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Editorial

This special issue of *Advanced Optical Technologies* is dedicated to the field of Optical Design. This field requires expertise in a number of tangentially related areas, including aberration theory, basic design principles, optimization algorithms, understanding of new manufacturing technologies, as well as tolerancing and design-for-manufacture techniques.

Our list of contributors for this issue reflects a leading-edge mix of experts in these areas, from around the world.

In this issue, David Shafer presents a survey of systems having extreme performance characteristics, such as a wide spectral band, high NA, insensitivity to perturbation, and extreme (or perfect) wavefront correction. Included among the perfectly corrected systems is a previously unrecognized way in which the Maxwell fisheye can be used.

Akira Yabe presents a method of desensitizing an optical system that is not axisymmetric and provides an example of its use. The method uses his previously described traveling freeform method, in which the surface number on which the asphere is to be placed is treated as an optimization variable. The method also uses sensitivity controls inserted into the merit function.

Jose Sasian discusses extrinsic aberrations, i.e., those that are induced at a surface when the incoming wavefront is already aberrated by previous surfaces, and he provides formulas for calculating them.

Ilhan Kaya and Jannick Rolland describe a method for describing freeform surfaces that is a hybrid between the phi polynomial (e.g., Zernike or Q polynomials of the type presented by Menke and Forbes in this same issue) type and the radial basis function (RBF) type. This method uses phi-polynomial functions to describe the surface on multiple, overlapping subapertures and uses RBF functions as weightings among the various subapertures.

Kevin Thompson gives an analysis of the as-built behavior of large telescopes, based on the nodal aberration theory. One important conclusion is that the software that dynamically calculates the alignment and mirror figure changes in response to the measured wavefront data needs to anticipate that the overall pattern of astigmatism will be binodal rather than rotationally symmetric and quadratic, or the alignment and/or the figure will be incorrectly controlled.

Christoph Menke and Greg Forbes present a two-dimensional set of polynomials similar to the recently introduced Q polynomials, but (like the Zernikes) include both a rotationally symmetric dependence and an azimuthal dependence. The rotationally symmetric Qbfs polynomials are a special case of the new polynomials, in which the azimuthal functions are set to unity. The authors demonstrate, using diverse design examples and three different optimization programs, that the new polynomials have the remarkable property of allowing the optimization routine to find a better solution than when other surface representations are used.

Andrew Rakich and Norman Rumsey present a new type of prime focus corrector for an astronomical telescope. The new corrector has advantages over previously known corrector designs unless the field of view is unusually small or if the spectral band is unusually large.

In addition to the above technical papers, this issue of AOT also contains four tutorial articles.

Rob Bates develops a the form of a modern miniature camera objective, starting with the Wollaston 'landscape lens' and ending with a five-element, highly aspheric, photographic objective. Solving the optical design challenges one-by-one, he draws parallels to the development of other well-known systems along the way.

Massaki Isshiki describes a new version of his global optimization method, based on the idea that good solutions form long 'strings' in the space of the variables. The merit function includes the angles of incidence and refraction as a method of reducing the system sensitivity.

Irina Livshits and Vladimir Vasilyev assemble a list of frequently asked questions (FAQs) about optical design. Collectively, the answers to these questions provide a description of the structure of the process of optical design.

John Rogers explores the importance of induced aberrations in the correction of chromatic aberration. The tutorial underscores the importance of investigating different design forms that minimize residual color aberrations before searching for glasses with special glass properties.

This collection of papers confirms very clearly that modern optical design is still a fascinating science combined with a certain kind of art. A dash of passion remains the key for the optical designers success, but most important for their success is to focus on the demands of the customers, considering the application requirements as well as the costs. This leads to a very close interaction

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with the customers, technologists, and production specialists. This multifaceted aspect of optical design is one reason why we love our work and a great reason for young scientists to join the optical design profession. We do hope that you, the reader, will share our joy for optical design.

In closing, we would like to thank the AOT team as well as the authors who contributed to this issue.

John R. Rogers, Wilhelm Ulrich and Kimio Tatsuno

John Rogers, PhD, is a Senior Scientist for Imaging Optics at Synopsys. He received his PhD from the Optical Sciences Center at the University of Arizona in 1984 and spent 10 years working as an optical designer and metrologist in the Swiss optical industry, at Kern AG and later at Leica. For 4 years, he taught geometrical optics and optical testing at the University of Rochester. In 1997, he joined Optical Research Associates (now Synopsys) where, working in the Engineering Services group, he has designed a wide variety of optical systems.

Wilhelm Ulrich, Carl Zeiss AG, Corporate Research and Technology, Senior Director Optics, Wilhelm Ulrich received his engineering degree from the University for Applied Science in Hamburg. In 1980, he joined the mathematical department for optical design at Carl Zeiss and has worked on various advanced optical design projects for several business units. Between 1997 and 2009, he was head of optical design for leading-edge microlithography systems at Carl Zeiss SMT AG. During this period, the lens designers of Carl Zeiss SMT developed highly innovative design concepts for projection lenses and illumination systems, ensuring the outstanding success of the SIA microlithography roadmap. Since July 2009, he has been in charge of optical design at Corporate Research and Technology at Carl Zeiss AG.

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