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Book review

Probabilistic Reliability Engineering
Genedenko and Ushakov

This book is an authoritative, rigorous treatment of aspects of reliability theory, written by two internationally known scientists and edited by an equally well-known US operations research professor. Its publication in English gives access to a great body of work in the area, which has been published in Russian. The text is well written and easy to read, with useful worked examples to illustrate many of the techniques. According to the authors' preface, the book was originally undertaken in 1987, although some of the references are to literature published after this date. Most of the chapters contain a 'Conclusion' section, which is usually a summary of literature and further reading in the area covered by the chapter. Although this is not what one would normally expect in such a section it is, nevertheless, very helpful.

Almost inevitably, the book commences with an outline of the fundamentals of reliability theory followed by a description of reliability indexes. After this introduction, the book begins to address the application of reliability theory to practical problems. The main areas of treatment are: unrepairable systems, repairable systems, repairable duplicated systems, and two-pole networks. Chapters are also included on load–strength models, analysis of performance effectiveness, optimal redundancy, optimal technical diagnosis, and heuristic methods applied to reliability. Series, parallel and mixed unrepairable systems are treated early in the book, with discussion of more generalized networks being deferred until later. Repairable systems are more difficult to treat with general mathematical models, and are dealt with in this text using mainly Markov models.

The later chapters of the book are concerned with the analysis of systems with complex structures. After a chapter on performance effectiveness in instant and enduring systems respectively, the difficulties of non-reducible two-pole networks are considered. Here, methods of decomposition are covered with a range of examples, and numerical analysis by Monte Carlo simulation is introduced. Optimal redundancy is then described in its context of reliability improvement, and this is followed by a chapter on optimal diagnosis, where recognition and location of failure in the most effective manner is the technical goal. The book ends with a discussion of heuristic methods. The authors avoid the most subjective interpretation of the heuristic approach, and present heuristic methods as approximate or pragmatic methods that are directed at obtaining an answer in systems where the exact solution is prohibitively difficult 'for even Monte Carlo simulation'.

The authors are always aware of the applicability of the mathematics, and use numerous examples to illustrate how the techniques can be used. Wisely, they avoid indulgence in mathematical treatment, frequently truncating the discussion when the method becomes too unwieldy for practical use. In fact, the last four chapters (particularly that on heuristic methods) are devoted to simplifications in the treatment of complex systems, which allow a solution to the reliability problem. This is a refreshing approach, as it allows the engineer to recognize the degree to which a particular system is tractable, and to choose an appropriate method without oversimplifying or running into computational difficulty.

The cover notes indicate that the book could be used by engineers in design, operations research and maintenance, as well as cost analysts and research and development managers. However, for many readers of this journal, much of this book will be of only marginal interest. The examples are more often in electronics or computing, and the relatively few mechanical examples are of a systems nature rather than a component nature. The chapter on load–strength reliability models is of definite interest. It commences with a treatment of static load–strength reliability including idealized distributions, and also a numerical approach whereby discrete statistical data can be used. Cyclic loading is then considered with both fixed and deteriorating strength. Finally, dynamic load–strength models are considered as a generalization of the cyclic loading problem. However, the examples in this chapter are hypothetical rather than being applied specifically to fatigue, and, by the authors' own admission, the treatment of this topic is very brief, as their intention in the book was primarily to treat system reliability.

Overall, it is this reviewer's opinion that the book will be of most use to operations research engineers. The treatment is mathematical and, although reasonably accessible, the investment in time required to appreciate this book and make full use of its contents would require the reader to be primarily rather than marginally involved in OR. For those with an interest in probabilistic fatigue analysis there are other texts that would be more accessible and of more direct use.

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