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Renyan Jiang

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(质量与可靠性工程基础)

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Renyan Jiang
School of Automotive and Mechanical
Engineering
Changsha University of Science
and Technology
Changsha
China

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Preface

Manufacturing businesses need to develop new products and improve current products to better meet consumer needs in order to survive and grow in a fierce competitive environment. Customers have expectations regarding product performance over time. Product quality and reliability are crucial competence factors and hence the major concerns of manufacturing industries. To achieve world-class quality, the manufacturer of a product must satisfy customer needs using various models, tools, and techniques to help manage reliability and quality for new and current products.

The life cycle of a product refers to several stages from its conception, through design and manufacture, to service and disposal. Each stage can add value to the product and the magnitude is characterized by a well-known smile curve shown in Fig. 1. As can be seen from the figure, the efforts made in the pre-manufacturing and post-manufacturing stages can result in greater value than the value resulting from the efforts made in the manufacturing stage. This implies that manufacturing businesses not only emphasize on the manufacturing stage of the product life cycle but also need to get into the pre-manufacturing (design and development) and post-manufacturing (post-sale support). In order to do this, engineers need to be educated on product reliability and quality.

The education on quality and reliability engineering becomes essential to train product engineers. This book is written as an introductory textbook for senior undergraduate and postgraduate students in various engineering and management programs and can be used as a reference book for researchers and engineers in related fields. It provides readers with a primary training in quality and reliability engineering in the real industrial context.

This book focuses on concepts, models, tools, and techniques of quality and reliability in the context of product life cycle. These can be used for deciding the reliability for new product, ensuring certain level of quality of the product, assessing the quality and reliability of current products being manufactured, and improving the reliability and quality of the product.

The book comprises 17 chapters organized into four parts and some extra materials. The first part consists of six chapters and aims to provide basic concepts

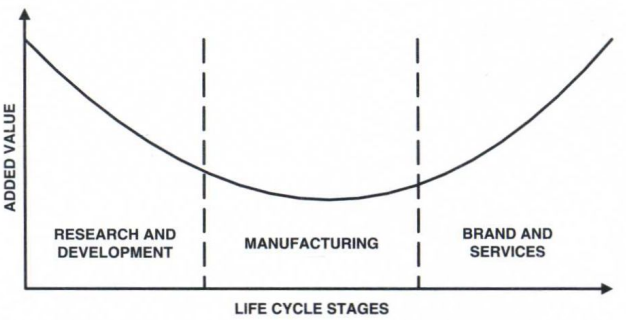

Fig. 1 Smile curve

and background materials such as product life cycle, basic concepts of quality and reliability, common distribution models in quality and reliability, basic statistical methods for data analysis and modeling and, models and methods for modeling failure point processes.

The second part consists of five chapters and deals with major quality and reliability problems in product design and development phase. The covered topics include design for X, design for quality, design for reliability, and reliability tests and data analysis.

The third part consists of four chapters and deals with quality and reliability problems in product manufacturing phase. The covered topics include product quality variations, quality control at input, statistical process control, and quality control at output.

The fourth part consists of two chapters and deals with product warranty and maintenance.

The extra materials consist of three appendices and deal with some important theories and tools, including multi-criteria decision making analysis techniques, principal component analysis, and Microsoft Excel, with which a number of real-world examples in this book can be computed and solved. Exercises for each chapter are also included in extra materials.

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Abbreviations

5M1E	Materials, Manufacture, Man, Machine, Measurements, and Environment
ADT	Accelerated Degradation Testing
AGREE	Advisory Group on Reliability of Electronic Equipment
AHP	Analytic Hierarchy Process
AIC	Akaike Information Criterion
ALT	Accelerated Life Testing
AMSAA	Army Materiel Systems Analysis Activity
AOQ	Average Outgoing Quality
AQL	Acceptable Quality Level
ARINC	Aeronautical Radio, Inc.
ARL	Average Run Length
ATS	Average Time to Signal
CA	Customer's Attributes
CAD	Computer-aided Design
CAE	Computer-aided Engineering
CAQ	Computer-aided Quality
CBM	Condition-Based Maintenance
CDF (cdf)	Cumulative Distribution Function
CHF (chf)	Cumulative Hazard Function
CM	Corrective Maintenance
CMMS	Computerized Maintenance Management System
CNC	Computer Numerical Control
CV	Coefficient of Variation
DEA	Data Envelopment Analysis
DFA	Design for Assembliability
DFD	Design for Disassembliability
DFL	Design for Logistics

DFM	Design for Manufacturability
DFMAIN	Design for Maintainability
DFR	Design for Reliability
DFRc	Design for Recyclability
DFSp	Design for Supportability
DFSv	Design for Serviceability
DFT	Design for Testability
DFX	Design for X
DOE	Design of Experiments
EC	Engineering Characteristics
EDF	Empirical Distribution Function
ELECTRE	Elimination et Choice Translating Reality
EMM	Expectation-Maximum Method
ESS	Environmental Stress Screening
ETA	Event Tree Analysis
FEF	Fix Effectiveness Factor
FMEA	Failure Mode and Effects Analysis
FMECA	Failure Mode, Effect, and Criticality Analysis
FMS	Flexible Manufacturing System
FRACAS	Failure Reporting, Analysis, and Corrective Action Systems
FRW	Free Replacement Warranty
FTA	Fault Tree Analysis
HOQ	House of Quality
HPP	Homogeneous Poisson Process
IID (i.i.d.)	Independent and Identically Distributed
ISO	International Organization for Standardization
KMM	Kaplan–Meier Method
LCC	Life Cycle Cost
LCL	Lower Control Limit
LHS	Left-Hand Side
LSL	Lower Specification Limit
LSM	Least Square Method
MCDM	Multi-Criteria Decision Making
MCF	Mean Cumulative Function
MDT	Mean Downtime
MLE	Maximum Likelihood Estimation (Estimate)
MLM	Maximum Likelihood Method
MRL	Mean Residual Life
MROM	Mean Rank Order Method
MSE	Mean Squared Error
MTBF	Mean Time between Failures
MTTF	Mean Time to Failure

MTTR	Mean Time to Repair
MVF	Mean Value Function
NAM	Nelson–Aalen Method
NHPP	Nonhomogeneous Poisson Process
OC	Operating Characteristic
OCAP	Out-of-Control-Action-Plan
OEE	Overall Equipment Effectiveness
PAA	Part Average Analysis
PCA	Principal Component Analysis
PCI	Process Capability Index
PDCA	Plan-Do-Check-Action
PDF (pdf)	Probability Density Function
PEM	Piecewise Exponential Method
PHM	Prognostics and Health Management
PHM	Proportional Hazard Model
PLC	Product Life Cycle
PLM	Product Lifecycle Management
PLS	Partial Least Squares
PM	Preventive Maintenance
PMF (pmf)	Probability Mass Function
PRW	Pro-rata Rebate Warranty
QFD	Quality Function Deployment
RAMS	Reliability, Availability, Maintainability, and Safety (or Supportability)
RBD	Reliability Block Diagram
RBM	Risk-Based Maintenance
RCM	Reliability-Centered Maintenance
RHS	Right Hand Side
RMS	Root Mean Square
RP	Renewal Process
RPN	Risk Priority Numbers
RUL	Remaining Useful Life
SA	Supportability Analysis
SPC	Statistical Process Control
SSE	Sum of Squared Errors
SSP	Supplier Selection Problem
TAF	Test-Analysis-and-Fix
TBF	Time Between Failures
TBM	Time-Based Maintenance
TFT	Test-Find-Test
TOPSIS	Technique for Order Preference by Similarity to an Ideal Solution
TPM	Total Productive Maintenance
TQM	Total Quality Management
TTF	Time to Failure

TTFF	Time to the First Failure
TTT	Total Time on Test
UCL	Upper Control Limit
USL	Upper Specification Limit
VOC	Voice of Customer
WPM	Weighted Product Model
WPP	Weibull Probability Paper
WSM	Weighted Sum Model
ZIP	Zero-Inflated Poisson

Contents

Part I Background Materials

1 Overview 3
1.1 Introduction 3
1.2 Product and Product Life Cycle 3
1.2.1 Product 3
1.2.2 Product Life Cycle 4
1.2.3 Technology Life Cycle of a Product 4
1.3 Notions of Reliability and Quality. 5
1.3.1 Product Reliability 5
1.3.2 Product Quality 6
1.3.3 Link Between Quality and Reliability 7
1.4 Objective, Scope, and Focus of this Book 8
1.5 Outline of the Book 8
References. 9

2 Engineering Activities in Product Life Cycle 11
2.1 Introduction 11
2.2 Engineering Activities in Pre-manufacturing Phase 11
2.2.1 Main Activities in Front-End Stage 11
2.2.2 Main Activities in Design and Development Stage . . . 12
2.3 Engineering Activities in Production Phase 15
2.3.1 Types of Production Systems 15
2.3.2 Production System Design 16
2.3.3 Quality Control System Design. 19
2.3.4 Production Management 22

2.4 Engineering Activities in Post-manufacturing Phase 22
2.4.1 Main Activities in Marketing Stage 22
2.4.2 Main Activities in Post-sale Support Stage 22
2.4.3 Recycle, Refurbishing, and Remanufacturing 23
2.5 Approach for Solving Quality and Reliability Problems 24
References 24

3 Fundamental of Reliability 27
3.1 Introduction 27
3.2 Concepts of Reliability and Failure 27
3.2.1 Reliability 27
3.2.2 Failure 28
3.2.3 Failure Mode and Cause 29
3.2.4 Failure Mechanism 29
3.2.5 Failure Severity and Consequences 30
3.2.6 Modeling Failures 30
3.3 Reliability Basic Functions 31
3.3.1 Probability Density Function 31
3.3.2 Cumulative Distribution and Reliability Functions 32
3.3.3 Conditional Distribution and Residual Life 33
3.3.4 Failure Rate and Cumulative Hazard Functions 34
3.3.5 Relations Between Reliability Basic Functions 35
3.4 Component Bathtub Curve and Hockey-Stick Line 36
3.5 Life Characteristics 37
3.5.1 Measures of Lifetime 37
3.5.2 Dispersion of Lifetime 40
3.5.3 Skewness and Kurtosis of Life Distribution 41
3.6 Reliability of Repairable Systems 41
3.6.1 Failure-Repair Process 41
3.6.2 Reliability Measures 43
3.6.3 Failure Point Process 44
3.7 Evolution of Reliability Over Product Life Cycle 46
3.7.1 Design Reliability 46
3.7.2 Inherent Reliability 47
3.7.3 Reliability at Sale 47
3.7.4 Field Reliability 47
3.7.5 Values of Weibull Shape Parameter Associated with Different Reliability Notions 48
References 48

4 Distribution Models 51
4.1 Introduction 51
4.2 Discrete Distributions 51
4.2.1 Basic Functions of a Discrete Distribution 51
4.2.2 Single-Parameter Models 52
4.2.3 Two-Parameter Models 53
4.2.4 Hypergeometric Distribution. 56
4.3 Simple Continuous Distributions. 57
4.3.1 Weibull Distribution 57
4.3.2 Gamma Distribution 58
4.3.3 Lognormal Distribution 59
4.4 Complex Distribution Models Involving Multiple Simple Distributions. 59
4.4.1 Mixture Model 59
4.4.2 Competing Risk Model 60
4.4.3 Multiplicative Model. 61
4.4.4 Sectional Models 62
4.5 Delay Time Model 64
References. 66

5 Statistical Methods for Lifetime Data Analysis 67
5.1 Introduction 67
5.2 Reliability Data 67
5.2.1 Sources and Types of Data 67
5.2.2 Life Data. 68
5.2.3 Performance Degradation Data 72
5.2.4 Data on Use Condition and Environment. 72
5.3 Nonparametric Estimation Methods for cdf. 73
5.3.1 Complete Data Case 73
5.3.2 Grouped Data Case. 73
5.3.3 Alternately Censored Data Case 74
5.4 Parameter Estimation Methods 79
5.4.1 Graphical Method. 79
5.4.2 Method of Moments 80
5.4.3 Maximum Likelihood Method 81
5.4.4 Least Square Method. 83
5.4.5 Expectation-Maximum Method. 83
5.5 Hypothesis Testing 84
5.5.1 Chi Square Test 84
5.5.2 Kolmogorov–Smirnov Test 85
5.6 Model Selection 85
5.6.1 Likelihood Ratio Test 86
5.6.2 Information Criterion. 87
References. 87

6 Reliability Modeling of Repairable Systems 89
6.1 Introduction 89
6.2 Failure Counting Process Models 90
6.2.1 Renewal Process 90
6.2.2 Homogeneous Poisson Process 91
6.2.3 Nonhomogeneous Poisson Process 91
6.2.4 Empirical Mean Cumulative Function 92
6.3 Distribution Models for Modeling Failure Processes 93
6.3.1 Ordinary Life Distribution Models 93
6.3.2 Imperfect Maintenance Models 94
6.3.3 Variable-Parameter Distribution Models 94
6.4 A Procedure for Modeling Failure Processes 94
6.4.1 An Illustration 94
6.4.2 Modeling Procedure 95
6.5 Tests for Stationarity 96
6.5.1 Graphical Methods 97
6.5.2 Tests with HPP Null Hypothesis 97
6.5.3 Tests with RP Null Hypothesis 100
6.5.4 Performances of Trend Tests 101
6.6 Tests for Randomness 102
6.6.1 Runs Above and Below Median Test 102
6.6.2 Sign Test 104
6.6.3 Runs Up and Down 104
6.6.4 Mann–Kendall Test 105
6.6.5 Spearman Test 105
6.6.6 Discussion 106
6.7 Tests for Normality and Constant Variance 106
6.7.1 Tests for Normality 107
6.7.2 Tests for Constant Variance 108
References 108

Part II Product Quality and Reliability in Pre-manufacturing Phase

7 Product Design and Design for X 113
7.1 Introduction 113
7.2 Product Design and Relevant Issues 113
7.2.1 Product Design 113
7.2.2 Key Issues 114
7.2.3 Time-Based Product Design 114
7.2.4 Design for Life Cycle 115
7.2.5 Design for X 115

7.3 Design for Several Overall Performances 116
7.3.1 Design for Safety 116
7.3.2 Design for Environment 119
7.3.3 Design for Quality 119
7.3.4 Design for Reliability 120
7.3.5 Design for Testability 120
7.4 Design for Production-Related Performances 121
7.4.1 Design for Manufacturability 121
7.4.2 Design for Assembliability 121
7.4.3 Design for Logistics 122
7.5 Design for Use-Related Performances 123
7.5.1 Design for Serviceability 123
7.5.2 Design for Maintainability 124
7.5.3 Design for Supportability 125
7.6 Design for Retirement-Related Performances 125
7.6.1 Design for Recyclability 125
7.6.2 Design for Disassembliability 126
References 126

8 Design Techniques for Quality 129
8.1 Introduction 129
8.2 House of Quality and Quality Function Deployment 129
8.2.1 House of Quality 129
8.2.2 Priorities of Engineering Characteristics 131
8.2.3 Satisfaction Degrees of Customer Attributes 132
8.2.4 Quality Function Deployment 133
8.3 Cost of Quality and Loss Function 134
8.3.1 Quality Costs 134
8.3.2 Loss Function 134
8.3.3 Applications of Quality Loss Function 136
8.4 Experimental Optimum Method 137
8.4.1 Basic Idea 137
8.4.2 Specific Procedure 137
8.4.3 Design of Experiments 138
8.4.4 Data Analysis 140
8.5 Model-Based Optimum Method 143
8.5.1 Constraint Conditions 144
8.5.2 Objective Function 144
References 146

9 Design Techniques for Reliability 147
9.1 Introduction 147
9.2 Process of Design for Reliability 147
9.3 Reliability Requirements 148

9.4 Reliability Analysis . . . 149
9.4.1 Change Point Analysis . . . 149
9.4.2 FMEA . . . 149
9.4.3 System Reliability Analysis . . . 150
9.5 Reliability Prediction . . . 154
9.5.1 Empirical Methods . . . 154
9.5.2 Physics of Failure Analysis Method . . . 155
9.5.3 Life Testing Method . . . 157
9.5.4 Simulation Method . . . 157
9.6 Reliability Allocation . . . 158
9.6.1 Reliability Allocation Methods for Nonrepairable Systems . . . 158
9.6.2 Reliability Allocation Methods for Repairable Systems . . . 160
9.7 Techniques to Achieve Desired Reliability . . . 162
9.7.1 Component Deration and Selection . . . 162
9.7.2 Redundancy . . . 165
9.7.3 Preventive Maintenance . . . 165
9.7.4 Reliability Growth Through Development . . . 166
9.8 Reliability Control and Monitoring . . . 166
9.8.1 Reliability Control in Manufacturing Process . . . 166
9.8.2 Reliability Monitoring in Usage Phase . . . 167
References . . . 167

10 Reliability Testing and Data Analysis . . . 169
10.1 Introduction . . . 169
10.2 Product Reliability Tests in Product Life Cycle . . . 169
10.2.1 Reliability Tests Carried Out During Product Development Stage . . . 169
10.2.2 Reliability Tests Carried Out During Product Manufacturing Phase . . . 170
10.2.3 Reliability Tests Carried Out During Product Usage Phase . . . 171
10.3 Accelerated Testing and Loading Schemes . . . 171
10.3.1 Accelerated Life Testing . . . 171
10.3.2 Accelerated Degradation Testing . . . 172
10.3.3 Loading Schemes . . . 172
10.4 Accelerated Life Testing Data Analysis Models . . . 174
10.4.1 Life Distribution Models . . . 174
10.4.2 Stress-Life Relationship Models . . . 176
10.4.3 Inverse Power-Law Model . . . 177
10.4.4 Proportional Hazard Model . . . 177
10.4.5 Generalized Proportional Model . . . 179
10.4.6 Discussion . . . 179

10.5 Accelerated Degradation Testing Models 181
10.5.1 Physical-Principle-Based Models. 182
10.5.2 Data-Driven Models 182
10.5.3 Discussion 184
10.5.4 A Case Study. 184
10.6 Design of Accelerated Stress Testing. 187
10.6.1 Design Variables and Relevant Performances 187
10.6.2 Empirical Approach for ALT Design. 189
References. 192

11 Reliability Growth Process and Data Analysis 193
11.1 Introduction 193
11.2 TAF Process 193
11.3 Reliability Growth Plan Model 195
11.3.1 Reliability Growth Plan Curve 195
11.3.2 Duane Model 195
11.4 Modeling Effectiveness of a Corrective Action 197
11.4.1 Type of Failure Modes 197
11.4.2 Effectiveness of a Corrective Action 197
11.5 Reliability Growth Evaluation Models 198
11.5.1 Software Reliability Growth Models and Parameter Estimation. 199
11.5.2 Discrete Reliability Growth Models for Complex Systems 202
11.5.3 Continuous Reliability Growth Models for Complex Systems 204
11.6 Design Validation Test 208
11.7 A Case Study. 209
11.7.1 Data and Preliminary Analysis 209
11.7.2 Assessment and Prediction of Failure Intensity of Each Mode 209
11.7.3 Prediction of Unobserved Failure Modes 213
11.7.4 Discussion 215
11.7.5 Reliability Growth Plan Curve 216
References. 217

Part III Product Quality and Reliability in Manufacturing Phase

12 Product Quality Variations and Control Strategies. 221
12.1 Introduction 221
12.2 Variations of Quality Characteristics and Their Effect on Product Quality and Reliability 221

12.2.1 Variations of Quality Characteristics and Variation Sources 221
12.2.2 Effect of Unit-to-Unit Variability on Product Quality and Reliability. 223
12.2.3 Effect of Operating and Environmental Factors on Product Reliability 225
12.3 Reliability and Design of Production Systems. 226
12.3.1 Reliability of Production Systems 226
12.3.2 Design of Production Systems 228
12.4 Quality Control and Improvement Strategies. 228
12.4.1 Inspection and Testing. 229
12.4.2 Statistical Process Control 229
12.4.3 Quality Control by Optimization. 230
12.5 Quality Management 232
12.5.1 Principles of Quality Management 232
12.5.2 Quality Management Strategies. 232
12.5.3 ISO Quality Management System 233
References. 234

13 Quality Control at Input 235
13.1 Introduction 235
13.2 Acceptance Sampling for Attribute 235
13.2.1 Concepts of Acceptance Sampling 235
13.2.2 Acceptance Sampling Plan 236
13.2.3 Operating-Characteristic Curve 236
13.2.4 Average Outgoing Quality 237
13.2.5 Acceptance Sampling Based on Binomial Distribution 237
13.2.6 Acceptance Sampling Based on Hypergeometric Distribution 240
13.3 Acceptance Sampling for a Normally Distributed Variable 241
13.4 Acceptance Sampling for Lifetime 242
13.5 Acceptance Sampling for Variable Based on the Binomial Distribution 245
13.6 Supplier Selection 247
13.6.1 A Mathematical Model for Component Purchasing Decision 247
13.6.2 Supplier Selection Problem Involving Strategic Partnership with Suppliers 248
References. 249