Preface

This book is intended to serve undergraduate engineering students in their introductory heat transfer course. It has been adjusted specifically to match the needs of chemical and mechanical engineering students at the University of Kentucky. The anticipated prerequisites for the course are engineering thermodynamics, two years of calculus, and an introduction to fluid mechanics. The material can be taught to students who lack a fluid mechanics background, but the pace should be considerably slower.

The organization of material has a few unconventional aspects, and the intent of these features should be explained:

- Heat exchangers are discussed in the beginning of the book rather than toward the end. This is easy to do, once the students have learned what a convective heat transfer coefficient is, even though they do not yet know how to predict its value. We have found that students have much more confidence in the worth of subsequent analytical work once they have encountered a major area of application of the subject. Furthermore, heat exchanger design provides a natural link between heat transfer and the previous subject of thermodynamics.
- The first three chapters make up a mini-course in heat transfer—an attempt to acquaint the students rather broadly with the whole subject. In the subsequent development, we try to keep the students aware of the interactions among different modes of heat transfer.
- Dimensional analysis is introduced, without reference to the cumbersome method of indices, in connection with heat conduction. It is then used

throughout the book to simplify the mathematics and to explain data correlations.

- Radiation, though it appears as the final chapter, can be dealt with at any point following Chapter 3.
- The role of the Biot number as a diagnostic device is introduced in the first chapter along with the related notion of a lumped-capacity solution. We view these simple notions as being quite important, and we return to them often.
- Natural convection and film condensation appear in the same chapter. They can be dealt with as separate issues, but we suggest that they be treated together. There is a strong kinship between the subjects, and it is useful to capitalize on this kinship.
- It has been conventional to give short shrift to boiling heat transfer. But modern processes more and more often employ boiling to remove heat. We therefore provide a great deal of material for the instructor who has time to present it.
- R. Eichhorn's chapter on the numerical analysis of heat transfer is rather detailed and self-explanatory. It can be dealt with at any point after Chapter 3—either all at once, or as the material is needed.

It should be easy to teach the entire book in two, 3-credit "quarters." About 80% of the material is normally treated in a conventional 3-credit, one-semester course at Kentucky by passing lightly over selected portions of Chapters 5 through 11.

I owe an enormous debt of gratitude to many colleagues and students for their generous contributions to this effort. At the University of Kentucky these include: Roger Eichhorn, who in addition to writing Chapter 6 provided extremely useful and detailed criticism of all the other chapters; James Elliott, Md. Alamgir, Robert Altenkirch, and Shiva Singh, who taught from earlier versions of the text and helped greatly in correcting it; Graeme Fairweather, who provided very helpful criticism of Chapter 6; Clifford Cremers, Richard Birkebak, Eralp Özil, Robert Peck, Margaret Somers, and Hans Züst, who provided critical readings and commentary to other portions of the text; Annaliese Griffin, who provided programming assistance for Chapter 6; and the many students who have responded constructively to the effort (three—Frank Loxley, Kenneth Allen, and Ronald Foster—were so energetic in tracking errors that I must mention them by name).

Among colleagues at other institutions who have been of great help, the first has been Ephraim M. Sparrow who very graciously provided a line-by-line reading of the entire first draft. With inexorable thoroughness, he identified pedagogical lapses, errors, and better sources of information. My debt to him is very great. I also wish to thank Jerry Taborek for his important advice on heat exchanger problems; Stuart Churchill for his help in providing the best information on convective heat transfer data correlations; Vijay K. Dhir for his critical reading of Chapters 9 and 10; and Prof. J. Robert Mahan, whose suggestions improved Chapter 11.

Many colleagues and friends have helped to improve the subsequent printings of the book. I cannot credit them all, but N. Shamsundar, R. B. Bannerot, S. M. Liu, L. C. Witte, T. W. Davies, R. F. Boehm, A. Haji-Sheikh, R. O. Warrington, and D. J. Shlien have been particularly helpful.

Beth Altenkirch—one of the best technical typists in the business—prepared the manuscript. She not only ate through three drafts of the 875-page manuscript, but she also contributed materially to its consistency and correctness and made the job look easy. The graphical work was done at the University of Kentucky by Pati Marks, Mack Mosely, Jr., and Cindy Taulbee, under the direction of R. William DeVore.

Special thanks are also due to the Prentice-Hall editors and staff. The support and positive attitude of Mike Melody, John Cross, Hank Kennedy, and Riley Humler, who initiated this project, and of Chuck Iossi, Gary Samartino, and Ros Herion, who saw it through, has been unrelenting.

Finally, I am really grateful to my nice family: Carol, Andrew, and John, for the cheerful way in which they suffered their absentee *paterfamilias* during the writing of the book. John also indexed the book and did some of the computer programming for it.

University of Kentucky
March 1980

JOHN LIENHARD