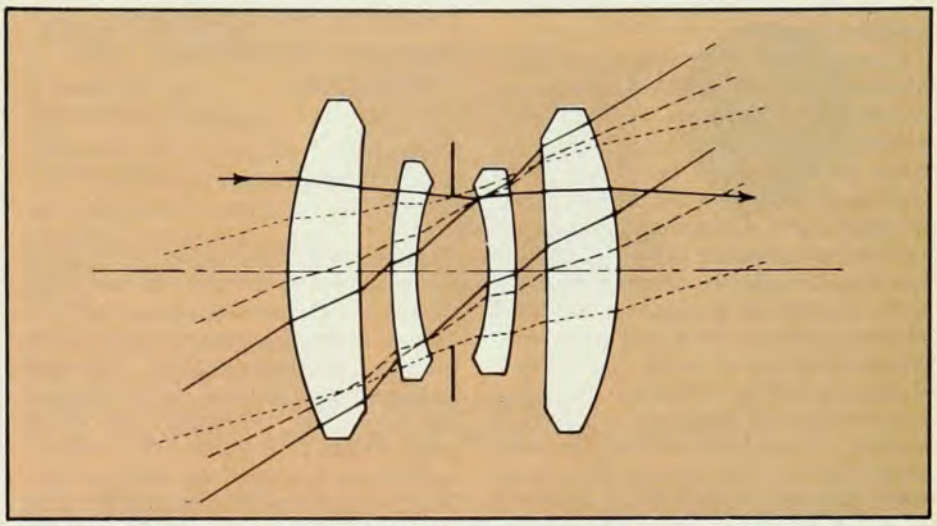
# Classical lens design: a "how to do it" text

## Lens Design Fundamentals

**R. Kingslake**
366 pp. Academic, New York, 1978.
$26.00

*Reviewed by Robert R. Shannon*



**Passage of rays** at various field angles through a typical lens is shown in the above illustration from Rudolf Kingslake's *Lens Design Fundamentals*, reviewed here. Kingslake discusses in detail the interpretation of aberration plots, which describe the aberration correction of the lens. The lens designer generates these plots from numerical values obtained from ray tracing.

The subject of the design of lenses has interested many physicists and mathematicians over the years. Lens design has evolved from the "black-art" stage of the pre-computer days to what now appears on the surface to be a "mathematical exercise" using a computer. Success in lens design, however, is not found through magic or mathematics alone, but is developed through an appreciation by a specialist of the limitations and possibilities for the application of a few simple principles that can be explicitly evaluated only through extensive numerical computation.

Rudolf Kingslake's *Lens Design Fundamentals* stands as the best text on the subject of classical lens design. Classical lens design here is defined as the exercise of determining and predicting the aberration correction that may be attained in a lens through the examination and understanding of the limited set of aberration coefficients that may be easily computed on each surface of the lens system. Today, the use of high-speed computers permits the exploration of hundreds of possible variations of a lens type within the brief span of a few minutes. The lens designer then serves in the role of an observer, entering the design process to suggest a change in the direction of the program. No method has yet been developed that completely eliminates this human intervention, and it is no accident that the designer who comprehends the principles of design enumerated in this book is likely to be the more successful designer. In short, a solution cannot be found if it just is not there.

This book is a "how to do it" text in the sense that Kingslake describes several examples of lenses from the point of view of aberration correction. The specialist will learn much of value from these examples, while the novice will gain an appreciation for the reason that lens types take on the form that they do.

Kingslake begins with a general discussion of the design process, and develops several formulae and techniques for tracing rays and setting up the first-order, or paraxial, characteristics of lens systems. A minor complaint is that he has chosen to retain a traditional "backwards" sign convention for ray angles that is the opposite of standard geometrical convention. This choice is unfortunate, as it makes integration of the formulae and techniques into other optical-analysis programs somewhat more difficult and subject to possible errors.

The discussion of the source of aberrations and their correction on a surface-by-surface or element-by-element approach is excellent and informative. Although most modern lens design uses a high-speed computer to vary all parameters simultaneously, the principles discussed in this book will be useful in understanding why many of the computer-derived solutions tend to look the way they do. The discussion of the aberrations in terms of ray-intercept curves has long been a standard for comparing types of lenses used by the specialist in optical design. The discussion of the topic here will help to make this description more widely understood and help in communication.

This book is directed toward the specialist. The generalist may feel that the approaches of classical lens-design methods described here are more empirical than would seem to be appropriate for such an old field. If anyone spends a little time studying this book, however, he will learn that the process of lens design is not, and likely never will be, subject to complete automation. This book summarizes many years of experience in the subject, and will likely be the last word on the subject of optical design for several years.

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## Physical Metallurgy

**P. Haasen**
381 pp. Cambridge U.P., New York, 1978 (German edition, 1974). $42.50 clothbound, $9.95 paperbound

The field of physical metallurgy is, by now, a fairly mature one, not only in terms of the sophistication of much of the research in the field, but also because many facets and techniques of physical metal-