NEW BOOKS

Statistical Methods for Chemical Experimentation

W. L. GORE. xi + 210 pages. Interscience Publishers Inc., 250 Fifth Ave., New York, N. Y., 1952. $3.50. Reviewed by B. B. DAY, U.S. Naval Engineering Experiment Station, Annapolis, Md.

IT CAN be said without fear of contradiction that the chemists rank first among physical scientists in recognizing the value of small-sample statistical theory to research and development and in doing something about it. This is indicated by the number of avowed chemists who have recently written books on the subject. Chronologically these are: Davies 1946, Brownlee 1947, Youden and Villars each 1951, and now Gore with this newest "manual," the subject of this review. This is a healthy situation. Not only should the man in the field present the subject in a more readable form than the statistician, but the cautious doubting chemist is more likely to take the first look at a book if written by another chemist. This imposes a special responsibility on the chemist-writer. He must make sure his statements on a subject are completely accurate and adequate, whether it be for a "manual" or a more ambitious effort.

It is regrettable that a number of discrepancies and inaccuracies were not discovered and corrected in "Statistical Methods for Chemical Experimentation" in manuscript. There is nothing in the preface to indicate that this book was reviewed or edited prior to publication. This omission, plus certain loose writing in the manual, leads one to question whether the author appreciates that statistics is not just a kit of useful tools, but is a Science with well-defined laws and concepts.

Reviewing this book was a difficult task. It is stated that the primary purpose was to fill a need which the author felt none of the current books had done, that is "give an adequate description of how the present knowledge of design of experiments can be applied in chemical investigations," while on the next page it states that the techniques presented, "were chosen by eliminating all except those for which numerous examples could be found in our files." Either of these tasks would have been ample for the size of the book.

A nice job is done in presenting the concepts of the population frequency distribution and that of the parameters of samples drawn from such. However there is a serious error in the figures showing the population distribution against that of the average of samples from the population.

The fact that these are not drawn to scale would not explain why the distribution of the average, with standard deviation, $s/\sqrt{N}$ should have been no higher in one case and actually lower in the other than the curve of the population from which the samples were drawn.

The approach to the analysis of variance and the discussion of the meaning of interaction is good. But, a firmer stand should have been taken here and elsewhere on the principle that variation between duplicate, triplicate, etc., readings is *not* a measure of experimental error. It is too bad to perpetuate among chemists the misunderstanding on this point. It has already been the cause of much wasted effort. There appears to be confusion of thinking as to the meaning of "replicates," "replications." In fact, the treatment of experimental error is inadequate and misleading. It is inferred that there is a choice as to what shall be the error of the experiment instead of emphasizing the fact that the design or plan of the experiment determines what it shall be. Nothing is said regarding the fact that main effect mean squares should be tested against interaction mean squares to answer certain questions. The statement on page 79 beginning with "when it is necessary to discard the 'replicate' variance from the error estimate a great loss in discrimination may result due to losing the large number of degrees of freedom from the error estimate" is erroneous as well as the misuse of the term 'replicate variance.' Such large 'numbers' are not justified and really represent paddings.

There is not sufficient space to adequately cover the chapter on Design of Experiments. Briefly, a few points: the 2×2 latin square, that is the crossover design, is over emphasized to the exclusion of mention of the efficiency in the use of the higher order squares; "Incomplete Designs" are really Youden Squares, a special kind of the incomplete block designs, but the naive would have difficulty identifying these in the standard texts, (higher order interactions *are* included in the design but are confounded with block effects); the discussion on control of bias is good.

It is unfortunate that the simplification and advancements made in the past twenty years in regression analysis are ignored here; for example, the direct method of computing the regression coefficients and the use of Analysis of Variance for testing significance. Two misconceptions should be mentioned: (1) The statement that $r_{03}\beta_3$ measures the contribution of the factor, X_3, to the multiple regression analysis. This contribution is measured by the amount of the reduction in the sum of squares in the error term by including X_3. (2) A negligible correlation between a factor and the dependent variable is an indication that this factor is of no importance. This is not necessarily true, see example (Davies 1946).

It treats concepts of variation, distributions, sampling, Students' t, and a chapter each on Analysis of Variance, Design of Experiments, Correlation and Regression, and Attribute Statistics. There is a tremendous amount of material crammed into only slightly over 200 pages of almost pocket-size. The chemist will want to use the book for it is readable and non-mathematical. However, it is much too abbreviated for those who know no statistics. Specific references at the end of each section would have helped greatly, except that the author has at times adopted his own terminology and definitions to the extent that the reader would be confused trying to read standard texts. It would be good reading for the statistician who is interested in the chemist's approach.

Synthetic Organic Chemistry

ROMEO B. WAGNER AND HARRY D. ZOOK. 887 pages. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall Ltd., London. $11.50. Reviewed by P. H. GROGGINS, Consulting Editor, Journal of Agricultural and Food Chemistry.

SYNTHETIC Organic Chemistry is designed to summarize in a single volume the methods of organic synthesis most frequently employed in the preparation of mono- and di-functional compounds. The methods are collected in chapters, each of which is devoted to the formation of compounds containing a particular functional group.

In each chapter the principal methods of synthesizing compounds containing a specific functional group are treated briefly. The text is supplemented by tables which record other examples and additional references to the literature. In fact the literature coverage is particularly extensive and will be a definite aid to research workers.

The volume serves admirably as a convenient reference work to check on or review methods of synthesis. The material is systematically organized and clearly presented. Equations are used liberally to show type reactions. The book merits a place in university, industrial, and private libraries.