BOOK REVIEWS

STATLIB: A Statistical Computing Library

Reviewed by George W. Barton, Jr., Section Leader of General Chemistry Section, Lawrence Livermore National Laboratory, Livermore, CA; Chairman of ASTM Committee E-31 on Computerized Systems.

REFERENCE: Brelsford, W. M. and Relles, D. A., *STATLIB: A Statistical Computing Library*, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1981.

This book will have a very specialized audience. First, you must have a background in and a need for statistics. Then you must have an IBM® 370 series computer or one with the identical command structure, such as an Amdahl. Next, you must obtain the software from Bell Telephone Laboratories. After that, you will need a course or a tutor in the use of STATLIB.

STATLIB itself seems to be a very powerful library of computer programs, designed to address most of the common and many uncommon statistical analyses. The routines can be accessed from FORTRAN or from an extension to the IBM job control language called ISX. Although ISX is a powerful command language, its very brevity contributes to incomprehensibility.

The description of STATLIB is divided into sections covering statistical analyses of two-way matrices, time series analysis, spectrum analysis, table manipulation and analysis, regression analysis, and a triangular matrix package. Along with these are utility and service routines and some special mathematical functions not available in more ordinary computer libraries, such as normal, beta, gamma, F, and t distribution probabilities.

I have not tested the library. My facility is partial to Control Data and Digital Equipment computers. The authors have tried to put STATLIB on non-IBM 370 compatible systems and do not recommend it (p. 390).

As a reference document it is clearly written and well organized. The calling sequences are well described. The book gives examples of the use of the routines and will be very valuable for refreshing your memory.

There is a place for this book, but not for use by itself. It is a reference manual for statisticians who already know how to use STATLIB and IBM systems. I can imagine an excellent course entitled "Use of Computers and Statistical Analysis" for which this book is a required text but only one of the texts required. The primary text would be one on statistics, and that would be the main point of the course. Too often, statistics are misapplied by people who have no feeling for the assumptions underlying a technique. At the other extreme, statistics are not used when they can give great insight because of the labor of arithmetic calculations. STATLIB addresses this latter problem, but not the problem of misapplication. Another secondary text would be the local computer installation's primer for computer users.

If you encounter a statistics course that cites this book as part of its required material and if you have an IBM computer, seriously consider taking it. It may be an excellent and valuable course. But this book probably will be included as part of the course fee, so you will not have to buy it separately.

Acoustic Emission

Reviewed by J. C. Spanner, Chairman of ASTM Subcommittee E07.04 on Acoustic Emission and Secretary of ASTM Committee E-7 on Nondestructive Testing.

REFERENCE: Williams, R. V., *Acoustic Emission*, Adam Hilgier, Ltd., Bristol, England, 1980, 130 pp., $29.00.

In the Introduction (Chapter 1), Dr. Williams states that "... there appears to be no coherent account of the state of acoustic emission technology in the late 1970's" and that this monograph was written to fill that void. After reviewing this book and knowing of no other comparable publication, I conclude that, unfortunately, this void still exists. However, Dr. Williams has provided a well organized and well written account of work conducted in the United Kingdom during the decade of the 1970s. Although he has included references to work done in the United States, Western Europe, and Japan, this coverage is not considered sufficient to adequately represent the progress that was achieved outside of the United Kingdom during the 1970s, especially in Japan and the United States.

Nonetheless, Dr. Williams has made a worthwhile contribution to the acoustic emission (AE) literature by virtue of his comprehensive coverage of recent development and application activity within the United Kingdom and a few other areas of Europe. Dr. Williams' characterization of his book as a "monograph" is correct; it is a concise (118 pages), well referenced, and adequately indexed account of recent work in the United Kingdom. His use of unpublished reference materials enhances the coverage and timeliness of the book, but will be somewhat disconcerting when a reader tries to pursue a reference to a "private communication" to obtain additional information.

The topical coverage seems about what it ought to be. The book includes chapter on AE techniques and systems, and on AE related to metallurgical effects. Chapters 4 through 8 emphasize AE applications with one chapter each devoted to pressurized components, welding processes, offshore platforms, aircraft structures, and fiber-reinforced materials and concrete, respectively.

As in any publication in which an author attempts to survey the work of others, there seem to be errors of interpretation. For example in Section 3.1.3 on codes, Dr. Williams describes the American Society for Mechanical Engineers (ASME) document, Proposed Standard for Acoustic Emission Examination During Application of Pressure as "... straightforward and simple, and concentrates on the location of defects rather than the evaluation of defect severity, and calls for the use of an impulse tester to calibrate location systems." On the other hand he states that "In contrast the ASTM code attempts to give some credence to defect evaluation by categorizing the variation of total counts with applied pressure or load into three distinct categories, A, B, and C, depending on the shape of the curve." Dr. Williams considers it "... not meaningful to categorize the results of AE tests in this way at this state of our knowledge of the behavior of materials under loading conditions." First, it should be recognized that the ASTM document was not intended as a "Code." Rather, the purpose of the ASTM document

is best reflected in its title, ASTM Recommended Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation (E 569). It should also be noted that the ASME document has been issued only for "Trial Use and Comment" and has not yet been approved for adoption in the ASME Boiler and Pressure Vessel Code, even though it was first published in 1975. His characterization of these two documents seems to be reversed since the ASME document classifies AE sources into three categories: Grades A, B, and C; whereas, the ASTM document classifies AE sources into four categories, and the three curves are provided as illustrative examples rather than as criteria for classifying AE sources. Finally it should be recognized that, with very few exceptions, the same individuals participated in the preparation of both of these documents; hence, there are relatively few substantive differences between the two. The basic concepts and the technical approach are quite similar, and the few substantive differences are primarily attributable to the organization and content requirements between an ASME Code document, and an ASTM Recommended Practice document. Another major difference, perhaps, is that those of us who wrote the ASTM document were individually about two years older and collectively at least 20 years wiser.

Some of Dr. Williams' errors and oversights are quite disconcerting. For example, Chapter 1 (Introduction) includes the traditional listing of previous publications which the author considers particularly significant. ASTM's *Acoustic Emission Monitoring of Pressurized Systems, STP 697* is conspicuous in its absence, and in referring to the bibliography compiled by Tom Drouilliard (1979), Tom's last name is misspelled (Drolliard, sic). Similar errors were also noted in the references for Chapter 5 where two of the cited authors' names are misspelled: D. M. Romrell (Rommerell, sic), and E. B. Schwenk (Schwerk, sic). Two puzzling terms were noted in Section 6.3: Dr. Williams refers to "coercion fatigue" in Item (1), and "radio frequency" in Item (2). In the context in which they were used, these two terms were quite baffling to this reviewer (unless perhaps "coercion fatigue" was intended to be "corrosion fatigue"). Section 8.1 contains the potentially misleading statement that "... carbon-fibre-based material has led to some significant work on the use of acoustic emission; in contrast, glass-fibre-reinforced plastics (GFRP) material has received little attention from acoustic emission specialists." This conclusion may derive from Dr. Williams' limited reference sources. Although this statement may be true within the United Kingdom, the inverse is true in the United States if the titles of papers presented at various technical conferences, as well as my personal reference files, accurately reflect the relative amount of U.S. work in these two areas.

In his preface Dr. Williams states that "The over-enthusiastic claims of the early days of the technique have been replaced by healthy, skeptical approaches to new applications...." I agree with Dr. Williams' statement, but in reviewing his book it appeared that he had also succumbed to the "over-enthusiastic" syndrome. I found this to be even more disconcerting than errors of technical interpretation. Many of the judgements made by Dr. Williams with respect to the relative applicability of today's technology exhibit a disturbing lack of healthy skepticism and an overabundance of optimism. For example, Section 4.2.1 contains the statement: "... in many countries acoustic emission monitoring is regarded as an almost essential adjunct to the use of ultrasonic and radiographic testing." I know of no country where this statement is true. Another instance occurs in Section 5.8 with the statement, "The arc welding of nuclear equipment is successfully monitored by acoustic emission and in one instance special equipment has been developed to monitor multi-pass submerged arc welds used in pressure vessel manufacture." This reviewer takes strong exception to this statement which implies that AE is being applied on a routine, production basis to monitor welding processes in the nuclear industry. It has definitely *not* been applied on this basis in the United States, and most of his cited references on this topic were written to describe development programs, not production applications, that were conducted in the United States. Although these are probably among the most obvious examples of "over-enthusiastic" claims, it seemed to this reviewer that numerous judgement conclusions in this book tended to describe AE applications more favorably than can be justified at this time. Let me hasten to say that I do hope that Dr. Williams' optimism will soon be justified, and I fully expect that many of these developmental results will be translated into successful production applications over the next few years.

As noted earlier, this monograph provides a useful compendium of development and application work within the United Kingdom during the past decade. Additionally, since it includes reference material through 1980 and describes some of the more recent AE instrumentation and system concepts, this book would also be useful as a supplementary text for use in short courses and seminars. For example, this monograph could be effectively used in conjunction with another more extensive, but older, text entitled *Acoustic Emission: Techniques and Applications* (available through the American Society for Nondestructive Testing).

All in all, it is expected that Dr. Williams' monograph will generally be regarded as a useful contribution to the AE literature. However, in view of the foregoing comments with respect to errors and misinterpretations, it is suggested that the readers of this book exercise both caution and skepticism with respect to many of the optimistic statements on the actual, or applied, state of the art. This word of caution is particularly appropos for neophytes in this technology who could be mislead by taking all of Dr. Williams' conclusions literally. The experienced practitioner in this field is also cautioned to study the original reference, whenever possible, before applying Dr. Williams' interpretations and conclusions to a specific acoustic emission application problem.

Selected Papers by Alfred M. Freudenthal

Reviewed by James T. P. Yao, Professor of civil engineering, Purdue University, West Lafayette, IN.

REFERENCE: *Selected Papers by Alfred M. Freudenthal. Civil Engineering Classics,* Engineering Mechanics Division, American Society of Civil Engineers, New York, 1981, 805 pp., $54.00.

This volume was published by the American Society of Civil Engineers (ASCE) to honor the late Professor A. M. Freudenthal (1906-1977). As an active member of the Society, he received the Norman Medal in 1948 and again in 1957, and the von Karman

Medal in 1972 from the American Society of Civil Engineers in addition to other honors and medals. In 1975, the ASCE Board of Direction officially instituted the Alfred M. Freudenthal Medal, which is awarded to an individual in recognition of distinguished achievement in safety and reliability studies applicable to any branch of civil engineering.

Because most of Professor Freudenthal's work dealt with mechanical properties of materials and structural fatigue and reliability, the contents of this volume should be of interest to members of ASTM. All of these papers were published in recognized journals and represented pioneering efforts or definitive studies or both at the times of their publication. It is indeed a valuable source of reference materials for serious students of these subject areas.

Although I was familiar with many papers of the late Professor Freudenthal before making this review, I cannot help but be awed by both the broad scope and the great significance of his contributions as given in these 56 selected papers spanning some three decades. The selection was made by an Ad-Hoc Committee on the A. M. Freudenthal Volume, the Engineering Mechanics Division of ASCE. This blue-ribbon committee consisted of Gerard Fox, Robert Heller, Harold Liebowitz, Paul Parisi, M. Shinozuka, and W. R. Spillers.

The volume was subdivided into the following three parts: (1) Structures (14 papers), (2) Theories of Mechanical Behavior of Materials (13 papers), and (3) Fatigue and Reliability (29 papers). In fact, it is difficult to clearly classify some papers into these three categories. For example, the 1961 paper entitled "Reliability Analysis of Fatigue-Sensitive Structures" is listed in Part 2, though it may fit equally well in either one of the other two parts. Nevertheless, it is evident that most of his investigations were concerned with the safety and reliability of structures.

Professor Freudenthal's 1947 paper entitled "The Safety of Structures," which was first published in ASCE Proceedings in Oct. 1945, has been generally recognized as the pioneering work starting the subject area of structural reliability. His 1956 paper on "Safety and the Probability of Structural Failure" gave a definitive treatise and his 1966 paper on "The Analysis of Structural Safety" (co-authored with J. M. Garrelts and M. Shinozuka) remains a comprehensive state-of-the-art review of the classical theory of structural reliability to-date. He remained active in making further developments and contributions to this subject area until his untimely death in 1977 (see his last three papers on "The Scatter Factor in the Reliability Assessment of Aircraft Structures," "Reliability Assessment of Offshore Platforms in Seismic Regions" [with J. N. Yang], and "Structural Optimization and Risk Control" [with H. Kupfer]).

His joint works with the late Professor E. J. Gumbel (for example, "On the Statistical Interpretation of Fatigue Tests," 1953) and Professor R. A. Heller (for example, "On Stress Interaction in Fatigue and a Cumulative Damage Rule," 1959) are indeed classics in fatigue studies dealing with experimental data. On the other end of the spectrum, his ability in applied mathematics and physical insight was illustrated in his papers such as "A Law of Work-Hardening" (with M. Reiner in 1947), "Creep Deformation and Stresses in Pressurized, Long Cylindrical Shells" (with M. P. Bieniek in 1960), "Solution for the Infinite Layer and the Half-Space for Quasi-Static Consolidating Elastic and Viscoelastic Media" (with W. R. Spiller in 1962), and "Second-Order Viscoelasticity in a Filled Elastomer" (with B. Albrecht in 1966). Note that Professor Freudenthal always tried either to (a) confirm his analytical results with the use of experimental data or (b) explain experimental observations on the bases of mathematical and physical laws.

Because of the different sizes of original publications, some of the reprinted papers are reduced to such an extent that it is difficult to read (especially some tables such as those on pages 551 and 552). Nevertheless, the quality of printing is very good otherwise. More importantly, the technical contents are excellent and represent a collection of significant references on viscoelastic and inelastic behavior of materials, fatigue and creep studies, as well as safety and reliability of structures. Professor A. M. Freudenthal was truly a giant among competent structural and materials engineers in the 20th century, and we all can benefit from reading these selected papers.