Proposed Bylaw Amendment

Business Meeting to be held on November 1, 1965

Society President Ethan M. Stifle has announced that the Board of Governors approved at its July 22, 1965 meeting that an Annual Meeting be called for Monday, November 1, 1965. This Annual Meeting will be held in the Marquette Room, Queen Elizabeth Hotel, Montreal, Quebec, Canada, and will be held in conjunction with the 98th Semiannual Technical Conference immediately following the Get-Together Luncheon.

One purpose of this meeting is to vote on a proposed revision to the Society's Bylaws. This revision has been prepared by the Revisions Committee, Robert G. Hufford, Chairman, and has been approved by the Board of Governors. The Society's Constitution and Bylaws were published in the April 1965 *Journal*, Part II, pp. 13–18.

The proposed Bylaw revision to be offered at this meeting is:

Article III, Sec. 2, Subsec A, paragraph 2. Regional Representation

Amend to read: "Except as hereinafter provided, the Eastern and Central regions of the United States shall include such Sections of the Society as have their headquarters' city located respectively in the Eastern and Central time zones; the Western region shall include all other Sections having their headquarters within the United States and all other members of the Society resident in the United States but not included within the geographical area assigned to any Section. The Board of Governors may assign any of the foregoing Sections or members to an adjacent region upon determination that such assignment will better serve the interests of the members of that Section. The headquarters city and geographic boundaries of each Section, together with the region to which assigned, shall be defined in the Administrative Practices."

Letters to the Editor

Re: Automatic Lens Design

Dear Sir:

Mr. Brixner's article on automatic lens design* might easily leave its readers with some incorrect impressions. The "classical" lens referenced by Brixner is erroneously reputed to have been designed by me. It is not sufficient to publish a simple note to the effect that I did not design this lens. This would receive no attention and the damage has been done. Furthermore, such a disclaimer would be an implied insult to those who did design the lens and an implied agreement with Brixner. I make no such implications; the fact is not that the performance of this lens is bad, but that Brixner's evaluation of it is fallacious. I have analyzed the relative merits of the Brixner lens and the classical lens and summarize my findings below.

I first evaluated the "classical" lens by causing the computer to duplicate, insofar as possible, the type of evaluation which Brixner performs — more as a matter of curiosity than as a serious attempt to "evaluate" the lens. The numbers generated thereby were too large to be taken seriously. When results are as incredibly bad as those indicated it is a matter of common sense — to say nothing of common courtesy — to submit them to the criticism of the lens designer. I thereby obtained from the Northrop Corporation the following information:

(1) The entrance pupil of the lens is well behind the first lens vertex, not in front (as shown by Brixner);

(2) the lower rim rays of oblique pencils are vignetted by a filter in front of the lens;

(3) the lens was designed to concentrate the maximum possible amount of the energy of a star image into a suitably small core, and rather than allow this core to become unduly large, a flare around the core was allowed in the off-axis images;

(4) the lens is to be used with a square image format and the nature of its use assured that almost all events recorded would fall within the inscribed circle ($8\frac{1}{2}°$ off-axis). Consequently, *little design attention was given to the corner images* — except as regards distortion — compared with the area which would contain almost all of the information. (I was also presented with a high-quality photograph taken with the "classical" lens.)

An evaluation of the "classical" lens according to the intended use as outlined above — and with the proper plane of best focus, the proper entrance pupil, and the proper vignette of oblique rays — promises good performance. The axial image (discounting the inevitable secondary spectrum) is excellent. This fact is of course buried if off-axis flare light is allowed to participate in selecting the plane of best focus. The position of the plane of best focus as reported by the designer is 0.26 mm inside Gaussian focus, whereas Brixner finds the plane of "best" focus to be 0.37 mm outside. To well beyond 8° off-axis, the core image remains small and contains a substantial part of the total energy.

It is an extremely tedious task to compute to any degree of precision how small the core image is and what percentage of energy it contains. In the final analysis this depends on secondary spectrum and hence will be almost completely dominated by the amount of weight given to the ends of the spectral range.

Brixner's allegation that the lens has a large residual of lateral chromatic aberration is particularly illustrative of the misconceptions which can arise from an off-the-cuff analysis. The centroids of the off-axis images do indeed move with wavelength about as Brixner reports. (Some of the most aberrated rays are vignetted and centroid shift is not quite so severe as alleged.) This chromatic aberration of the centroids is primarily due to the fact that in blue light flare tends to be inwardly directed, and in yellow light more outwardly directed, but the core images are essentially superposed at all wavelengths. A

*"Automatic lens design illustrated by a 600mm $f/2.0$, 24° field lens," *Jour. SMPTE, 73:* 654–657, Aug. 1964.

ens designer could easily change lateral chromatism so that the centroids show no lateral shift, but then the core images would exhibit chromatism and the lens would be worsened in performance, perhaps as much as twofold.

It is a complete mystery to me how the alleged 0.2-mm distortion could have been computed.

Of the lenses designed by Brixner, the one selected for study is the C-d lens, so that secondary spectrum would not becloud the analysis (secondary spectrum over the C-d range is about 15 times smaller than over the D-G′ range.) This lens shows core images of uniform energy distribution, averaging about 70 microns in diameter, and containing perhaps 90% or more of energy, and surrounded by flare of about 150 microns diameter or less. It was the intention of the designers of the "classical" lens to achieve core images appreciably smaller than 70 microns in diameter. They believe they succeeded in doing so, and I find nothing in my analysis which contradicts their belief. Even the corner images (to which little design attention was given) show the remnants of a small core especially when the ends of the spectral range are weighted according to the relatively small amount of energy they contain.

Many articles will be written about the improvements in lens design which can be realized by automated computer methods, and many of these will be written by persons of little or no experience in optics. It would be well if such persons treat the work done by "classical" methods with the respect it deserves. Further, if a non-expert wishes publicly to proclaim that he has designed a lens which is better than lens A, he would do well to obtain responsible confirmation of his assertion.

The basic fallacy of Brixner's comparison (aside from tracing the wrong rays) is misuse of the rms spot size criterion. Even if most of the energy in a star image is concentrated into a small core surrounded by flare, an rms evaluation rates the image primarily by the diameter of the flare — not by the diameter of the core and the percentage of energy it contains. Experienced lens designers rate an image by precisely what the rms spot size neglects, and neglect what the rms spot size considers most heavily. If residual aberrations be readjusted so that the core be made larger and the flare smaller, an rms criterion will indicate great improvement, but the image may well have been made worse.

Those who use rms spot size as a method of lens design justify doing so on the grounds that if a lens puts *all* of the energy into the core, it is clearly a better lens than one which allows flare. This is a valid argument if the flare-free core be sufficiently small. Usually the rms designed flare-free core is not sufficiently small, as is the case with the Brixner lens. Those who use rms spot size as a method of lens design do so at their own peril. It is more than presumptuous of them to use it as a means of derating the work of others.

January 12, 1965

David S. Grey
Formerly, Consultant in Optics,
Lexington, Mass.; present address:
Aerospace Corp.,
2400 E. El Segundo Blvd.,
El Segundo, Calif.

Dear Sir:

I have received and reviewed the letter by David S. Grey and give my comments below. The letter reports the author's analysis of the relative merits of two of the lenses described in my paper "Automatic Lens Design Illustrated by a 600mm F/2.0, 24° Field Lens." So many extraneous ideas are included in the report that the precise conclusions, if any, elude me. But one thing is clear, the author has not discovered an error in my numbers and given the correct number so that I can check the error. I make no claim that my methods give the same numbers as the classical methods.

I believe that the author has lost sight of the fact that we were asked by the designers, as an exercise, to use the LASL program to try to improve their lens. My paper reported the results of those efforts, which were guided by the information given in my reference 1 (106-page report) and the USAF bid specifications (11-page TECHNICAL EXHIBIT RE/9415-863A).

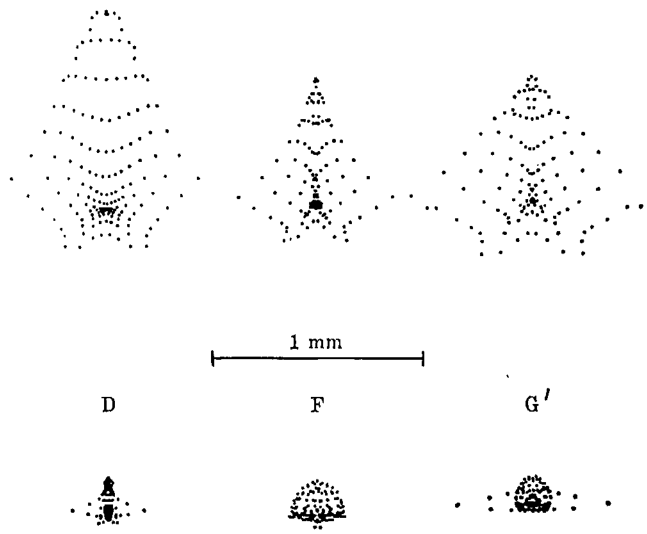

Fig. 1. Spot diagrams of the 12° off-axis images made by the Classical (above) and the LASL Improved (below) lenses. Thanks go to Glenn Wooters for these spot diagrams, which are part of the comprehensive series he sent us.

The lens data I used and called "Classical" was obtained from reference 1. This is the lens which resulted from the efforts of the Nortronics designers to adapt the scaled-up Grey lens prototype to the new use. To the best of my knowledge this report does not give the precise location of the aperture stop or the plane of best focus. Nor does it mention the vignette of oblique bundles. I therefore found it necessary to discover the stop position and the plane of best focus by means of the LASL code.

Our Lens Design Program automatically determines the stop position which gives optimum performance of the lens being studied, and this is the number which I reported. The program chooses as the plane of best focus the one which gives the smallest average weighted rms spot sizes. There was no vignetting of oblique pencils because no vignette specifications were given in the report. (Nor was there vignetting in my designs.) The rms spot size is part of the statistical analysis which I have applied to lens performance evaluation and to lens design.

Periodic reports were made and appreciation received for the performance improvement achieved. Spot diagrams of the 12° images produced by both the "Classical" and the "LASL Improved" lenses were sent us and are reproduced herewith (Fig. 1).

I should also like to report that my C-d lens design was subjected to classical analysis by the sponsors of the Post-ICO-Meeting Seminar on Lens Design (Tokyo, Japan, 11–12 September 1964) and reported to be an excellent design.

I conclude that the author's performance analysis of my design is not revealing the good performance characteristics found by other investigators. My experience has indicated that it is difficult to determine what the optimum performance of a strange design might be. But I will not quarrel with the author because he does not agree with the utility of the methods I use.

January 20, 1965

B. Brixner
University of California
Los Alamos Scientific Laboratory
Los Alamos, N.M. 87544

Re: A Birefringent Screen

Dear Sir:

Congratulations on the fascinating tutorial article on traveling-matte techniques by Walter Beyer in the March edition. I had the good fortune to attend the 95th Technical Conference at Los Angeles in 1964, to deliver a minor paper, but missed Beyer's lecture. I found particular interest in the article's section on polarized light, since I did my thesis years ago in polarization and birefringence, and have several patent disclosures and patent applications (assigned to Martin Company and others) in these areas. It occurs to me that a significant improvement and added degree of freedom could be obtained in the opaque screen, front-lighted polarization technique by Beyer, if a birefringent screen were employed.

A birefringent screen could be very readily and cheaply made by painting the back of transparent or translucent plastic material which has been optically stressed to show a uniform quarter-wave of phase retardation or optical path difference for white or incandescent light (more precisely for 5500-to-6000 Angstroms). Actually, such plastics are available to close enough approximation for incandescent light and reasonably close for true white light except for a secondary blue-violet residue. These plastics or other quarter-wave material would be back-painted with aluminum, gold, or other metallic paint. (A well-known source is E. I. de Nemours & Co., Wilmington, Del. Their 0.004 polyethylene film comes in 54-in. wide rolls, 100 or more yards long, at about 50 cents per yard. Samples can be readily tested for approximate quarter-wave birefringence prior to purchase, using an ordinary polarizing filter.)

All illumination could now be plane-polarized light from one or several sources but all oriented at the same polarization angle at any one time. If this polarization angle or axis is plus-or-minus 45° from the fast axis of the birefringent screen, the light will be reflected from the screen, still plane-polarized but with its plane or axis of polarization now rotated 90° from the source axis or angle of polarization at which it entered the screen. Thus, to a camera employing a parallel oriented polarizing filter, the screen will appear black or deep blue-violet, depending on the materials used for the screen and whether incandescent, arc light, or other source light is employed. No special light is necessary. To the actors and studio personnel the screen would appear white. Identically oriented polarization filters in front of both source and camera are necessary, however, since the emergent light from the birefringent screen will be polarized at right-angles (crossed) to the incident source beam.

The principal advantage here is that stray or spilled light from that employed to illuminate the foreground action will not spoil the uniform black of the background as seen by the camera, since this spilled light is also identically source-polarized and also rotated 90° by the screen; and therefore it is also blocked by the camera's polarized filter. However, direct light reflected from foreground to camera is not rotated and not blocked. Thus, much greater freedom in lighting the foreground is afforded. In the simple polarization technique of Beyer's article, such foreground light gains no advantage if polarized; for, if it is polarized parallel to the source light in Beyer's proposed technique, some of it reflected from the foreground action will retain this polarization even though most of it will not (due to diffuse reflection from most clothing, etc.). All metallic and many other specular components of the foreground would thus appear black or dark on the film. If the foreground light is crossed polarized to the screen light, this will not happen, but once more spilled light will bounce off the nonbirefringent screen and cause matte degradation. If the foreground light is non-polarized, as Beyer suggests, spilled light will again bounce off the screen, spoiling the matte effect. All this is prevented by use of the birefringent screen and properly aligned polarized sources. However, the birefringent background screen has still other advantages. Perhaps, versatility is the most important of these. Starting with the alignment described above, by simply rotating the screen-illuminating source polarization filters 45° one way (for example, clockwise) and the camera polarization filter 45° the other way (counterclockwise), the birefringent screen becomes a "monorefringent" or ordinary polarization screen in its behavior, and Beyer's suggested technique can be employed where this is not found objectionable. In addition, it is also very possible that the blue-violet residue of the birefringent technique can be expanded spectrally and intensity-wise to permit the use of the blue-screen technique, using front-lighted white polarized light, and with less fringe effect and limitation on permissible foreground colors.

Thank you and Mr. Beyer for an extremely interesting, remarkably complete, and unusually well-written article.

May 11, 1965

Burton J. Askowith
Research Scientist
MP-200
Martin Company
Orlando, Florida