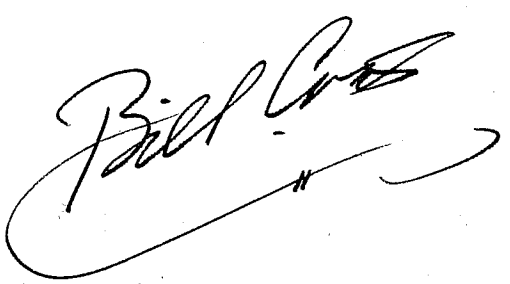
ENERGY ENGINEERING AND MANAGEMENT FOR BUILDING SYSTEMS

William J. Coad



VNR VAN NOSTRAND REINHOLD COMPANY
NEW YORK CINCINNATI TORONTO LONDON MELBOURNE

Library of Congress Catalog Card Number: 81-134
ISBN: 0-442-25467-9

Manufactured in the United States of America

Published by Van Nostrand Reinhold Company
135 West 50th Street, New York, N.Y. 10020

Van Nostrand Reinhold Limited
1410 Birchmount Road
Scarborough, Ontario M1P 2E7, Canada

Van Nostrand Reinhold Australia Pty, Ltd.
17 Queen Street
Mitcham, Victoria 3132, Australia

Van Nostrand Reinhold Company Limited
Molly Millars Lane
Wokingham, Berkshire, England

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Library of Congress Cataloging in Publication Data

Coad, William J.
Energy engineering and management for building systems.

Includes index.
1. Buildings—Energy conservation. 2. Buildings —Mechanical equipment. I. Title.
TJ163.5.B84C6 696 81-134
ISBN 0-442-25467-9 AACR2

ENERGY ENGINEERING AND MANAGEMENT FOR BUILDING SYSTEMS

To
DOODIE

Introduction

The difference between competence and excellence in engineering generally lies not as much with a difference in technical knowledge as with a difference in philosophy. The same could be said for most other professions based upon the physical sciences, because a relatively high level of technical skills is necessary simply to achieve competence. This observation is the cornerstone of the contents of this book.

The Western world is facing a dilemma today which will change all of our lives rather dramatically in the next two decades. This dilemma, since the mid 1970s, has manifested itself in various ways ranging from gas lines in many areas of the United States; to revolution, anarchy, and foreign occupation in the Persian Mideast: to economic stagnation; to the creation of a gigantic new department of the United States government; to prime interest rates in the United States of 18 percent; to an alarming devaluation of United States currency on foreign markets; and on and on. These are not unrelated incidents, nor are they "manufactured" by and for the benefit of special interest groups. The underlying cause of all of these related incidents is the very basic and simple economic law of supply and demand. The reason the supply and demand situation relating to one resource group—energy—has such an overwhelming effect upon all segments of our social structure is simply that energy is the commodity upon which our current growth in productivity (and thus GNP) has been supported for several decades. *Remove the foundation and the building tumbles.*

The relationship between the discussions of the above paragraphs is important to recognize if the energy situation is to be successfully addressed without a collapse of our financial institutions and economic systems. Not only will this effort require an unprecedented surge in excellence in engineering, it will also require an integration between the activities of the engineering community and other professions who will be addressing the problem, that is, economists, attorneys, business managers, legislators, legislative assistants, bureaucrats, and educators. No longer can the lawmakers ignore the input of the engineer. No longer can economists solve the problems of inflation by manipulating money. No longer can the businessman treat the precious energy resources casually. The only way that the Western world will economically survive the closing decades of the twentieth century will be by utilizing the available fossil energy resources in a more effective manner, that is, in a manner which will enable us to continue to increase productivity while actually reducing our rate of consumption of fossil fuels. There is no other answer. Recognition of this concept will set the stage for the twofold needs of the long-range solution. First, it will give us the necessary time to develop alternative energy sources—whatever they might be. And second, it will

provide the knowledge of and experience in the methods for more efficient or effective use of energy which will be of paramount importance in the overall economics of utilizing the future alternative sources (they *will* be both precious and costly).

This book is a collection of various articles, periodical columns, and papers written by the author. Although most of the chapters were originally intended for an engineering readership, many are more philosophical than technical, and the technical content of others is quite elementary as presented. The technical complexity of some of the writings was intentionally limited in the hope that this would assist in the necessary interaction between the engineering community and those other professions addressing the energy problems. Thus the title of the book *Energy Engineering and Management* . . . was selected in the hope that its use and its message would not be limited to those practicing, or preparing to practice engineering.

The content of many of the topics was germinated in discussions with engineering students. Because of the ever-increasing vastness of the technical substance required in engineering curricula, the present-day student has little time to develop the ever-important philosophy of design and other elements of engineering application. As a result it is found that as the technical burden has been increasing, the ranks of competence have been swelling while the ranks of excellence seem to be diminishing. Thus, at a time when there is an unprecedented need for engineering designers and educators of superior skills, too many of our graduates are seen to lack the excellence to fill the needs. This gap in supply and demand is second only to that in the fossil energy markets (but not unrelated). The solution to this problem is not more engineers, but engineers educated not only in the technical routines but also in the philosophy of engineering. To this end a good portion of these writings have been directed. Although the specific discussions in most cases relate to building systems engineering, the subject matter is applicable to all areas of mechanical engineering—indeed, all areas of all disciplines of engineering.

Some of the chapters appear, by their title and content, not to relate to "energy" per se. But considering that the definition of mechanical engineering "is the applied science of energy conversion," any and all aspects of the study, analysis, and performance of mechanical systems relate directly to "energy." Perhaps the most detrimental concept to the control of energy waste is to try to approach the problem independently of the tried, true, and established channels. Those who would approach a curriculum of "energy engineering" independently of mechanical engineering, or such subsciences as solar engineering or nuclear engineering as independent disciplines will most assuredly fail. The most effective area in which to channel all ofour energy-oriented activities is in the basic area of mechanical engineering. Conversely, if we are to be successful in these efforts, *every* segment in the study of mechanical engineering must be considered as a subdiscipline of energy conversion. Thus, any topic or discussion relating to mechanical systems concepts or designs, is in fact, a discussion of energy.

Every aspect of the design of a building mechanical system relates to energy economics. Additionally, any and all other forms of energy consumed in a building ultimately decay to heat which deducts from the necessary heating energy required or adds to the cooling system energy. Thus, all disciplines of engineering in building systems impact the energy requirements. This observation is not unique to buildings; it can be extended to any system which consumes energy—transportation, industrial processes, etc.—which is to say, that those concepts which apply to the reduction of the waste of energy in building systems are directly applicable to energy engineering in automobiles, airplanes, pipelines, heat treatment, assembly process, and all other processes, devices, and systems that consume energy. The energy required to satisfy the

product need must be defined, and every reasonable effort must be made to reduce the energy potential in the fossil fuel consumed until it is as close to the product need as the laws of physics and thermodynamics will allow.

The contents of this book are intended to assist the reader be he (or she) a student, engineer, manager, or legislator, in some small way, in enabling him to do his part in contributing to a solution to the energy dilemma.

Acknowledgments

The author wishes to acknowledge the assistance and cooperation of the original publishers of the materials in this book for their cooperation and encouragement. These publications are *Heating | Piping | Air Conditioning*, *ASHRAE Journal*, *ASHRAE Transactions*, *Purdue University* and *Specifying Engineer*. Recognition is also given to my colleagues Philip D. Sutherlin and Albert W. Black, III, coauthors of some of the original articles. The appendix contains a detailed list of the original publications, titles, and dates.

Special recognition is given to Robert W. Roose who provided counsel in the organization and planning and extensive assistance in the rigors of editing this work.

WILLIAM J. COAD