Analysis and Presentation of Experimental Results

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Analysis and Presentation of Experimental Results

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Preface

First-degree courses in engineering and science quite rightly require a considerable portion of a student's time to be spent in the laboratory. The teaching of experimental methods is now an accepted part of many degree courses; the recently constituted C.N.A.A. degrees place particular emphasis on the importance of formal instruction in experimentation in engineering courses.

The authors have for some years been associated with a course on experimental methods for first-year students of mechanical engineering at Teesside Polytechnic. This was originally introduced into the curriculum with the object of improving the quality of presentation of course laboratory work, including a final-year research project. With due modesty we may claim to have achieved some success.

In teaching this course we were struck by the lack of guidance available to students on the analysis and presentation of experimental data. Although many excellent textbooks exist on the planning and performance of experiments, their treatment of this important topic is usually perfunctory. The required information is available but is scattered throughout books which are either too expensive or too specialised, or both, for the undergraduate reader. We felt there was a need for a textbook which would for the first time combine the most important and basic of the methods available for data presentation and analysis in a form suitable for assimilation by first-year students.

This book is largely based upon our course. Its size has been deliberately restricted so that it may be conveniently carried as a reference book to be at hand at all times. With this in mind all the tables likely to be required have been included as an appendix. These statistical tables are reproduced, with permission, from H. J. Halstead, *An Introduction to Statistical Methods*, Macmillan Company of Australia Pty. Ltd (1960). At the beginning of the book a flow diagram is given suggesting how the book may most effectively be used.

Throughout the book emphasis has been placed on methods which may be considered as tools of general utility: many of these are statistical. We take the view that, provided it is safe, these methods may legitimately be used without the necessity of a deep understanding of their mathematical derivation. This may well be considered heresy by some professional statisticians, who are generally sensitive about the possible abuse of their techniques. On the other hand most students will study statistics as a subject taught by a statistician. A little duplication is not a bad thing. A different approach to the subject can be enlightening and help to give more meaning to some of the notions when it is seen that they have useful applications. In the past, the considerable amount of repetitive arithmetic involved in statistical calculations has mitigated against their more widespread use. Nowadays most teaching establishments are equipped

with some form of computing aid and much of the drudgery of routine calculations has disappeared.

The methods described in this book (with the possible exception of Chapter 8) could well be introduced in sixth-form colleges where much of the habit-forming takes place. This would ease the transition into the more sophisticated surroundings of university and polytechnic laboratories.

Finally, in all fields of engineering, deterministic methods are giving way to stochastic treatments. The introduction of time-series analysis in Chapter 8 has been included, not only because of its utility as an experimental tool but also because we feel that students should develop an attitude of mind based on probabilistic reasoning as early as possible.

Flow Charts for Error Analysis

The three figures below suggest how the book may most effectively be used as a work of reference, to save time in finding a particular analysis. Numbers in parentheses refer to the relevant chapters.

(All operations shown here refer to chapter 6)