conclusion	193
10	Conclusions: Consolidated Research Findings and Recommendations	195
10.1	Introduction	195
10.2	International Backstopping and Benchmarking	196
10.3	Industry Engagement	196

10.4	Professorial Chairs and Adjunct Professors.....	197
10.5	Practical Applications and Case Studies	197
10.6	Maintenance and Sustainability of the DTC Scheme	198
10.7	Impact of Doctoral Training Centres	198
10.8	Risk Management and Mitigation	199
10.9	Generic Skills and Training	199
10.10	Indigenous Capacities and Skills for Economic Growth.....	200
10.11	Furtherance of Doctoral Training and Way Forward.....	200
Appendixes.....		201
References		227
Index.....		237