OPTICAL

Specification, Fabrication, and Testing

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Preface

This book is a continued development of the notes for a course called Optical Specification, Fabrication and Testing that I teach at the University of Arizona College of Optical Sciences. The course is required for undergraduate optical engineering students in their final semester of study. At this point in their academic career, the students have a solid background in optics and are focusing on the next phase of their lives, typically securing a job in industry. In reviewing the coursework that the students have taken over their undergraduate career, I find that the topics tend to be compartmentalized. We teach geometrical optics in one course, interference and diffraction in another course, and aberrations in still another. The goal for the course and for this book is to connect the dots between these chunks of knowledge and to illustrate the development of an optical system from the initial layout, to design and aberration analysis, to fabrication, and finally to testing and verification of the individual components and the system performance. This book also seeks to cover more specialized topics such as fitting Zernike polynomials, representing aspheric surfaces with the Forbes Q polynomials, and testing with the Shack–Hartmann wavefront sensor. These topics are covered in more detail than is found in other textbooks, and the techniques are developed to the point where the reader can pursue their own analysis or modify to their particular situation. Finally, there is also a limit on the detail that can be provided on any of the topics found in the book. Bibliographic references have been provided at the end of each chapter to facilitate more in-depth study.

I would like to thank John Greivenkamp, José Sasián, Bill Duncan, Ping Zhou, and Greg Forbes for their valuable suggestions in improving the manuscript. I wish to also thank the peer reviewers. Their thorough reading of the material and constructive comments have greatly enhanced the content. Thanks also go to Tim Lamkins and editor Dara Burrows for their help in turning a batch of messy notes into a quality book. I appreciate all of the members of the SPIE staff who have helped in the production of the book. Finally, with much love, I owe many thanks to my wife, Diana, and to my children, Max and Marie, for their unwavering love and support.

Jim Schwiegerling
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List of Acronyms

BFD	back focal distance
BFL	back (rear) focal length
bfs	best-fit sphere
CCD	charge-coupled device
CMOS	complementary metal-oxide semiconductor
DIN	Deutsche Industrie Norm
DOF	depth of focus
EE	encircled energy
EFL	effective focal length
FFD	front focal distance
FFL	front focal length
FFOV	full field of view
FOV	field of view
HFOV	half field of view
IBF	ion beam figuring
JIS	Japanese Industry Standard
LSI	linear-shift-invariant (optical system)
LWIR	long-wave infrared
MRF	magnetorheological finishing
MWIR	mid-wave infrared
NA	numerical aperture
OPD	optical path difference
OPL	optical path length
OTF	optical transfer function
PSF	point spread function
PTF	phase transfer function
PV	peak-to-valley (error)
PZT	lead zirconate titanate
TCE	thermal coefficient of expansion
TPI	threads per inch