Book reviews

Design of Experiments with Minitab

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Paul Mathews has nearly 20 years experience 12 years experience in industry, five years as a an academic and six years in quality engineering and applied statistical training and consultancy for a wide range of organizations. He is a Certified American Society for Quality Certified Quality engineer and a Certified Six Sigma Black Belt. He describes himself as a "physicist by education, engineer by experience and a statistician out of necessity".

This book is a practical introduction to design of experiments (DOE) using Minitab software and includes a CD-ROM that contains Excel files with the data from many examples provided in the book. It comprises 11 chapters, nine appendices and a short bibliography.

Chapter 1 deals with basics of presenting data and briefly explains how to use Minitab software. Chapters 2 and 3 introduce respectively descriptive and inferential statistics that are important to methods of designing experiments and analyzing the results. Measures of location, variation and the basics of the normal distribution are covered in Chapter 2. Chapter 3 focuses on hypothesis tests and confidence intervals.

The basic language and concepts required to understand all aspects of DOE are presented in Chapter 4. The concepts introduced here include variables and responses, types of experiments, models, and designs. An 11-step procedure for planning, executing, analyzing, and reporting an experiment is described in detail.

The following two chapters deal respectively with experiments involving single or multiple variables using analysis of variance (ANOVA). First, the theory is introduced and then the design considerations are explained. A number of tables and graphs are used to support the explanations. Advanced ANOVA topics dealing with mixed (fixed and random) variables, nested variables are covered in the following chapter, which primarily covers qualitative experimental variables.

The theme of Chapter 8 is linear regression. The rationale underpinning linear regression is explained first. This is followed by a detailed explanation of the regression coefficients, the satisfying conditions required, confidence limits for the regression line and correlation coefficient, and goodness of fit tests. Multiple regression and general linear models are also briefly covered.

The next two chapters focus respectively on two-level full factorial and fractional factorial experiment designs. In Chapter 9, first, 2^1 factorial experiments are explained

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with the aid of an example. This is followed by explanations of 2^2 and 2^3 factorial designs before extending the procedures to analyses *of* 2^k designs. The application of Minitab for creating and analyzing 2^k designs is included. Chapter 10 explains how to cut back on the size of experiments as k gets very large, using fractional factorial designs, and how to interpret the results obtained by using the Minitab software. The final chapter deals with designs for quadratic models or response-surface designs.

Two valuable features that standout are the numerous worked examples that support the chapters and detailed instructions and examples given for calculating sample sizes for most common DOE problems. The topic of sample size is especially useful considering the cost implications of using wrong sample sizes. The accompanying CD-ROM contains descriptions of simple experiments, involving magic dice, paper helicopters, catapults, etc., that could be conducted at home or in a DOE class. The CD-ROM also contains Minitab macros for analyzing various designs covered in the earlier chapters. It is a really valuable book for those that are interested in designing experiments and analyzing them using Minitab.

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Reliability Engineering: Theory and Practice, 4th edition

A. Birolini
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One of the key components of customer satisfaction (a pillar of the total quality management movement) is the reliability of a product. Hence, knowledge of both theory and practices of reliability engineering (RE) will aid in the pursuit of improving reliability, maintainability, availability and safety of components, equipment and systems.

This book is based on Birolini's 30 years experience in this field both in industry and academia. Alessandro Birolini is Professor emeritus and was full Professor of Reliability Engineering at the Swiss Federal Institute of Technology (ETH), Zurich.

The book comprises eight chapters and nine appendices. The text is supported by 130 figures, 60 tables, and 110 examples. Chapter 1 introduces basic concepts showing how they are related to cost/system effectiveness, and discusses the tasks required to assure quality and reliability of complex equipments and systems. Terms most commonly used in RE and their definitions are given in Appendix 1. In Appendix 2, standards for quality management systems are very briefly (four pages) discussed. Important aspects in defining and realising quality and reliability requirements are

discussed in Appendix 3. Check lists for design reviews and requirements for quality data reporting systems are covered respectively in Appendices 4 and 5.

Reliability analysis during the design phase is the topic of the second chapter. This chapter presents techniques and tools, in seven sections, for failure rate and failure mode analysis of complex equipment and systems considered as non-repairable up to system failure.

Chapter 3 focuses on qualification tests (such as environmental tests, reliability tests, and failure analysis) for components and subassemblies of electrical and electronic equipment and systems. Maintainability, which is a important parameter in the optimization of availability and life-cycle costs of equipments, is the focus of Chapter 4 and is covered in some depth in six sections by considering also spare parts reservation. In Chapter 5, attention is turned to design rules for reliability, maintainability and software quality, incorporating in particular software of the right quality, at the design and development phase, to improve reliability and maintainability of complex equipment and systems.

Chapter 6 is the longest chapter (100 pages) in which reliability and availability of repairable systems is covered in nine sections. The mathematical foundations of basic probability theory are covered in Appendix 6 and the foundations of stochastic processes (Markov, semi-Markov, and semi-regenerative) are given in Appendix 7. Most of the reliability models for systems with redundancy are systematically investigated in this chapter by considering in particular fault tolerant reconfigurable repairable systems including imperfect switching, incomplete coverage, items with more than two states, and phased-mission systems, as well as reward and frequency/duration aspects. A large number of approximations are given.

The last two chapters respectively deal with statistical quality control and reliability tests and the basic aspects of quality and reliability during production including testing and screening procedures for electronic components and assemblies. Theoretical foundations for Chapter 8 are given in Appendix 8 and Appendix 9 contains all relevant charts and tables.

The book also contains useful acronyms and 20-page references used in the text.

All in all, the book of Professor Birolini can be highly recommended. It is more engineering than management oriented and it is thus written as a text book for those versed in maths and working in the field of RE, and as reference book for other including project managers.

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