



**Review: [Untitled]**

**Reviewed Work(s):**

*Probability and Statistics for Engineers and Scientists* by Ronald E. Walpole; Raymond H. Myers

Jeffrey A. Robinson

*Technometrics*, Vol. 32, No. 3. (Aug., 1990), pp. 348-349.

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I have found numerous things to criticize, but many of these criticisms are minor and, of course, represent personal biases. The book is well written and presents the concepts and limitations of statistical methodology in a much more precise and serious way than most competing textbooks. There is an abundance (837 in all!) of well-chosen exercises at the end of the sections and a review set at the end of each chapter. The exercises stress the concepts, as well as providing computational practice. Brief solutions are provided to the odd-numbered exercises. The availability of the companion video programs "Against All Odds" to supplement the text and motivate the relevance to the real world makes this book a welcome addition to the new generation of introductory statistics textbooks that are aimed at capturing the attention of students instead of turning them off. It is certainly worthy of serious consideration for a general audience at all levels where the mathematical demands need to be relatively low.

Harvey J. Arnold  
Oakland University

**Introductory Statistical Methods: An Integrated Approach Using Minitab**, by Richard A. Groeneveld, Boston: PWS-Kent, 1988, xv + 655 pp.

The author's intent is to provide a textbook for an introductory statistics course that provides students with a foundation for understanding statistics, illustrates the importance of statistics' role in the scientific method, and creates an awareness of the role statistics plays in a technological society (pp. vii and viii). The foundation is built by concentrating on basic principles applied to real-life situations in such areas as medicine, politics, business, sports, and education. This type of situation may stimulate more meaningful associations for students who do not have a strong science or math background. The role of statistics in the scientific method as presented in this book can be exemplified by the author's definition of statistics:

*Statistics is a body of knowledge dealing with the collection, summarization, and presentation of the data as a basis for inference. Statistics is essentially concerned with how justifiable conclusions can be made on the basis of necessarily incomplete information. (p. 4)*

Implementing the statistical principles with a computerized statistical package allows students to see the results of using these principles on many data sets without the burden of numerous hand calculations and shows them how statistical analysis will be carried out in the future.

The book contains 12 chapters titled as follows:

1. What Is Statistics?
2. Summarizing Data
3. Elementary Probability
4. Discrete and Continuous Random Variables
5. Large-Sample Estimation
6. Hypothesis Testing in Large Samples
7. Small-Sample Inference
8. Two-Sample Comparisons
9. Categorical Data
10. Simple Linear Regression
11. Multiple Regression
12. Analysis of Variance

The chapter on random variables introduces the binomial, geometric, Poisson, and normal distributions. The last two chapters include coverage of the general linear-regression model, estimation and prediction, polynomial regression, the completely randomized design for equal or unequal sample sizes, contrasts, and the randomized block design.

The book also contains three appendixes:

- A. A Review of Some Mathematical Notation and Topics
- B. Elementary Commands in Minitab
- C. Statistical Tables

Appendix B explains with examples the concepts basic to using Minitab and the commands referenced in the text.

Each chapter has about five sections with exercises after each section and ends with a summary of the concepts, key words, and Minitab commands presented in it. The material is presented clearly with a nice flow of concepts from section to section. Each section also contains step-by-step examples of executing the techniques, followed by a discussion of the results. For the concepts or techniques for which Minitab can be used, computer printouts with the required Minitab commands and the expected output are displayed. Proofs are included; a few are left for the instructor to provide, if desired. The exercises address each major concept or technique presented in the section and provide adequate practice with different data sets. There are a few more difficult problems and some in which concepts are introduced. Answers to a large number of the exercises are provided after the appendixes.

Use of this book requires a background of no more than two years of secondary-school algebra and no previous experience with Minitab. The appendixes provide reference material from these subject areas at the level required. The material is relatively error-free, but two instances that should be clarified for students are on page 91 (top line), where "mutually exclusive" should read "mutually independent," and on page 477 (line 6), where "jth treatment mean" should read "jth block mean."

Some of the points presented in the book that I feel are important in making students aware of statistics' role in the scientific method are the differentiation between population and sample parameters, the importance of design in estimating parameters or making decisions, the choice of an appropriate technique for a given question, the effect of Type I and Type II errors in testing research hypotheses, and the different questions answered by hypothesis testing and confidence intervals.

This textbook is presented at an elementary level and would not be the best choice for scientists and engineers. It is, however, a book that should definitely be considered for technicians and plant workers when one wants to provide a good basic understanding of statistics. With this foundation, students can apply the basic principles covered to any field.

Carol B. Thompson  
Desert Research Institute

**Probability and Statistics for Engineers and Scientists** (4th ed.), by Ronald E. Walpole and Raymond H. Myers, New York: Macmillan, 1989, xv + 765 pp.

This is a good book full of wonderful examples and exercises with real data. The exposition is outstanding—very clear and well honed—in this fourth edition.

The objective is quite ambitious—"to provide an introductory probability and statistics textbook for students majoring in engineering, mathematics, statistics, or one of the natural sciences." The only stated prerequisite is calculus, although a little matrix algebra appears in the multiple-regression section. The preface also states that the book will "attempt to achieve a balance between theory and applications." Writing a good textbook that is both applied and theoretical for a target audience this diverse is a nearly impossible task. A book such as this is bound to compare unfavorably with more specialized books in their niches, such as those written explicitly for engineers.

The book is intended to provide material for a one-semester or two-semester introductory course. The first eight chapters cover probability, random variables and distributions, expectation, discrete probability distributions, continuous probability distributions, functions of random variables, estimation, and hypothesis testing. These could be the basis for a one-semester course. The second half of the book includes simple linear regression and correlation, multiple regression, one-factor experiments, two-factor and three-factor experiments,  $2^k$  factorials, nonparametric statistics, and statistical quality control. The book contains some sections on sample-size selection and power of tests, material not always found in introductory textbooks.

The first edition appeared in 1972 and was reviewed in the May 1974 issue of *Technometrics* (Feder 1974). The book was praised for its clear exposition and many examples but criticized for not fully using the available statistical-computing capabilities of the time. Feder also questioned the failure to discuss topics such as residual plotting, interactive data analysis, life-data analysis, quality-control methods, and probability plotting. Most of these holes have now been filled. Residual plotting and studentized residuals are discussed in the multiple-regression chapter. The Weibull distribution is presented as a model for lifetime data. A chapter on quality control has also been added. But the latest edition still does not discuss probability plotting, which could naturally have been included with the normal or Weibull distributions, with residual plotting, or with Yates's algorithm.

Other additions to the fourth edition include maximum likelihood estimation, Tukey's multiple-range test, and Plackett-Burman designs. Moreover, more emphasis or additional discussion is included for proportion-defective and life-data problems, degrees of freedom, randomization, graphical displays including box-and-whisker plots, and the relationship between tests and confidence intervals.

There are two ways to interpret this book, as a low-level theory book with lots of additional data and examples or as an applied-statistics book supplemented with enough theoretical development to motivate the mathematically inclined. I believe it is much more the former than the latter. For example, there are 11 theorems stated in the chapter on mathematical expectation including Chebyshev's theorem, which is stated and proved. The central limit theorem is motivated by outlining a proof in an exercise based on a Taylor expansion of the moment-generating function rather than an intuitive approach based on simulations of sample averages. [Feder (1974) also made this comment.] The book contains a lot of data, but not a lot of intuitive data analysis. The format is along mathematical lines providing definitions, examples, theorems, proofs, and discussion.

For an introductory textbook for engineers, the coverage of topics is somewhat uneven. There is a great deal of probability, distribution theory, linear models, and design of experiments. The inclusion of such topics as Bayes's rule, negative binomial distributions, ridge regression, and Resolution III and IV designs attests to this. Other areas important to engineers get little or no attention. The Weibull distribution is presented as a life-data model, and its hazard function is derived. But students are not taught how to estimate the parameters or how to construct a probability plot. The Poisson distribution is presented and motivated as a limiting form of the binomial distribution. But the (homogeneous) Poisson process is defined only in general terms, and the discussion does not indicate that this process is useful for modeling failures that occur on a repairable system. Other processes, such as non-homogeneous Poisson processes and renewal processes, are not mentioned, nor are applications to areas such as reliability growth. The hypergeometric distribution is discussed, but its relevance to acceptance sampling is not.

Some minor problems include a few fairly obvious mistakes in the preface and table of contents. Moreover, in the discussion

of the Weibull distribution, the typesetting of the expression  $\exp(-ax^\beta)$  makes it appear as  $e^{-ax^\beta}$ . On balance, though, the book is remarkably free of errors. Other small problems include referring to the hazard function of the Weibull distribution as the "failure rate." This is a frequent but unfortunate practice, since the concept is easily confused with the rate of occurrence of failures over time of a repairable system. Moreover, "computational" forms of sums of squares are recommended in practice. These are the type that require only one pass through the data but have terrible round-off error properties. The need for computing sums of squares this way ended with the passing of the desk calculator.

In summary, this is very clearly written book covering a lot of material. A major strength is the inclusion of many examples, problems, and data sets taken from real practice. Despite the wealth of data, formal inference is emphasized over intuitive data analysis. There is ample material around which to structure a good course for mathematics, statistics, and some science majors. The tone of the book, however, is too theoretical for engineers in my opinion. To design a good course for engineers, the material would have to be substantially restructured and supplemented.

Jeffrey A. Robinson  
General Motors Corporation

#### REFERENCE

- Feder, P. I. (1974), Review of *Probability and Statistics for Engineers and Scientists*, by R. E. Walpole and R. H. Myers, *Technometrics*, 6, 325.

**Problem Solving: A Statistician's Guide**, by Christopher Chatfield, New York: Routledge, Chapman & Hall, 1988, xvi + 261 pp., \$35 (paperback).

If you are looking for a book dealing with fishbone diagrams, Pareto analysis, process flowcharts, Deming circles, and other problem-solving tools, then this is not the book for you. If you are, however, interested in a good book on data analysis, then this book is definitely your cup of tea. The book should be named *Data Analysis: A Statistician's Guide to Useful Techniques*. The book, although claiming to be problem-solving oriented, is devoted to data analysis.

In all fairness to Chatfield, there are parts of the book devoted to problem solving; for example, there are a few pages devoted to tackling statistical problems, a few pages devoted to the stages of statistical investigation, and a few pages devoted to how to become an effective statistician.

Although the majority of the book is devoted to data analysis, the thrust of the data analysis part of the text is on what Chatfield calls the initial examination of data or initial data analysis (IDA), which I think is a great idea.

IDA is a combination of graphical analysis, numerical analysis of the data, and model formulation. In the words of the author, IDA is a combination of data description and model formulation. IDA is performed so that one can make "a proper analysis proper." If you bought the book just to learn about IDA, it would be money well spent. IDA should be practiced by all statisticians.

The book has two parts and four appendixes. Part 1 deals mainly with IDA; Part 2 deals with problems and solutions. This is an excellent part, as there are a wide variety of problems with solutions.

Appendix A (which should be called Part 3) is a digest of statistical techniques which takes up 15 sections. The 15th section, called Appendix A15, deals with quality control and reliability, but it does not do justice to this topic at all. Appendix B is devoted