Journal of Fluids and Structures (2000) **14,** 441–442
doi:10.1006/jfls.1999.0271, available online at http://www.idealibrary.com on IDEAL®

BOOK REVIEW

APPLIED DIMENSIONAL ANALYSIS AND MODELING

THOMAS SZIRTES

McGraw-Hill, New York, 1998, 815 pp; ISBN 0-07-062811-4

SCIENTISTS AND ENGINEERS alike will find this book a unique treasure of information. Its scope is applicable to virtually every engineering discipline and scientific endeavor, and should become a must have reference for every technically oriented individual. The book develops a heretofore unpublished method for the derivation of formulae which define physical relations, an it also finds application in the fields of biomechanics, astronomy, geometry, and economics. It is written in a warm, easy flowing style which is entertaining as well as informative. The subject matter is covered in exhaustive depth backed by frequent historical references and human insights which reflect a rich sense of humor not often found in a technical text. The author never "talks down" to his reader; each concept is developed and explained in detail and then supported by numerous examples, yet the material is presented in such an engaging manner, it will hold the interest of the nontechnical reader as well.

Of particular importance, the author develops a very powerful tool expressed as the Fundamental Formula by which a Dimensional Set is constructed and dimensionless variables are readily generated. The power of this tool is also demonstrated by the quick identification of any dimensionally irrelevant variable an investigator may have erroneously introduced in a problem, thereby greatly reducing the complexity of resulting equations. The Fundamental Formula is applied in a wide array of examples in the last 10 chapters to show how it may be used to simplify and solve diverse problems found in several disciplines.

This book should be an essential text for every technical library, and a valuable reference for all engineers and scientists, irrespective of the individual's field of expertise. The book will most assuredly become a key text for use in Dimensional Analysis and Modeling courses at university level throughout the world, and should be required reading for students in science and engineering. By modeling experiments, industry can save millions of research dollars by using the techniques expounded in Applied Dimensional Analysis and Modeling. These methods are applicable when the full-scale product is either too large, too small, or when the experimentation on it would be too dangerous, too costly, would take to long or to short time.

Over 200 examples are used to clarify and demonstrate the theoretical concepts throughout the book touching on subjects from the extremely sophisticated to the sublime, i.e., from the "Bending of light in gravitational field" to the "Maximum running speed of animals". Mechanics occupies a significant place, but so do Hydraulics, Electricity, Biomechanics and Astrophysics, to name only a few.

The book has 18 chapters, plus references, appendices, and indices. The Table of Contents includes a list of titled examples.

For the reader whose command of linear algebra and matrix arithmetic may be a bit rusty, Chapter 1 presents, Mathematical Preliminaries, written by guest author Pál Rózsa, Professor of Mathematics at the Technical University of Budapest. This chapter is followed in Chapter 2 by Formats and Classification.

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Chapter 3, on Dimensional Systems, is one of the best reviews of the subject to be found in any text, and should be required reading for all undergraduate students in science and engineering. The Rules of Etiquette in writing dimensions and equations — which are often slighted in even 'learned' technical texts — are eloquently brought to the readers attention in this chapter.

Chapters on Transformation of Dimensions, Arithmetic of Dimensions, Dimensional Homogeneity, and Structure of Physical Relations follow in sequence. Then in Chapter 8, titled systematic Determination of Complete Set of Products of Variables, the author's ingenuity and originality are demonstrated with the truly eloquent development of the Fundamental Formula. With it, a user — who needs to know only which dimensions are involved — can derive equations which define complex phenomena, all with application of a few simple steps.

In Chapter 10, Number of Sets of Dimensionless Products of Variables is discussed and a definition setting the condition under which two sets of dimensionless variables are equivalent. In this chapter, distinct and equivalent sets are also defined and their differences are explained.

Chapter 11 is titled Relevancy of Variables. Here techniques are described by which the presence of dimensionally and physically irrelevant variables can be detected. This is of paramount importance is simplifying resulting equations. This chapter also explains and demonstrates how 'heuristic reasoning' can be used to reveal some astonishing properties of a physical system.

Chapters 12 and 13 describe the economy of graphical relations and the forms of dimensionless relations (monomial and nonmonomial). The number of curves or charts required to describe the behavior of a physical system increases very rapidly as the number of variables increase; Chapter 12 illustrates how a dimensionless plot can substantially reduce the number of curves necessary to describe system behavior.

Chapter 14 treats the sequence of variables in the Dimensional Set, and, in Chapter 15, examples are used to introduce and illustrate the use of alternate dimensions. Chapter 16 presents methods of reducing the number of dimensionless variables describing the behavior of a physical system, since by these reductions, significant savings in labor to perform an analysis can be realized.

Chapter 17 studies the subject of dimensional modeling wherein the model built to a different scale than the prototype can be used to predict the full-scale behavior of a physical system. It is clearly demonstrated here that models may be either larger or smaller than their prototypes, and that in some instances it is an advantage for the model to be geometrically dissimilar to the prototype.

Chapter 18 is a collection of 43 additional applications in which the usefulness and great facility of the dimensional method in solving problems in the physical sciences is further demonstrated. The techniques applied in these examples cover 26 topics.

Finally, references cited in the text are cataloged in numerical and alphabetical order. These are followed by the Appendices and lastly the Index which is arranged by both subject and surname. Where definitions of physical constants and named dimensionless variables are given in the appendices, the author injects interesting insights about the scientists who gave their name to scientific units (e.g. Ampere).

To sum up, "Applied Dimensional Analysis and Modeling" is a major work which belongs in the library of every practicing engineer and scientist engaged in analysis, design, or testing of physical systems and equipment.

ROBERT C. FERGUSON
Chief Engineer
Taiga Engineering Group, Inc.
Bolton, Ontario, Canada L7E 5R8