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Book reviews

Experimentation and Uncertainty Analysis for Engineers. Hugh. W. Coleman, W. Glenn Steele (Eds.), Wiley, 2nd edn., 1999, £46.00 (hardback), 275 pp., ISBN 0-471-12146-0

Correctly, the title of this book has the term experimentation appearing before the term uncertainty, because it is foremost a general treatise about experimentation. The reasoning is that engineers need to base their decisions in operations and designs on reliable data. The accuracy of, or uncertainty in, these data is of paramount importance for the quality of the engineering decision making process. Therefore, the guiding criterion is uncertainty, but the structuring of the book is along all aspects of experimentation. We meet general planning, detailed design, debugging, execution, data analysis and the reporting of an experiment. The approach taken is that of a typical engineer. There are extensive quotations from ISO standards, to which the authors had contributed. Further, little knowledge of statistics is assumed, and the necessary statistical background is summarised in one chapter. Thirdly, a thorough analysis is done of all contributions in uncertainty without forgetting that only a few effects determine the uncertainty of the desired quantity. Finally, the design- an engineering activity -of experiments gets the greatest emphasis.

This book is especially suited as a work of reference and for the continuing education of the practising engineer. In addition, the experimental scientist will benefit from the direct approach. The book fits well in an advanced undergraduate engineering course, but the subject does not lend itself for a graduate course.

The authors identify the traditional division between systematic and random errors but, unlike some other texts, they give a balanced treatment of both classes and their contribution to the outcome of the data reduction equation. The propagation of errors is a recurring calculation, which is consistently applied in all descriptions and examples. Added to these general subjects are some specialised topics: asymmetrically distributed errors, and the treatment of correlated errors both in biases and in the random errors. The application of Monte Carlo calculations as an analysis tool is not surprising nowadays in the field of stochastic phenomena, but the authors actually only devote a few pages to the principle, while an application is relegated to the appendix.

With respect to the general treatment of experimentation, it must be stated that the planning and design of experiments really form the core of the treatise. The authors show with relatively simple means how to make proper choices in experiments. However, related subjects are not present. They only mention the existence of factorial design and completely overlook the recent rebirth of model based D, G and E-optimal designs. The execution and data analysis phases are treated in the context of uncertainty modelling, but the book does not open new insights at this level. Data reconciliation is of special importance for chemical engineers. This concept is very briefly mentioned as a balance check.

The examples are often taken from the field of mechanical engineering, but these comprise those in the field of measurements around flows. A chemical engineer easily finds examples relevant to his discipline, while the authors have adhered to the philosophy that the treatment of the examples should be clear to all engineering disciplines. The examples are dealt with in detail with respect to analysis and little specific knowledge is required. A list of unsolved problems completes each chapter, so there is sufficient material to do exercises, and to validate the efforts of the reader in this field.

The procedure of identifying outliers is briefly mentioned and the authors take the unjustified point of view that such measurements should be rejected. This reviewer is of the opinion that such measurements should be re-evaluated and not discarded too lightly.

In conclusion, this book is a complete treatise on the propagation of errors from experimental planning to the results. The authors repeat, and this cannot be repeated too often, that any design of experiment should be preceded by a thorough uncertainty analysis in order to appreciate the value of an experiment and its results.

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