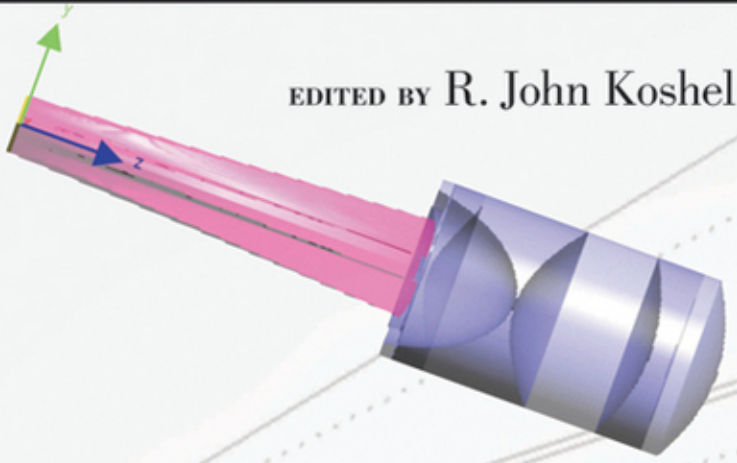

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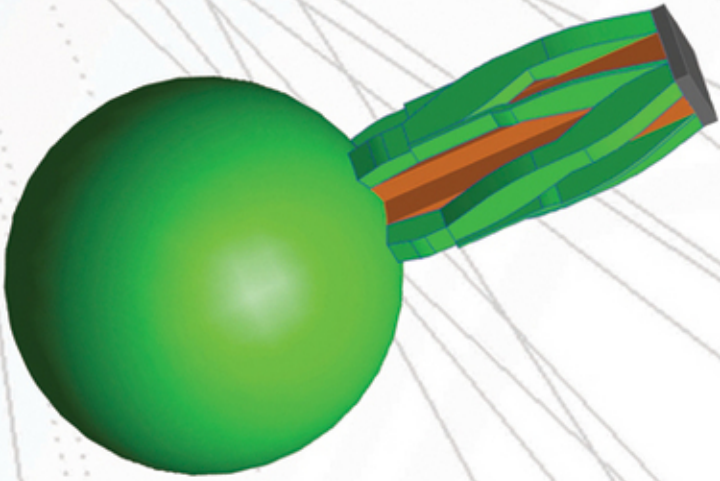
Illumination Engineering

Design with Nonimaging Objects



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Design with Nonimaging Optics

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To my family
Dee, Gina, Abe, Lucy, Tanya, Fred, Frankie, and Trudy

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PREFACE

This book was started some time ago. At first I thought to write an introductory book in the field of illumination engineering, but the book has since evolved to have more breadth. The original title was "Advanced Nonimaging/Illumination Optics," but that title just did not convey the intent of the publication. I felt it important to have both "nonimaging" and "illumination" in the final title. Illumination, as discussed in the first chapter, indicates a light distribution from a source as used or detected by an observer. "Nonimaging" denotes that the imaging constraint is not required, but rather, as will be discussed in detail, pertains to the efficient transfer of radiation from a source to a target. The difference is subtle, but in the simplest sense, illumination demands an observer, while nonimaging optics strives to obtain a desired distribution and/or efficiency. Thus, I struggled for a better title, but just prior to submission, I came upon "Illumination Engineering: Design with Nonimaging Optics." Of course, not all illumination systems use nonimaging design principles (e.g., a number of projection systems use Köhler illumination, which is based on imaging principles). Additionally, not all illumination systems must have an "observer," but they have a target (e.g., solar power generation uses a photovoltaic cell as the target). Therefore, the terms "illumination" and "nonimaging" are a bit broad in their presentation herein. Such a broad interpretation is appropriate because, as will be seen, most nonimaging principles, such as the edge-ray, have imaging as the base of their design methods. Also, for illumination, consider that the source is "illuminating" the target rather than providing "illumination" for an observer. Thus, the major focus of this book is the use of nonimaging optics in illumination systems.

While the field of illumination is old, only recently have individuals started researching the utility of nonimaging optics to provide a desired distribution of radiation with high transfer efficiency. Increasingly, our society faces environmental and energy use issues, so optimally designed illumination/nonimaging optics are especially attractive. Additionally, solar power generation uses a number of nonimaging optics design methods to provide the power that we can use to drive our illumination systems. In essence, we have the potential "to have our cake and eat it too": with nonimaging/illumination optics, we can create and use the electrical power we use in our daily lives. Nonimaging optics will only gain in importance as the field and technology advance. One might say the illumination field is comparable to the lens design field of the early 20th century, so there is large room for improvement.

There is a wide breadth of topics that could be considered for this book, from design methods to sources to applications to fabrication. Ten years ago most of these topics were barely within the literature, with only one book actually addressing the topic of nonimaging optics. There was a bit more literature in the illumination field.