

Book Review

Elements of Structural Optimization, R. T. Haftka and M. P. Kamat, Editors,
Martinus Nijhoff Publishers, 1984, 276 pp. \$45.75.

There are quite a few books on structural optimization, however most of them present a somewhat incomplete coverage slanted towards the author's views. This book gives a general introduction to the field of structural optimization involving discrete and continuous design variables. The text is organized into eight chapters that cover a rather complete set of the popular and most successful approaches. In addition, two appendices review elements of the calculus of variations and the finite-element method necessary for completeness and to help understand the numerous examples. The book is intended as a two-semester course for advanced seniors and graduate students. The text provides enough explanation and is well supported by illustrative numerical examples for the book to be used by practicing engineers in a self-teaching mode.

Chapter 1 formulates the structural optimization problem in general terms and gives a classification procedure. This chapter also contains a good discussion of the interaction between the formulation and solution techniques of the optimization problem and those of the analysis problem. Chapter 2 contains the case of distributed parameters and classical calculus of variations. The ideas of necessary and sufficient conditions of optimality are introduced. Examples worked out include optimization of beams and columns under displacement, vibration, and stability constraints. Chapter 3 focuses on those structural applications that can be solved using linear programming. The concepts of linear programming are introduced in a concise manner and much of the explanation is through examples. The simplex method is discussed in detail and the use of linear programming in solving nonlinear programming problems is also treated.

Nonlinear mathematical programming techniques are described in Chaps. 4 and 5, for the unconstrained and the constrained case, respectively. Algorithms discussed include: the sequential simplex method; the conjugate directions method; conjugate gradient techniques and variable-metric algorithms for unconstrained optimization and gradient projection; reduced gradient methods; and feasible directions method; penalty function and multiplier methods; and projected Lagrangian methods for constrained optimization. Derivatives of displacement,

stress, and eigenvalue constraints are treated in an elementary fashion followed by an extensive discussion of constraint sensitivity involving linear and nonlinear transient behavior constraints. Optimal design sensitivity is also treated. This chapter briefly discusses some generally applicable approximations for constraints. While the focus seems to be on mathematical programming techniques, this book also gives a detailed account of optimality criteria methods in Chap. 7. The discussion begins with the fully stressed design technique followed by the more formal optimality criteria methods properly separating intuitive and derivable algorithms. The dual programming concept is used as the framework for the presentation which, unfortunately, neglects the all important connection between structural behavior and the rapid convergence characteristics of optimality criteria methods. The last chapter, entitled "The Overall Solution Process" briefly discusses design-variable linking, move limit strategies, and shape optimizations. Decomposition techniques and the use of optimization algorithms for structural analysis are discussed in more detail. The chapter is closed with a brief description of optimization program packages and sample problems to test them.

The reader can profit from the extensive lists of references compiled at the end of each chapter. Many of the examples are application oriented. The much needed discussion of sensitivity analysis and approximation methods is a good aspect of the presentation. The book requires only an elementary knowledge of the finite-element method as a prerequisite. Structural optimization is still an active field of research and this book treats some of the latest work done in this field as evidenced by the number of recently published references. A discussion of the relative efficiency of a number of the algorithms presented would perhaps make the book more complete, although performance tends to be problem oriented. This book is recommended not only for students, but also to those interested in application of structural optimization methods to their practical design problems.

L. Berke and D. Murthy
NASA Lewis Research Center