

Preface

Most of the products that affect our daily lives are becoming more complex. Quality and Reliability Management—which integrates processes, policies, and reliability predictions from the beginning of the product development life cycle to ensure high levels of product performance and safety—helps companies to address the challenges of increasingly complex systems and globally widespread processes in today’s competitive marketplace.

This book consists of 15 chapters, organized into four parts: Quality Management, Reliability Management, Maintenance Management, and Design, Applications and Practices. It aims to present both theoretical research and practical aspects of product quality and reliability management with particular emphasis on system design, processes, modeling, and its applications. The topics covered include:

Design for reliability	Change-point models
Fatigue reliability assessment	Failure mechanisms and failure modes
Data fusion	Health monitoring
Machine condition monitoring	Multi-criteria analysis
Multivariate process capability	Network reliability
Random replacement and policies	Reliability management
Random environments and uncertainty	Statistical quality management
Safety inspection	System reliability and availability
Maintenance inspection	Surveillance system
System failure behavior	Soft computing
Systemability	Sensor fusion
Ultrasonic inspection	Warranty policy
Supplier quality evaluation	Maintenance and risk management
Multi-state system reliability	Performance monitoring healthcare
Product development life cycle	Product durability design
Applications in automotive industry	Case studies

Each chapter has been written by active researchers and/or experienced practitioners with international reputations in the field and with a hope of bridging the gap between the theory and practice in the area of quality and reliability management. The book consists of four parts.

Part I—*Quality Management*—contains three chapters, focuses on the aspects of supplier quality multicriteria management approach, risk-adjusted monitoring in healthcare quality management, and the area of multivariate statistical process control. Choosing the right supplier quality always plays an important role in decisions—making organizations profitable. The first chapter by Al Salem, Awasthi, and Wang discusses a new multi-criteria multistep approach to evaluate the quality of large data sets of suppliers based on both qualitative and quantitative criteria using the analytic hierarchy process (AHP) among several other techniques. The proposed approach enables customers to deal with suppliers' large data sets and identify the quality of the suppliers. “[Risk-Adjusted Performance Monitoring in Healthcare Quality Control](#)” by Zeng provides in detail an overview of existing studies on risk-adjusted monitoring in healthcare aspects. He also discusses several case studies that illustrate the use of some techniques such as Bayesian for related problems in risk-adjusted monitoring. Some potential research problems in risk-adjusted monitoring using data mining techniques to select significant patient risk factors have also been discussed. “[Univariate and Multivariate Process Capability Analysis for Different Types of Specification Limits](#)” by Chakraborty and Chatterjee gives a brief overview of the process capability index (PCI) for both the bilateral and unilateral specification limits. It is worth noting that to compute the PCI of a process, practitioners need to make sure, or assume, that the quality characteristic under consideration follows normal distribution and the process is under statistical control. The chapter also presents some recent studies in the area of multivariate process capability indices.

Part II—*Reliability Management*—containing three chapters, focuses on the aspects of reliability modeling of complex systems and its applications in practice with the uncertainty of operating environments. In today's highly competitive world, reliability and maintainability are the two most important measures that determine the quality of the product. “[Modeling and Analyzing System Failure Behavior for Reliability Analysis Using Soft Computing-Based Techniques](#)” by Garg discusses an optimization reliability model considering the reliability, availability, and maintainability aspects of complex systems to obtain the optimal values of mean time between failures and mean time to repair for each of its constituent components in the system. Production managers often look at ways to identify the most sensitive stations in order to increase the reliability of the entire manufacturing networks. “[System Reliability Evaluation of a Multistate Manufacturing Network](#)” by Lin, Chang, and Huang discusses graphical transformation and decomposition probability models in order to determine the reliability of multi-state manufacturing networks (MMN) with multiple production lines in parallel and multiple reworking actions. The production managers can use the transformed MMN and decomposed paths approach to develop a decision-making strategy to assign the amount of output that each production line should produce to fulfill the demand. Reliability is

defined as the ability of a system or component to perform its required functions under stated operating conditions for a specified period of time. In reality, the operating environment is often unknown and different from the laboratory or testing environments. “[Systemability: A New Reliability Function for Different Environments](#)” by Persona, Sgarbossa, and Pham provides a literature review of systemability—a concept of reliability with consideration of operating environments. It also discusses recent studies on systemability of age replacement maintenance policy. The chapter also discusses several real-world applications in the automatic packaging machines for beer production, gear component, and motor-cycle drive-system to illustrate the systemability in practice.

Part III—*Maintenance Management*—containing four chapters, focuses on the aspects of maintenance modeling and inspection design policy programs of complex systems and its maintenance applications in practice. “[Innovative Maintenance Management Methods in Oil Refineries](#)” by Bevilacqua et al. aims to discuss an innovative maintenance program applied to the turnaround management and two methodologies based on the risk analysis and the application of criticality index to evaluate the criticalities of equipment and plants. These approaches can be used to optimize the use of economical, human and instrumental resources needed for the refinery maintenance activities. If the age of an operating unit is always known and its failure rate increases with age, it may be wise to replace it before failure on its age. A commonly considered age replacement policy for such a unit is made if the unit is replaced at a total operating time T after its installation or at failure, whichever occurs first. “[Age Replacement Models with Random Works](#)” by Zhao and Nakagawa discusses four age replacement models for an operating unit where it works successively for jobs with random working cycles. Optimal policies for each model that minimizes the expected cost rate are analytically discussed.

“[Availability of Systems with or Without Inspections](#)” by Hwang and Mi provides an overview of availability of systems subject to different inspection policies where failures are subject to either self-announcing or not self-announcing. This chapter also discusses explicitly expressions of the steady-state availability, limiting average availability, and the instantaneous availability of systems with and without inspections.

The modeling of the surveillance systems has recently received wide attention in various applications especially in the security areas. “[Reliability and Maintenance of the Surveillance Systems Considering Two Dependent Processes](#)” by Zhang and Pham discusses the existing works related to surveillance system modeling including sensor deployment, intelligent surveillance system design involving data mining and computer automation techniques, and the attack-defense model that quantifies the interaction behavior between the defender and adversary. The chapter further discusses several recent works in the field of surveillance system reliability modeling with considerations of two stochastic processes.

Finally Part IV of the book contains five chapters, on *Design, Applications and Practices*.

Reliability management is responsible for the oversight of reliability activities. In general there are two basic approaches to managing product reliability: reactive

and proactive. “[Reliability Management](#)” by Schenkelberg discusses the difference between reactive and proactive reliability programs and provides an introduction to the reliability maturity matrix and how to take specific steps to move the organization to proactively managing reliability. Reactive organizations respond to each field failure, to each product testing failure, and to each vendor component failure. Proactive organizations design and build products with an acceptable reliability and anticipate the type and number of field failures. Reliability, time to market, and cost are the three most important factors that determine whether a product is successful in the marketplace or not. “[Design for Reliability and Its Application in Automotive Industry](#)” by Yang discusses effective designs for reliability (DFR) process and techniques, and the integration of DFR into the product life cycle especially in the automobile industry. It describes phases of the product life cycle including product planning phase, design and development phase, design verification and process validation phase, production phase, field deployment phase, and the disposal phase as the terminal phase of a product in the life cycle. A practical application in the automobile industry is discussed to illustrate how DFR improves reliability and robustness.

“[Product Durability/Reliability Design and Validation Based on Test Data Analysis](#)” by Wei et al. discusses several practices in product durability and reliability designs. It also discusses the concepts and approaches on five major aspects which are essentially the procedures of newly developed durability and reliability analysis and design methods. The five aspects are: failure mechanisms and modes, linear data analysis, design curve construction, Bayesian statistics for sample size reduction, and accelerated testing. These approaches can serve as a practical guide for product design engineers and testing managers in their test planning and validation analysis. “[Turbine Fatigue Reliability and Life Assessment Using Ultrasonic Inspection: Data Acquisition, Interpretation, and Probabilistic Modeling](#)” by Guan et al. presents a systematic method and procedure for assessing fatigue reliability of steam turbines using ultrasonic nondestructive inspections. The uncertainties from ultrasonic inspections, flaw characterization, and fatigue model parameters are also discussed. Based on the inspection information, a probabilistic of detection model using a classical log-linear model coupling the actual flaw size and the NDE reported flaw size is developed in order to quantify the uncertainties from flaw sizing and model parameters. An application of steam turbine rotor integrity assessment with actual ultrasonic inspection data is used to demonstrate the overall method. “[Fusing Wavelet Features for Ocean Turbine Fault Detection](#)” by Duhaney, Khoshgoftaar, and Wald focuses on employing feature-level sensor fusion to enable machine learners to detect changes in the operational state of the dynamometer. The authors discuss a machine condition monitoring system that allows for automated detection of changes in the state of a machine being monitored. This chapter also discusses several case studies to show the performance of feature level fusion.

All the chapters are written by more than 35 leading experts in the field with a hope to provide readers the gap between theory and applications and to trigger new research challenges in quality and reliability management in practice.

I am deeply indebted and wish to thank all of them for their contributions and cooperation. Thanks are also due to the Springer staff for their editorial work. I hope that the readers including engineers, teachers, scientists, postgraduates, researchers, managers, and practitioners will find this book a state-of-the-references survey and a valuable resource for understanding the latest developments in quality and reliability management and its applications in process, design, and development of products.

Piscataway, New Jersey
December 2014

Hoang Pham

Quality and Reliability Management and Its Applications

Pham, H. (Ed.)

2016, XVII, 451 p., Hardcover

ISBN: 978-1-4471-6776-1