
TABLE OF CONTENTS

Part One: Transfer Functions and Quality Function Deployment	1
Chapter 1: Lean Six Sigma	2
1-1 Six Sigma - Reducing Variation	2
1-1.1 What makes a Six Sigma Approach so Special?	2
1-1.2 A Simple Six Sigma Case	3
1-2 The Secrets of Six Sigma	5
1-2.1 Define the Goals of the Process	8
1-2.2 Measure the Process	9
1-2.3 Analyze the Process.....	10
1-2.4 Implement the Process	11
1-2.5 Control.....	12
1-3 The Three Fundamental Six Sigma Metrics	14
1-4 Lean Six Sigma	15
1-4.1 Lean in Manufacturing	15
1-4.2 Lean Six Sigma in Software	16
1-4.3 Lean Controls in Software	16
1-4.4 Making Transfer Functions Lean	17
1-5 Linking Responses to Controls in QFD	18
1-5.1 Responses.....	18
1-5.2 Connecting Cause to Effect	19
1-5.3 Lean Links between Controls and Responses	19
1-6 Conclusions	20
Chapter 2: Transfer Functions.....	21
2-1 Introduction.....	21
2-2 Transfer Functions - Mathematical Foundations	22
2-2.1 What is a Transfer Function?	23
2-2.2 Deriving Single Response Transfer Functions	24
2-3 Single Response Transfer Functions	25
2-3.1 Sensitivity Analysis	25

2-4 Multiple Response Transfer Functions.....	27
2-4.1 Linear Algebra Preliminaries	28
2-4.2 Solving Multiple Response Linear Transfer Functions.....	30
2-4.3 Solving $y = Ax$	34
2-4.4 Profiles and Weights	34
2-4.5 Regularization	36
2-5 Conclusions	37
Chapter 3: What is AHP?	38
3-1 Introduction.....	38
3-1.1 A Popular Rating Method Using Bad Mathematics.....	38
3-1.2 The Methodology of AHP	40
3-1.3 Improving with AHP	40
3-1.4 Applying AHP to Real-World Problems.....	42
3-2 The Details behind the AHP	43
3-2.1 Vector Distance Measurements	44
3-2.2 Calculating the Eigenvector	44
3-2.3 Cascading AHP.....	46
3-2.4 The Schurr Radius	47
3-3 AHP Project Management Applications	48
3-3.1 Early Project Cost Estimation.....	49
3-3.2 Project Portfolio Management	49
3-3.3 Product Management.....	50
3-4 The Kitchen Knife Case.....	50
3-4.1 The Kitchen Knife Product Features and Characteristics	50
3-4.2 The Analytic Hierarchy Process for the Kitchen Knife	51
3-4.3 Top Topics Profile.....	54
3-4.4 Learnings From this Sample Case	54
3-5 Productivity Impact Factor Determination by AHP	55
3-5.1 Productivity Impact Factors as Analytical Hierarchy	56
3-5.2 The PIF Group Personal, or Human Factors	56
3-5.3 The PIF Group Process.....	57

3-5.4 The PIF Group Product Characteristics.....	59
3-5.5 The PIF Group Technology	60
3-5.6 The AHP Process for the PIF.....	61
3-6 Conclusion	64
Chapter 4: Quality Function Deployment.....	65
4-1 Quality Function Deployment in a Nutshell	65
4-2 Early Adoption of Quality Function Deployment.....	66
4-2.1 The Origins of Quality Function Deployment	66
4-2.2 Where QFD is not Used Despite its Usefulness	67
4-2.3 Implications of Mixing up Cause and Effect on Society	67
4-2.4 QFD in Requirements Elicitation.....	67
4-2.5 QFD for Predictions.....	68
4-3 Quality Function Deployment Basics	68
4-3.1 From Voice of the Engineer to Voice of the Customer.....	68
4-3.2 Blitz or no Blitz?	69
4-4 Eliciting the Voice of the Customer	70
4-4.1 Workshop with Customers or Sensing Groups	70
4-4.2 Analytic Hierarchy Process (AHP)	71
4-4.3 Traditional Questionnaires and Surveys.....	72
4-4.4 The Kano Method	72
4-4.5 Kano for Safety and other Quality Characteristics	74
4-4.6 Going to the Gemba (現場).....	75
4-4.7 Net Promoter® Score	76
4-4.8 Social Media Metrics (NPS 2.0).....	76
4-4.9 New Lanchester Strategy.....	77
4-5 Transfer Functions in a QFD Context.....	77
4-5.1 Combining various Voices of Customers.....	77
4-5.2 Transfer Functions for Cause-Effect Relationships	78
4-5.3 The Spring Canon Example Revisited.....	78
4-5.4 Applying Transfer Functions to QFD.....	80
4-6 Transfer Functions as QFD Matrices	81

4-6.1 Bridging the Communication Gap	81
4-6.2 Traditional QFD	84
4-6.3 Consistency	86
4-6.4 Modern QFD	87
4-6.5 Confidence	88
4-6.6 Identifying the Right Controls	89
4-7 Designing Solutions for Business Drivers	90
4-7.1 The Software Development Example	90
4-7.2 Identifying Story Cards	91
4-7.3 The Seven User Stories	91
4-7.4 Defining Customer's Needs	93
4-7.5 Mapping User Stories to Customer's Needs	94
4-7.6 Evaluating the QFD	95
4-7.7 Monitoring Achievements	96
4-8 Conducting a QFD Workshop	97
4-8.1 Select the Team	97
4-8.2 Do a Voice of the Customer First	97
4-8.3 Always do a Kano Analysis	98
4-8.4 Brainstorming the Controls	98
4-8.5 Eliminating Controls	99
4-8.6 Controlling the Convergence Gap	99
4-8.7 Document Findings	99
4-9 Comprehensive QFD – The Deming Chain	100
4-9.1 Dependent Processes	100
4-9.2 Comprehensive QFD	101
4-10 Conclusion	102
Chapter 5: Voice of the Customer by Net Promoter®	103
5-1 Introduction	103
5-1.1 The Gemba Way for Getting Feedback	104
5-1.2 Net Promoter® Score	104
5-1.3 The Net Promoter® Survey	105

5-1.4 NPS – A Lean Extension to the Six Sigma Toolbox	106
5-2 WOM Economics	107
5-2.1 The Loyalty Effect.....	107
5-2.2 A Sample Case.....	108
5-2.3 Sample NPS Scores in the ICT Area.....	109
5-2.4 The Impact of NPS to Corporate Strategy.....	110
5-2.5 Transfer Functions for Understanding Cause-Effect.....	110
5-2.6 Finding the Right Controls.....	110
5-3 Voice of the Customer Analysis	111
5-3.1 Building Transfer Functions from VoC.....	111
5-3.2 Business Drivers.....	111
5-3.3 Measurement Errors.....	112
5-3.4 Adjusting the Analysis.....	112
5-3.5 Benefits	112
5-3.6 Limitations.....	113
5-4 A Sample NPS Survey.....	113
5-4.1 Sample NPS Profile	113
5-4.2 Count of Verbatim.....	114
5-4.3 Sample VoC Analysis.....	115
5-4.4 Findings from this Analysis	116
5-4.5 Combining Importance and Satisfaction into a Profile	116
5-4.6 Comparing NPS Scores with Kano Analysis.....	118
5-5 Applying NPS	119
5-5.1 NPS as a Deming Chain.....	119
5-5.2 NPS for Continuous Project Monitoring.....	119
5-5.3 NPS with Social Media.....	120
5-5.4 Predictive Analysis.....	120
5-6 Conclusion	120
Part Two: Lean Six Sigma for Software	123
Chapter 6: Functional Sizing	125
6-1 Functional Sizing Overview.....	125

6-1.1 The ISO/ IEC Standards	125
6-1.2 First Generation Software Measurements.....	126
6-1.3 What is Functional Sizing?	127
6-1.4 The Key to Functional Sizing is to "Think Logical"	128
6-1.5 Functional Size and Work Effort	128
6-1.6 The Logical Boundary	129
6-1.7 Types of Functional Sizing	129
6-1.8 What is involved in Functional Size Counting?	130
6-2 ISO/IEC 20926:2009 IFPUG Functional Sizing.....	130
6-2.1 Functional Point Counting Components	132
6-2.2 Functional Size Count in ISO/IEC 20926.....	133
6-2.3 Transaction Complexity.....	133
6-2.4 Limitations.....	135
6-2.5 A Functional Sizing Case Study	136
6-3 ISO/IEC 19761 COSMIC Functional Sizing.....	138
6-3.1 The COSMIC Functional Size Measurement Method	139
6-3.2 The COSMIC Measurement Process.....	140
6-3.3 The Level of Granularity of the Measurement	140
6-3.4 Identification of Applications	141
6-3.5 Identification of Triggering Events	141
6-3.6 Identification of Functional Processes	141
6-3.7 Identification of Data Groups	142
6-3.8 Identification of Data Movements.....	143
6-3.9 Applying the Measurement Function.....	144
6-4 ISO/IEC 29881 FiSMA Functional Sizing	145
6-4.1 Characteristics	145
6-4.2 Advantages of ISO/IEC 29881 FiSMA	147
6-4.3 Challenges.....	147
6-5 How to Choose the Best Sizing Method.....	148
6-5.1 Model Accuracy	149
6-5.2 Which Method is Best?.....	149

6-6 Metrology and Measurement Accuracy	150
6-6.1 The Role of Transfer Functions in Measurements	151
6-6.2 A Sample Functional Size Measurement.....	151
6-7 Conclusion	153
Chapter 7: The Modern Art of Developing Software	155
7-1 Using UML 2.0 Sequence Diagrams in Agile	155
7-1.1 Sizing Sequence Diagrams	156
7-1.2 Embracing Change with User Stories.....	157
7-1.3 Sequence Diagramming in User Stories	158
7-1.4 Functional Sizing and Software Project Management	159
7-2 Counting Data Movement Maps with ISO/IEC 19761	160
7-2.1 Objects of Interest	160
7-2.2 Functional Processes	161
7-2.3 Triggers	161
7-2.4 Data Groups	162
7-2.5 Persistent Store.....	162
7-3 The Employee Database sized with ISO/IEC 19761	162
7-3.1 The Purpose.....	163
7-3.2 The Scope	163
7-3.3 Functional User Requirements	163
7-3.4 Functional Processes	164
7-3.5 Data Groups	165
7-3.6 Data Movements.....	167
7-4 The Sphygmomanometer Case.....	167
7-4.1 The Sphygmomanometer – a Medical Instrument	168
7-4.2 Functional Size according ISO/IEC 20926 IFPUG.....	168
7-4.3 Functional Size according ISO/IEC 19761 COSMIC.....	171
7-4.4 Comparing the COSMIC and the IFPUG Approach.....	173
7-5 The Web Ticket Shop Case	173
7-5.1 The Ticket Shop as an IFPUG Transaction Map	173
7-5.2 The Ticket Shop as a Data Movement Map	175

7-5.3 The Fast Ticket Apps.....	177
7-6 Mobile ID: Use Smartphone for Authentication	181
7-6.1 User Stories as Functional User Requirements	181
7-6.2 Mobile ID with GPS Sensing.....	182
7-6.3 Mobile ID Peer Service Architecture.....	182
7-6.4 The Mobile ID Get Credentials Application.....	183
7-6.5 The Mobile ID Service Application.....	184
7-6.6 The Mobile ID SIM Application	186
7-7 Conclusion	186
Chapter 8: Lean & Agile Software Development.....	189
8-1 Introduction.....	189
8-2 Lean & Agile Software Development.....	190
8-2.1 Detecting 無駄 (Muda) by Transfer Functions.....	190
8-2.2 Business Drivers and Functional User Requirements.....	190
8-2.3 Profiling Business Drivers	191
8-2.4 Transfer Functions for Root-Cause Analysis.....	192
8-2.5 Functional Effectiveness	193
8-2.6 User Stories and Functional User Requirements	193
8-3 A Sample Travel Helpdesk Project	195
8-3.1 Requirements.....	195
8-3.2 Business Driver Profile	197
8-3.3 Functional Effectiveness	198
8-3.4 Visualization of Muda for Agile Teams	198
8-3.5 Determining Business Impact for Story Cards.....	200
8-3.6 The Buglione-Trudel Matrix	200
8-3.7 Six Steps to Completion.....	204
8-3.8 The Kanban Chart.....	205
8-3.9 Harvesting Developer's Intelligence.....	206
8-3.10 Controlling Agile Development	206
8-3.11 Controlling Functional Coverage.....	207
8-4 Early Project Estimation the Six Sigma Way	207

8-4.1 Applying Traditional Estimation Approaches to Agile.....	208
8-4.2 Effort Prediction in Agile Methodologies	208
8-4.3 Business Drivers and Customer Needs	209
8-4.4 Calibrating Story Points.....	209
8-4.5 Early Estimation by a QFD Workshop	210
8-4.6 The Sundeck Matrix Prediction	212
8-4.7 Completing the Cost Prediction by Micro Estimation	213
8-4.8 Quality Management by Cost Prediction.....	214
8-5 Conclusion	217
Chapter 9: Requirements Elicitation	219
9-1 The New Economics by Deming	219
9-1.1 The Cosmic Inflation in the ICT of the 21 st Century.....	219
9-1.2 Arduino Technology	220
9-1.3 Three-dimensional Printing	221
9-1.4 Creating new Gadgets.....	222
9-2 Requirements Prioritization By Customer's Needs.....	222
9-2.1 Identify Customer's Needs.....	222
9-2.2 Functional and Non-functional Requirements.....	223
9-2.3 Non-Functional Requirements in Software	224
9-2.4 Evolution of Ticket Automata in Last Decennials	225
9-2.5 Assessing Non-Functional User Requirements (SNAP)	225
9-3 The Car Door Example.....	226
9-3.1 Initial Wrong Solution Approach.....	227
9-3.2 Improved Controls	228
9-3.3 Measuring the Transfer Function.....	229
9-4 Uncovering Hidden Requirements	229
9-4.1 Importance.....	231
9-4.2 Satisfaction.....	231
9-4.3 Combining Importance and Satisfaction.....	232
9-4.4 Agile Product Development	232
9-4.5 User Requirements as Controls	233

9-4.6 Detecting Missing Requirements	234
9-4.7 Completing User Requirements	235
9-5 The Kitchen Helper Case	236
9-5.1 Stakeholder’s Priorities Using AHP	237
9-5.2 User Requirements and Stakeholder’s Business Drivers	239
9-5.3 The Data Movement Map for the Kitchen Helper	239
9-5.4 The Buglione-Trudel Matrix for The Kitchen Helper	242
9-5.5 Detecting Fatal-Blow Requirements	245
9-6 Conclusions	246
Chapter 10: Software Testing and Defect Density Prediction	247
10-1 Introduction	247
10-1.1 What are Defects?	248
10-1.2 A-defects, B-defects, and C-defects	249
10-1.3 Fault Slip-Through Model	252
10-1.4 Technical Debt	254
10-2 Key Factors for Defect Density	256
10-2.1 Stakeholders	256
10-2.2 Transfer Functions and QFD	257
10-3 A Model for Defect Density Calculation	258
10-3.1 Measuring Defects	258
10-3.2 Counting Rules for Defects Counting	259
10-3.3 A Sample Defect Count	259
10-4 Defect Density Prediction by Measurement	261
10-4.1 Business Impact	261
10-4.2 Assessing Test Effectiveness	262
10-4.3 Dependency from Test Intensity	262
10-5 The Ticket App Example	263
10-5.1 Business Drivers for the Ticket App	263
10-5.2 Functional Effectiveness	263
10-5.3 Test Effectiveness	264
10-5.4 Defect Reporting	266

10-5.5 Test Status Reporting	267
10-6 Defect Density Prediction by σ Control Charts	268
10-6.1 Precondition	268
10-6.2 Statistical Process Control for Defect Tracking	268
10-6.3 Predicting Defect Density	268
10-7 Conclusions	269
Part Three: Lean Six Sigma Applications	271
Chapter 11: Application to Product Management	273
11-1 Transfer Functions in Product Management	273
11-1.1 What are Market's Preferences?	273
11-1.2 Deming Value Chains	274
11-1.3 Deming Value Chain for Software Products	275
11-1.4 Control by Measurements	276
11-2 A Call Center Example from Long Time Ago	276
11-2.1 Call Center Market Share	277
11-2.2 Market Preferences	278
11-2.3 Improving the Assumptions	279
11-2.4 Learning from Incomplete Knowledge	280
11-3 The Ideal Situation.....	281
11-3.1 The Lanchester Theory.....	281
11-3.2 Predicting Market Share Battles	282
11-3.3 The Shooting Range of a Competitor.....	283
11-3.4 „The Strategy of the Weak “	284
11-3.5 „The Strategy of the Strong “	284
11-3.6 New Lanchester Applied to Call Center Example.....	284
11-3.7 Creating a Winning Product	286
11-4 The Web Portal Example	286
11-4.1 Market Share	287
11-4.2 The New Lanchester Transfer Function.....	287
11-4.3 Improving the Web Portal.....	289
11-4.4 Validation with Kano	290

11-5 Overcoming Difficulties.....	291
11-5.1 Identifying Market Preferences	291
11-5.2 Using the IT Product Compass.....	292
11-5.3 Filling the Matrix	293
11-5.4 Analyzing Support Cases	293
11-5.5 Using Traditional QFD Workshop Techniques.....	294
11-5.6 Closing the Convergence Gap	294
11-6 Conclusions	294
Chapter 12: Effort Estimation for ICT Projects	297
12-1 Why is Software Project Estimation so Difficult?	297
12-1.1 What are Project Estimations?	298
12-1.2 Functional Size	299
12-1.3 Macro Estimations	299
12-1.4 Micro Estimations	299
12-1.5 Benefits	300
12-2 The Traditional Approach to Parametrization.....	300
12-2.1 Types of Software Project Cost Estimation	300
12-2.2 The ISBSG Benchmarking Database	301
12-3 Parametric Approaches to Cost Prediction.....	302
12-3.1 Cost Drivers.....	302
12-3.2 Measuring the Response of the Software Project Process.....	303
12-3.3 The Estimation Formula	304
12-3.4 Combining with Functional Size	305
12-3.5 Calibration	306
12-3.6 Quality of Estimations	306
12-4 Estimation Stacks as Transfer Functions.....	307
12-4.1 Selecting Cost Drivers.....	308
12-4.2 Quality of Estimation Stacks	308
12-4.3 Actual Estimation	309
12-4.4 Eigenvectors as Quality Criteria.....	309
12-5 Quality of Estimations in Practice	310

12-5.1 The ISBSG Sample Estimation Stack.....	311
12-5.2 The GUFPI-ISMA Productivity Impact Factors	312
12-5.3 Estimating Another Project based on the PIF	315
12-6 Conclusion	317
Chapter 13: Dynamic Sampling of Topic Areas	319
13-1 Introduction.....	319
13-2 Combinatory Logic.....	319
13-2.1 The Graph Model of Combinatory Logic.....	320
13-2.2 The Application Operation	322
13-2.3 The Graph Model Calculus	323
13-2.4 Sample Arrow Terms	324
13-3 Universal Models.....	326
13-3.1 QFD Deployments are a Model of Combinatory Algebra.....	326
13-3.2 The Lambda Theorem.....	327
13-3.3 Measuring Potential Knowledge Deployment.....	328
13-4 Testing the Internet of Things.....	329
13-4.1 A Simple IoT Testing Case	329
13-4.2 Connecting IoT Devices to the Database Application.....	330
13-5 Automated Test Case Generation	332
13-5.1 The Future of Software Testing	333
13-6 Conclusions	333
Appendices	335
Appendix A: Linear Algebra in a Nutshell.....	337
A-1 Vector Spaces	337
A-2 Linear Transformations	341
A-3 Matrices.....	345
Appendix B: Eigenvalues and Eigenvectors	353
B-1 Basic Definitions and Results	353
B-2 Eigenvalues & Eigenvectors for Symmetric Matrices.....	356
B-3 The Power Method.....	358
Appendix C: The Perron-Frobenius Theory	359

C-1	Preliminaries	359
C-2	The Perron Theorem	361
C-3	The Perron-Frobenius Theorem	364
C-4	Perron-Frobenius for Symmetric & Positive Matrices	365
	Bibliography	367
	Reference Index	377