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Book Review

STATISTICS FOR ANALYTICAL CHEMISTRY. J. C. Miller and J. N. Miller. Ellis Horwood Ltd., Chichester. 1984. Price Cloth, £18.50; Paperback, £7.50. 202 pp.

I have a book by E. L. Bauer called "*A Statistical Manual for Chemists*", published in 1971, and there was an earlier book by W. J. Youden entitled "*Statistics for Analytical Chemists*". Both were very good in their day. But as the authors of the book now under review state in their preface, one reason that has led them to write it is "the enormous impact of microelectronics, in the form of micro-computers and hand-held calculators, on statistics; these devices have brought difficult or lengthy statistical procedures within the reach of all practising scientists". This is very true, and it explains why most of the second half of this book discusses experimental designs for analytical research that, though very useful and productive, would not have been used twenty years ago, because the computations needed to produce maximum information therefrom either had not been worked out by statisticians or would have been impossibly lengthy and complex, even with the calculating machines available at that time. Now, the practicability of such computations means that a chemist who is seeking (for example) to increase the accuracy of an analytical method by varying its parameters is enabled to maximise the conditions with fewer determinations and more assurance than used to be possible.

While these are important considerations for the research worker, Public Analysts and heads of industrial control laboratories alike will be striving to obtain such information about each sample analysed as is relevant to the reason why it was submitted; they must therefore devote much attention to monitoring the analytical methods in use, to ensure that the output from the laboratory in terms of reports is as efficient as possible. "Efficiency" in this context means minimum cost per report while ensuring that each is as detailed, as accurate and as precise as is possible for its required purpose—but not more so if the unnecessary excess in any direction has cost unnecessary money.

For such top people—and for all their subordinates whose ambitions range beyond the laboratory bench—a basic knowledge of statistics is in these days essential, and to this end the first part of this book should be very useful. While the primary principles are expounded as simply as the subject itself permits, many illustrative examples are drawn from analytical experiments and data, and each chapter ends with a number of "test" problems of the same sort, with the solutions at the end of the book.

The important question of the treatment of "outliers" in a set of replicate observations is well discussed in this book (though it is rather surprising that

Cochran's test is not mentioned as well as Dixon's) from a strictly statistical point of view. But the very practical point is not made that the *reason* why the outlier occurred should be looked for, particularly if the set of observations in which it was found can be compared with other similar sets. This is very relevant to a matter with which all Public Analysts have become increasingly concerned lately—collaborative assays, where in the general case w replicates of an analysis by a prescribed method are performed by each of x analysts on each of y samples in each of z laboratories, so that when complete there are available $wxyz$ results for comparison. When properly designed and the results efficiently computed, such assays can yield as much important information about the laboratories as about the method, and it is the responsibility of the Head of each laboratory to go into this aspect of the results as completely as possible.

If (for example) the results from one laboratory are found to include three outliers when there are only three in those from all the other participating laboratories together, there is a strong suggestion that all is not well with the analytical skill of that laboratory as applied to that method, even though the mean result is very close to the other means. Again, a laboratory may obtain a set of replicates agreeing very closely with each other but the mean may differ significantly from those of the other laboratories, pointing to a systematic error arising within the laboratory that is out of step—and which the Head may never have suspected had he not been able to use the other laboratories' results for comparison. The subject of computing the results of collaborative assays is hardly dealt with at all in the book under review; the matter is mentioned on pp. 151/2 as an example of the use of an analysis of variance, but in a book intended for practical chemists the exposition could usefully have been considerably extended.

The latter part of the book will be of interest mainly to research workers trying to improve the precision of an analytical method or the yield in a manufacturing process, and it is noteworthy that to a large extent the book describes what can be done and the principles involved but assumes that anyone really interested will have access to a computer and to a programme suitable to his needs. I agree that having regard to modern conditions, this is completely acceptable.

I have no hesitation in recommending this book to all who wish to become familiar with the principles on which the science of statistics is based and even to be able to make the simpler computations for themselves; and perhaps even more importantly, to be able to understand not so much how an expert statistician conducts his computations as the practical meaning of the conclusions he reaches. I am sure that any M.Chem.A. could, by using this book, acquire at least that degree of expertise in applied statistics; I am equally sure that no Head of a laboratory can be efficient in its management without such knowledge. My advice to any such person who doubts his own abilities in this direction is—get this book.

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