

STATISTICS FOR EXPERIMENTAL DESIGN

Experimental Designs

By Prof. William G. Cochran and Gertrude M. Cox. Pp. ix+454. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 46s. net.

THIS book is essential to every statistician concerned with experimentation. When the discipline of experimental design was first introduced into quantitative biological research, materials and treatments were made to conform to one or two simple patterns, notably the randomized block, Latin square, and simpler factorial types; more recently, the trend has been reversed, with the better purpose of constructing designs that will compare the treatments most precisely within the limitations imposed by the materials. The consequent proliferation of designs has made difficult even the remembering of where papers describing their construction and analysis may be found. Here, for the first time, is a codification of most of the simpler and more useful types.

After an introductory chapter describing the role of statistical science in the planning of experiments, Chapter 2 explains how precision can be modified by replication and by grouping experimental units into blocks. The general principles of the analysis of variance and covariance are expounded in a long third chapter; the basic linear model, and the meaning and advantages of orthogonality, are particularly well illustrated. These three chapters deserve study by all who use statistical science, for they form an excellent account of the relationship between the arrangement of an experiment and its statistical analysis.

Apart from a short chapter on randomization, the remainder of the book consists of systematic discussion of different designs. Randomized blocks, Latin squares, factorial designs (unconfounded and confounded), quasi-Latin squares and the various types of incomplete block designs—balanced and partially balanced, rectangular and cubic lattices, lattice squares, and Youden squares—are all described, with many numerical examples drawn from agricultural, biological, and industrial research. Unless the method of construction is obvious, plans are shown for each type of design, with various numbers of treatments; these plans are indexed according to number of treatments and degree of replication, so that the user may easily find one suited to his needs and has then only to randomize the arrangement. This section of the book will be used for reference rather than for consecutive reading, though it could be the basis of an excellent course of instruction.

Had the authors done no more than list designs and methods of analysis they would have performed a valuable service. In addition, their extensive experience of statistical science has enriched their catalogue with an immense amount of information and advice about the interpretation of experiments. The importance of assumptions used in the analysis of variance, the analysis of experiments when some observations are missing, and the interpretation of series of experiments are among the topics so considered.

When the feast is so bountiful, to ask for more dishes may seem unkind: nevertheless, we must hope that the authors will give us either a second

volume or an expanded second edition. Further consideration of 'mixed' confounding schemes, especially of the incompletely balanced types that are sometimes inescapable, would be helpful. Fractional replication of factorial designs introduces special problems of interpretation, and the absence of numerical examples might be remedied. More might be said about long-term agricultural experiments. Finally, Rao's suggestions for a standardized method of analysis for incomplete block designs might provide an escape from the difficulty of learning a different computational scheme for each type. These remarks relate not to blemishes but to points of departure for future work. "Cochran and Cox" is already, and will long remain, the standard guide to experimental design.

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HUMAN BLOOD GROUPS

Blood Groups in Man

By Dr. R. R. Race and Dr. Ruth Sanger. Pp. xv+290. (Oxford: Blackwell Scientific Publications, Ltd., 1950.) 30s. net.

AT the beginning of the century, Landsteiner described the discovery of the *A*, *B* and *O* blood groups in man. Since that time many efforts have been made to discover other human blood groups. Such methods were by using as test sera suitably absorbed animal sera, and later by the injection of human red cells into animals. This latter method led to the discovery of the *M*, *N* and *P* groups. Subsequent experiments involving the injection of monkey blood into rabbits and guinea pigs and the testing of such antisera against human cells led Landsteiner and Wiener in 1940 to the discovery of the *Rh* blood group.

From this point onwards the discovery of new human blood groups advanced rapidly. This was due not only to the discovery of the *Rh* group, but also to the fact that this group was found to be the main agent in iso-immunization during pregnancy and the cause, in many cases, of haemolytic disease of the newly born. In certain cases the antibodies formed were due to other blood groups. A further factor has been the increasing use of blood transfusions and the study of the occasional reactions resulting from these; this was the way in which the recent 'Duffy' blood group was discovered. New techniques have also been devised for the detection of iso-antibodies, and notable among these have been the use of an anti-human globulin serum for detecting incomplete iso-agglutinins.

This book, by Drs. R. R. Race and Ruth Sanger, describes all the new ideas and the techniques which have been developed within the past ten years and also gives a complete and comprehensive description of the inheritance, characters and method of detection of the human blood groups. The study and understanding of blood-group inheritance is indeed important for, as Prof. R. A. Fisher states in a foreword, there is now a good marker on nine out of twenty-three autosomes; eight of them are blood-group markers.

The book is very readable and inspiring for one who works in this particular field of blood-group serology. One of the most valuable sections is that on the identification of antibodies and the determination of the nature of unknown antibodies occurring in human sera. For the general scientific worker,