BOOK REVIEW

Correspondence concerning reviews should be addressed to the Book Review Editor, Professor Jack Kiefer, Department of Mathematics, Cornell University, Ithaca, New York 14850.

RICHARD E. BARLOW AND FRANK PROSCHAN (with contributions by LARRY C. HUNTER), *Mathematical Theory of Reliability*. John Wiley and Sons, Inc., New York, 1965. $11.00. XIV + 256 pp.

Review by J. J. McCALL

The RAND Corporation

This is an excellent book. The spirit of modern reliability theory has been captured and presented in a compact and coherent manner. The need for such a book has been apparent for several years; it is surprising the need has been satisfied so successfully. The methodology utilized throughout is that of applied probability theory. With the exception of an appendix, the statistical properties of reliability problems are not investigated.

Increasing failure rate (IFR) (decreasing failure rate (DFR)) is a concept that recurs throughout the book and in many ways constitutes the unifying theme. The definition of failure rate,

$$(1) \qquad (F(t + x) - F(t))/(1 - F(t)),$$

where F denotes the failure distribution, differs slightly from the usual definition

$$(2) \qquad f(t)/(1 - F(t)),$$

where f denotes the density function. Of course, (2) is easily derived from (1) if (1) is divided by x and $x \to 0$. "A distribution is IFR (DFR) in t if and only if (1) is increasing (decreasing) in t for $x > 0$, $t \geqq 0$, such that $F(t) < 1$." The authors show that this definition of IFR (DFR) distributions is equivalent to stating that $1 - F(x + y)$ is totally positive of order 2 in x and y for $x + y \geqq 0$. The mathematics of totally positive functions has been developed elsewhere (a brief review is presented in an appendix) and is ingeniously exploited in this monograph.

In the past the exponential distribution, which is the boundary between IFR and DFR distributions, has played a prominent role in reliability analysis. The analytical simplicity of this distribution together with its frequent occurrence account for its popularity. However in some cases this popularity has been unwarranted and the introduction and analysis of distributions with monotone failure rate should cause reliability engineers to re-assess the role of the exponential distribution. Nevertheless, this re-assessment should be careful not to underemphasize the practical importance of exponential distributions. While indeed many equipments possess monotone failure rates, the deviation from ex-