
Contents

FOREWORD	xi
ACKNOWLEDGMENTS	xiii
INTRODUCTION	xv
CHAPTER 1. PROJECT MANAGEMENT – SYSTEMS ENGINEERING – THE INDUSTRIALIZATION PROCESS	1
1.1. Projects and project management	1
1.1.1. Definitions	1
1.1.2. Project critical success factors	2
1.2. Systems engineering	3
1.2.1. Systems classification	5
1.3. The industrialization process	6
1.3.1. Definition: the industrialization steps	6
1.3.2. Origin of projects – the initialization phase – preliminary projects	7
1.3.3. Industrialization steps. Typical costs and relevant documents – time scale	9
1.3.4. Validation steps and project stakeholders' involvement	14
1.4. Project engineering	15
1.4.1. Conceptual engineering and WBS	15
1.4.2. Project organization: customer/contractor relationship	16
1.4.3. Project scope control: engineering tools	19
1.4.4. The project on the owner's side – the investment file – impact on company profitability	27
1.5. Bibliography	30

CHAPTER 2. METRICS FOR SUSTAINABILITY ASSESSMENT OF CHEMICAL PROCESSES	33
2.1. Sustainable development in chemical process engineering	33
2.2. Indicators, indices and metrics for sustainability	36
2.3. Frontiers of the system	38
2.4. Metrics	39
2.4.1. Stages in sustainable process design	39
2.4.2. AIChE metrics	42
2.4.3. IChemE metrics	43
2.4.4. Using metrics for sustainable development	44
2.4.5. Potential environmental impact index (waste reduction algorithm, WAR)	46
2.4.6. Sustainable process index (SPI)	49
2.4.7. Exergy as a thermodynamic base for sustainable development metrics	51
2.4.8. Indicators from system-based environmental assessment management	52
2.4.9. Toward a sustainable lifecycle assessment	56
2.5. Design methods for sustainable processes and systems	57
2.5.1. Several roads to more sustainable processes and systems	57
2.5.2. Industrial ecology	57
2.5.3. Lifecycle assessment	58
2.5.4. Green chemistry/green engineering, process intensification and waste management	58
2.6. Conclusions	59
2.7. Bibliography	60
CHAPTER 3. FROM PRELIMINARY PROJECTS TO PROJECTS	67
3.1. Introduction	67
3.2. Process design: an interactive and multiple-step activity	68
3.3. Process flowsheeting	69
3.4. Optimization methods	72
3.4.1. Multi-objective optimization (MOOP)	72
3.4.2. MCDM (Multiple Choice Decision-Making) methods	75
3.5. Literature review in process modeling/optimization techniques and tools based on LCA	76
3.6. Case study: eco-designing a biodiesel production process	80
3.6.1. Biodiesel as an alternative to fossil fuel	80
3.6.2. Methodology and tools	81
3.6.3. Biodiesel production simulation	81
3.6.4. Inventory data and identification of potential factors	83
3.6.5. Optimization of biodiesel production	83

3.7. Conclusions and suggestions	85
3.8. Bibliography	86
CHAPTER 4. ANALYSIS OF THE STRATEGY OF THE ENTERPRISE AND THE ENTERPRISE STRATEGIC PLAN	91
4.1. The industrial enterprise: basic main features.	91
4.2. The couple “product/market”	92
4.2.1. Product viewed at the enterprise level.	93
4.2.2. The product seen by the customer	94
4.3. Product profitability: turnover and margins	95
4.3.1. Product cost evaluation	96
4.3.2. Margin analysis	99
4.4. Company and industrial processes evaluation	103
4.4.1. Benchmarking.	104
4.4.2. Industrial site selection and existing site evaluation	108
4.4.3. BCG analysis	110
4.4.4. SWOT analysis	111
4.5. Enterprise industrial strategic analysis	112
4.6. Enterprise industrial strategic action plan	114
4.7. Bibliography	116
CHAPTER 5. EXCELLENCE IN MANUFACTURING AND OPERATIONS CONTROL	117
5.1. Importance of manufacturing	117
5.2. The manufacturing facility – the heart of the industrial enterprise	119
5.2.1. The supply chain concept	120
5.3. Typology of industrial facilities and technology considerations.	120
5.3.1. Production unit – main types	121
5.3.2. VAT analysis	122
5.3.3. Plant support functions.	124
5.3.4. Interaction between manufacturing site and the corporate functions.	124
5.3.5. Plant architecture	126
5.4. Operations management	127
5.4.1. The two modes of a company/manufacturing operations: the operational mode and the entrepreneurial mode	129
5.4.2. Plant operations monitoring and control	129
5.5. Excellence in manufacturing – Toyota system – World Class Manufacturing	134
5.5.1. TOYOTISM” or “Toyota production system (TPS)”	136
5.5.2. Excellence in manufacturing – other methods	140

5.5.3. World Class Manufacturing (WCM)	144
5.5.4. Human aspects – production personnel	152
5.6. Bibliography	154
CHAPTER 6. INNOVATION AND CHANGE MANAGEMENT	155
6.1. Innovation	155
6.2. Change management	162
6.2.1. The company, a multitude of processes (processes, methods, procedures)	163
6.2.2. The expertise of the company – knowledge management	164
6.2.3. Core competencies	165
6.2.4. Human aspects of change	166
6.2.5. Change management key success drivers	167
6.2.6. Incremental improvement or breakthrough	172
6.3. Looking for breakthroughs – process improvement team (PTI)	172
6.4. Re-engineering, the American way	173
6.5. Bibliography	174
CHAPTER 7. WATER AND ENERGY CHALLENGES	177
7.1. The energy challenge	177
7.2. The water–energy nexus in process industries	180
7.3. The key role of process systems engineering	183
7.3.1. Energy integration: HEN, pinch analysis, exergy and mathematical optimization modeling	184
7.3.2. Mass integration, mass exchange networks and application to water allocation networks (WAN)	185
7.3.3. Minimizing water and energy consumptions in water and heat exchange networks	185
7.3.4. Multi-objective optimization of the hydrogen supply Chain (HSC) in the Midi-Pyrénées Region, France	187
7.4. Conclusions	190
7.5. Bibliography	191
CHAPTER 8. ENGINEERS AS KEY PLAYERS FOR SUSTAINABILITY: THE ROLE OF PSE ACADEMIA	195
8.1. The path to sustainability education for engineers	195
8.2. Process systems engineering as the cornerstone of sustainability	198
8.3. Reinforcing engineering ethics	200
8.4. Implementing sustainability in engineering education	201
8.4.1. Tier 1 – sustainability at the core of chemical and process engineering curricula	201

8.4.2. Tier 2 – sustainable energy systems engineering	202
8.4.3. Tier 3 – sustainable development as a whole: a systems thinking discipline based on complexity theory	206
8.5. Conclusions	207
8.6. Bibliography	207
CHAPTER 9. PLANT OF THE FUTURE	209
9.1. The enterprise, its manufacturing plants and society.	210
9.1.1. Corporate social responsibility (CSR)	210
9.1.2. Circular economy	211
9.2. Engineering revisited	213
9.2.1. Enterprise and engineering company cooperation – Project scope definition.	214
9.2.2. Project scope (Box A)	215
9.2.3. HSE Matters (Box B)	216
9.2.4. Human factors – operations control (Box C)	217
9.2.5. Project owner's clients and suppliers (Box D)	221
9.2.6. CAPEX – OPEX optimization	222
9.3. Equipment manufacturers and project engineering	223
9.3.1. Case study; pump selection	224
9.3.2. Case study: TWIN SCREW Extruder	225
9.4. Modular process systems – skid mounted systems.	228
9.4.1. Modular construction	228
9.4.2. Equipment on skid – Transportable units and artifacts – miscellaneous prefabrication	230
9.4.3. Container modules – The F3 factory – process intensification	232
9.5. Designing for flexibility	233
9.5.1. Raw materials – energy	233
9.5.2. Operations	234
9.5.3. Flexibility and customer satisfaction	235
9.5.4. Innovative plant	235
9.6. Manufacturing and process industries toward the 4.0 plant.	236
9.6.1. Traceability	237
9.6.2. 3D printing.	240
9.6.3. The 4.0 plant - the digital plant.	242
9.7. Operations abroad	244
9.7.1. Transfer of technology – facility building	245
9.7.2. The case of developing countries	247
9.7.3. International management: expatriation	248

9.8. The manufacturing plant of the future	249
9.8.1. First tier: products, markets, sales, competition, R&D benchmarking, globalization, societal demands and constraints, and enterprise strategy	250
9.8.2. Second tier: process selection (raw materials, water and energy availability), risks assessment, site selection, CAPEX, OPEX, plant architecture and project scope	250
9.8.3. Third tier: realization engineering	251
9.8.4. Fourth tier: the enterprise organization, plant operations and management, the workplace, knowledge worker, customer satisfaction, continuous improvement, flexibility and innovation for survival	251
9.9. Bibliography	253
APPENDIX	255
INDEX	257