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Book Reviews

Mechanical Reliability, A Designer's Approach, by Oleg Vinogradov, Hemisphere Publishing Corp., 1991, 142 pages.

Reliability Engineering, P. D. T. O'Connor, Ed., Hemisphere Publishing Corp., 1988, 305 pages.

Engineering Reliability, Fundamentals and Applications, by R. Ramakumar, Prentice Hall, 1993, 482 pages.

System Reliability, Concepts and Applications, by Klaas B. Klaassen and Jack C. L. Van Peppen, Routledge, Chapman & Hall, 1986, 256 pages.

REVIEWED BY R. E. BARLOW*

Mechanical Reliability is concerned with the reliability of mechanical engineering systems. It is very well written and suitable as a textbook since it contains well thought-out engineering problems and examples. It is an introductory text in which reliability is treated as part of the design process. Chapter 1 is an excellent introduction to mechanical engineering with relevant examples. Chapter 2 discusses integrating reliability into design and is the heart of the book.

Chapter 3 examines testing for reliability and presents the standard approach to analyzing data. The usual definition of confidence interval is used on page 81. The author gives the probability, before a sample is taken, that a parameter will lie in an interval determined by the sample to be taken. Most engineers, however, would be interested in the probability that the parameter lies in a specified interval conditional on the data after the sample is taken. This would require a Bayesian approach. A brief discussion of the Bayesian approach with a detailed example applying Bayes' formula is given in the last section of chapter 3. The emphasis is on updating a probability distribution for reliability (i.e., the limiting average of successes for a conceptually infinite population) given test data. The example given is not very convincing as the author indicates and does no justice to this approach.

Reliability Engineering is concerned with both mechanical and electronic systems reliability. It is a reference book consisting of 20 chapters of lectures by different authors and covers a very wide range of topics: system reliability modeling, design for reliability, failure mechanisms of microelectronic devices, power systems, software reliability, reliability testing and quality control. Examples are real engineering problems but discussion has less depth than *Mechanical Reliability*.

Engineering Reliability is primarily concerned with the mathematics of reliability analysis. It is a textbook with 10 chapters, covering standard introductory mathematical reliability problems. It is suitable for a course in industrial engineering but without sufficient engineering examples for a course in mechanical engineering in my view. Examples are more academic than real. There is no real engineering behind the examples and problems given. It very briefly touches on fault tree analysis without showing the power of this technique in discovering failure scenarios.

System Reliability is concerned in the main with electronic systems reliability. It is intended as a textbook with engineering problems and examples. It has 9 chapters together with solutions to problems. The first 2 chapters deal with definitions and commonly used terminology. The author is weak with respect to understanding probability. For example, under definitions on page 12, we find:

> "Probability: One should distinguish predicted, or a priori reliability, which is defined as a sheer likelihood, and proved, or a posteriori reliability, which is retrospective certainty, and is defined as the fraction of surviving items."

The author is totally confused at this point with respect to the concept of probability. He reinforces this judgment on page 115 where he speaks of using Bayes' formula when in fact he is using the "theorem of total probability." This is serious since probability plays a central role in reliability applications.

Summary

Mechanical Reliability is by far the most scholarly and cohesive of the books reviewed. Although the smallest of the books reviewed, it is likely to be of the greatest benefit to the student. With the exception of the material on data analysis, the author has given a very scholarly and well thought-out presentation. Although perhaps more limited in scope than the other books under review, I consider it the best.

Reliability Engineering covers by far the most material but is in many ways the least interesting. It is simply a collection of lecture notes by different authors.

Engineering Reliability is a well written textbook but would not motivate most engineers nor give them insight into the kind of engineering problems they are likely to encounter.

The authors of *System Reliability* have tried to present a serious discussion of engineering reliability problems but clearly do not understand the basics of probability. Hence I would not recommend it for study or reference.

All books reviewed repeat the usual frequentist concept of probability. It makes more sense from an engineering point of view to consider probability as an analytical tool based on judgment. Why would we be interested in the average number of successes in a conceptually infinite population? First of all,

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real populations are necessarily finite. In many cases they may in fact be quite small. Also, in many cases, the amount of data available is quite limited so that information from engineering analysis and past experience should be used. None of the authors seem to have been acquainted with the modern view of probability contained in say, the book by Dennis Lindley, *Making Decisions*. In chapter 1 of *Mechanical Reliability*, the author seems to be struggling with concepts he calls (*a*) physical uncertainty, and (*b*) cognitive uncertainty. However as Lindley points out, there is really only one way to measure uncertainty of an event regardless of whether it is "statistical," i.e., is in a sense repeatable, or "non-statistical." Since probability is at the heart of engineering reliability, this lack of understanding in all books reviewed is a serious deficiency.