# HINDSIGHT
# Journal of Optometry History

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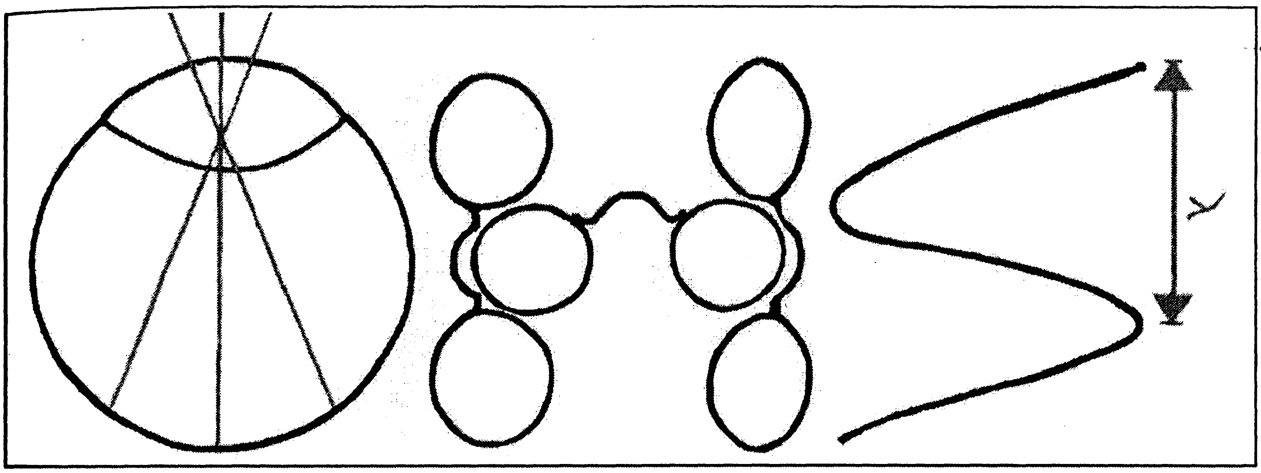




Official Publication of the Optometric Historical Society

Hindsight: Journal of Optometry History publishes material on the history of optometry and related topics. As the official publication of the Optometric Historical Society, Hindsight: Journal of Optometry History supports the purposes and functions of the Optometric Historical Society.

The purposes of the Optometric Historical Society, according to its by-laws, are:
- to encourage the collection and preservation of materials relating to the history of optometry,
- to assist in securing and documenting the recollections of those who participated in the development of optometry,
- to encourage and assist in the care of archives of optometric interest,
- to identify and mark sites, landmarks, monuments, and structures of significance in optometric development, and
- to shed honor and recognition on persons, groups, and agencies making notable contributions toward the goals of the society.



The official publication of the Optometric Historical Society was previously titled: Newsletter of the Optometric Historical Society, 1970-1991 (volumes 1-22), and Hindsight: Newsletter of the Optometric Historical Society, 1992-2006 (volumes 23-37). Hindsight: Journal of Optometry History began in 2007 with volume 38, number 1.

On the cover: The drawing represents OHS for Optometric Historical Society: the O an elementary schematic of an eye, the H three intersecting pairs of spectacles, and the S a representation of a light wave with the Greek letter lambda indicating one wavelength. The drawing artist was Diane Goss.

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# HINDSIGHT: Journal of Optometry History
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Journal articles:
Calvo M, Enoch JM. Early use of corrective lenses in Spanish colonies of the Americas including parts of the future United States: reference to Viceroy Luis de Velasco (the son). Optom Vis Sci 2003;80:681-689.

Section in a single author book:
Hofstetter HW. Optometry: Professional, Economic, and Legal Aspects. St. Louis: Mosby, 1948:17-35.

Chapter in a multi-author volume:
Penisten DK. Eyes and vision in North American Indian cultures: An historical perspective on traditional medicine and mythology. In: Goss DA, Edmondson LL, eds. Eye and Vision Conditions in the American Indian. Yukon, OK; Pueblo Publishing, 1990:186-190.

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Bennett I. The story behind Optometric Management magazine. Hindsight: J Optom Hist 2007;38:17-22.

# Editorial: Perspectives on the Importance of History

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Not everyone recognizes the importance of history. Those of us who see history as significant for the present and the future often find ourselves defending and advocating attention to history. In an article in the previous issue of *Hindsight: Journal of Optometry History*,[1] I listed reasons, paraphrased as follows, for the importance of the history of optometry: (1) Learning from the past helps guide better decision making in the present and more effective planning for the future. (2) Learning the history of a profession informs one about its perennial problems, about the cultural atmosphere that shaped it, and about the nature of professional life. (3) Appreciation of optometry's unique heritage can enhance the pride of students and practitioners in their profession. (4) Wider communication of optometry's contributions to society will engender respect for the profession. (5) The study and transmission of optometry history can confer honor and respect upon persons who have contributed to the profession and to human welfare, and it can promote correct attribution for such contributions. (6) History well-told is fun and interesting.

Hopefully such arguments can be taken as rational and compelling by those whom we are trying to convince of the importance of optometry history. But for many of us, there is also that intangible conviction or "gut feeling" that our professional history is a part of who we are, that an appreciation of our history is important for the present, and that our history should be preserved for, and transmitted to, the future. The optometry of the past is a part of what we are now and it will be a part of the optometrists of the future.

Similar sentiments are shared by persons in other fields and other pursuits. Persons studying their genealogy and family history, for instance, can see the personalities, struggles, and concerns of their ancestors in themselves. They may not be able to explain verbally why they are driven to find information about their great great grandparents, but they feel the connection when they learn about them.

I was struck by another illustration of this feeling for the significance of history when I read an article in the television section of our local newspaper.[2] It was an article about an upcoming PBS special featuring the 55-year-old popular singer Sting. He devoted more than a year to the study of the music of the 16th century British musician John Dowland. He subsequently recorded a CD of Dowland's songs accompanied by a lute. In the article he explained his attraction to the music and why he pursued the project. One quotation, in particular, caught my eye:

"I have plenty of curiosity, and not necessarily [only] in the past. I'm also interested in the music of the future, and trying to create some of that. But it's part of a continuum. You're not separate from what was written 500 years ago. If you investigate the bedrock of John Dowland or the Beatles or even me, it's English folk music underneath all of us. That connects us all."

One can easily change a few words and names to apply those sentiments to optometry. I have arbitrarily chosen a couple names, one from the 17$^{th}$ century and one from the 20$^{th}$ century, but there are other names that would work as well:

"I have plenty of curiosity, and not necessarily only in the past. I'm also interested in the optometry of the future, and trying to create some of that. But it's part of a continuum. You're not separate from what was done 500 years ago. If you investigate the bedrock of Daza de Valdes or Henry Hofstetter or even me, it's optometry underneath all of us. That connects us all."

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# Astigmatism, Its Measurement, and Fundamental Optical Properties

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In this issue of *Hindsight*, the writer has "bundled" two earlier publications with which he has been associated. These articles address issues related to the history of, and some very interesting optical properties relating to, astigmatism and its correction, and the underlying optical nature of the familiar "Conoid of Sturm."

The first article[1] addresses a very interesting brief passage taken from John Frederick William Herschel on testing for astigmatism dated 1845. In turn, that citation was apparently taken from a communication "from Slough, December 12, 1827". Herschel described fundamental distortions associated with astigmatism and certain features of the Conoid of Sturm. Separately, we know that Thomas Young first appreciated the presence of astigmatism at the very outset of the 19$^{th}$ century. He also made a serious attempt to characterize experimentally his own astigmatic disorder. In so doing, he created a very contact device, or contact lens. Because he had rather high lenticular astigmatism, he assumed that astigmatism, *per se*, was largely lens based.

As noted earlier in one of these columns, the writer had the special pleasure of having been invited (by the late Walter Stanley Stiles, FRS), to attend, in formal attire, a lecture at The Royal Institution in London, presented by a distinguished descendent of Thomas Young, Professor F.Z. Young. Professor Young, at that lecture, *using Young's original equipment*, stored at The Royal Institution, demonstrated this experiment to the audience, along with color mixture, and other important studies.

The second paper[2] addresses a curious finding (readily replicated – please try it!) associated with the Conoid of Sturm. We came to this realization some years ago while testing a patient at the Aravind Eye (Charity) Hospital in Madurai, Tamil Nadu State, India. Optics has made quite a number of rapid advances in recent decades; one of those advances relates to the "modulation and phase transfers" of an optical system. The concept of "spatial filtering" is associated with this form of analysis. The lowest spatial frequencies carry the bulk of the luminance or the apparent brightness of a figure of stimulus, and higher spatial frequencies carry much of the information defining the boundaries or edges of objects viewed. In essence, the "Conoid of Sturm" proves to be a characteristic form of high spatial frequency *spurious resolution* associated with astigmatism. By using a *spatial filter effectively removing the higher spatial frequencies* (here the spatial filter is created by a fine ground glass), the "Conoid" flattens and disappears and a rather blurred residual distribution, passed through by the spatial filter, is perceived by the observer. While considering this particular topic, it is useful to note that the so-called "circle of least confusion" in the Conoid need not be a circle! Actually, it takes the shape of *the aperture* of the optical system, be it circle, square, "D" shaped, etc.

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1. Enoch JM, Heitz R, Lakshminarayanan V. John Frederick William Herschel on testing for astigmatism in 1845. Ophthal Physiol Opt 1988;8:349-350.

2. Enoch JM, Lakshminarayanan V, Kono M (married last name Menz), Shih P, Strada E (married last name Russo). Refractive astigmatism acts predominantly as a source of high spatial frequency image distortion: The associated lineal distortions can be overcome by using a low pass spatial filter! Internat Ophthalmol 1999;22:181-182. *Note: In the original article Strada was spelled Strata incorrectly.*

## John Frederick William Herschel on testing for astigmatism in 1845

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Characteristic refractive anomalies of the eye, described by the term astigmatism, are caused by certain non-sphericities of the cornea and crystalline lens. Most people exhibit some degree of this anomaly. This anomaly results in the formation of a complex three-dimensional image (of a point) generally described by the conoid of Sturm. The common result is blurring of imagery and poorer resolution for objects in meridians not parallel to one of the eye's principal meridians. Thus individuals exhibiting this anomaly will selectively mis-read letters with certain oriented features, often over more than one line, on visual acuity charts with which all of us are familiar.

This selective blurring and resolution can be detected in an accurate manner, and such determinations are used to define that amount and axis of the astigmatic refractive error of the observer. One group of tests used for such determinations employs a form of protractor to detect the alignment of the blackest, sharpest, and most distinct direction of spurious resolution. These tests have been known as the fan dial, the clock dial, the 'T' test, the multiple lines cross, etc. Cohen, Jackson, Lancaster, Robinson, and Taylor are among those who have been associated with such techniques which developed late in the nineteenth century and early in this century. (For a description of various tests, *see* Borish 1970).

The same principle can be applied using geometric figures with multi-directional components, i.e., a circle, an arc, a pair of parabolas. A pair of hyperbolas or parabolas can describe virtually all directions and one can define that portion of such figures which appears blackest, sharpest, and most distinct. Such forms have been developed more recently by Raubitschek (1929, 1952), and Le Grand (1952). Le Grand's test was used less for astigmatism assessment, *per se*, than for defining details of the mechanism of ocular accommodation and the demonstration of transient effects that occur during accommodation and the astigmatic nature of some of these transients. The Raubitschek test, though not broadly used today, is rather elegant. It was marketed by the then American Optical Corporation as the paraboline test.

Such figures require 180 degrees of arc direction to meet the requirements of the test. The modern literature on astigmatism has missed the fact that this principle was clearly stated by John Frederick William Herschel (1792-1872) in his 'Discourse on Light' in the *Encyclopedia Metropolitana* **4**, 398 (1845). Although this volume is dated 1845, the last page of the test of Herschel's article is dated 'Slough, December 12, 1827', and the article was published separately in 1828. The full text of section 359 is given in Dickinson and Hall (1946). We quote the following passage (from Section 359, Malconformations of the Cornea):

"Malconformations of the cornea are much more common than is generally supposed, and few eyes are, in fact, free of them. They may be detected by closing one eye, and directing the other to a very narrow, well-defined luminous object, not too bright (the horns of the moon, when a slender crescent, only 2 or 3 days old, are very proper for this purpose) and turning the head about in various directions. The line will be doubled, tripled, or multiplied, or variously distorted; and careful observation of its appearance will lead to knowledge of the peculiar conformation of the refracting surfaces of the eye which causes them, and may suggest their proper remedy. A remarkable and instructive instance of the kind has recently been adduced by Mr. G.B. Airy (*Transactions of the Cambridge Philosophical Society)* in the case of one of his own eyes, which, from a certain defect in the figure of his lenses, he ascertained to refract the rays in the vertical to a nearer focus in a vertical than in a horizontal plane, so as the render the eye utterly useless."

Herschel then offers some suggestions as to how this anomaly might be corrected. These suggestions, interesting in and of themselves, bear on the early history of contact devices and contact lenses. We will separately discuss these points elsewhere. Airy (1801-1892), in his paper read before the Cambridge Philosophical Society in 1825 (and published in 1827) described his use of a crossline figure to detect and measure the astigmatism of his own left eye. Also, in 1826, J.I. Hawkins suggested the use of printed music staves as a suitable test object in the detection of astigmatism by means of an optometer.

Clearly Herschel properly understood and applied a sensitive test for astigmatism and the determination of the axis for astigmatism. Such tests are still in use today. It is proper to credit this distinguished scientist with the full appreciation of Airy's pioneering investigations.

**Acknowledgement**
This work was supported in part by NEI grant EY03674 to Jay M. Enoch.

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## Refractive astigmatism acts predominantly as a source of high spatial frequency image distortion: The associated lineal distortions can be overcome by using a low pass spatial filter!

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**Key words:** Astigmatism, "Conoid of Sturm", degraded retinal imagery, modulation transfer function (MTF), vernier acuity, visual acuity

**Abstract:**
*Purpose:* Surprisingly, an important characteristic of astigmatism has been overlooked by ophthalmic and clinical scientists. Apparently, refractive astigmatism is due largely to a form of high spatial frequency image distortion. *Methods:* Characteristic astigmatic image distortion can be minimized or eliminated by using a low-pass spatial filter (here, a ground glass plate was employed for this purpose). The ground glass is placed a short distance in front of a visual acuity chart, or it may be used with other tests, such as vernier acuity. *Results:* This test has been performed by us on large numbers of patients and test subjects. A clinician can try this test for himself/herself. Place a +2.00 D.C. (any axis) lens in front of the eye; the usual distortions will be observed. Locate the ground glass plate as described. The usual distortions associated with the conoid of Sturm will not be visible or will be virtually eliminated, although some image blur will remain. *Conclusions:* This technique has significance, e.g., in visual screening programs in developing nations, or in assessing patients with media disorders prior to ophthalmic surgery.

A ground glass reduces image contrast at all spatial frequencies. However, the effect is much greater at high spatial frequencies, e.g., [1–4]. Thus, a ground glass largely acts as a low-frequency-pass spatial filter (here, we ignore light scatter effects).

Previously, it was found that a ground glass resulted in the elimination of multiple images (polyopia) in patients with posterior sub-capsular cataracts [5–7], although the image viewed was somewhat degraded by the ground glass. The ground glass could also be used to simulate effects of nuclear cataract.

As part of these studies, when viewing an object through a ground glass, an interesting effect was found in patients with uncorrected astigmatism. We are all familiar with characteristic lineal distorted imagery encountered in uncorrected astigmatism. This effect was long ago characterized by Sturm (e.g., the conoid of Sturm). We found that the lineal distortions of astigmatic images can be removed or minimized to a large extent by placing a ground glass between the object viewed (usually by locating the ground glass reasonably close to the object viewed) and the observer.

For example, if one places a +2.00 or +3.00 D.C. cylindrical lens (any axis) in front of one's own eye and views an acuity chart (or a video display terminal [VDT]) through the lens, one sees the typical astigmatic distortions of the letters or objects viewed. If, then, one asks an assistant to hold (or mounts) a ground glass a bit in front of this chart (i.e., a discrete distance), the blur circles round up, and the distortion effects associated with astigmatism affecting the individual letters are eliminated. A self-luminous chart or VDT provides a superior effect in this application, because veiling glare is reduced.

Similarly, using the same cylindrical lens in a trial frame, the effect can be readily experienced for oneself by viewing a small flashlight beam and a placing a ground glass some mm in front of it. The luminous area of the flashlight can be viewed with and without the ground glass in place. Try using differing ground glass separations, and locate different power cylinders and axes before the eye.

A number of individuals have addressed various aspects of this problem [8–13]. Legge et al. [14] have shown that tasks requiring only low spatial frequencies will be more tolerant to defocus than tasks requiring higher spatial frequencies. More recently, Thorn and Schwartz [15] discussed the effects of defocus on letter and sine wave gratings and concluded that 'letters are recognizable only if the spatial components used for recognition are free of spurious resolution or phase reversals' (also see Ref. 10). Lakshminarayanan and Lang [16], using concurrent measurements of defocused modulation transfer function (MTF) and subjective letter recognition, confirmed that just recognizable letters are free of spurious resolution with approximate values of about 2.1 cycles/letter, and that spatial frequencies required for letter recognition fall below the first spurious zero in the defocused MTF and thus are free of spurious resolution.

Distortions caused by refractive astigmatism can be readily overcome by use of low-pass spatial filtering (provided by a ground glass or other predominantly low-pass spatial filter). The simple approach described here has been used successfully in visual studies of vernier acuity (or vernier alignment) and visual acuity conducted in India. There, one encounters settings, e.g., some eye camps, where reliable refractions were not always available or possible, particularly in patients with advanced cataracts or corneal disorders [5–7]. And in a number of developing nations, trial sets without cylinders may be encountered. The technique described is applicable for use with a variety of ophthalmic tests.

In general, this technique is useful in a number of screening situations and is not limited to developing world settings, e.g., it can be useful in testing certain patients who exhibit irregular astigmatism. It can be employed to evaluate potential retinal function pre-surgery or pre-treatment.

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# Clinical Optometry Textbooks

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When I was an optometry student at The Ohio State University during the 1940s, very few textbooks on Clinical Optometry were available. Although we had textbooks on Optics, Ocular Anatomy, and Ocular Physiology, our main source of information for the courses in Vision Science and Clinical Optometry taught by Prof. Glenn Fry was Fry's comprehensive mimeographed notes. By the time my classmates and I graduated, in 1946, we possessed about a dozen thick notebooks full of these valuable notes.

After graduation, I started an optometric practice --'from scratch'-- in Franklin, a small town in southwestern Ohio between Dayton and Cincinnati. During my first several years in practice, I became increasingly aware of the 'unsettled' condition of optometry: Those optometrists who had graduated from the University schools (Ohio State and Berkeley) learned to use the 'Graphical' method of analysis of binocular vision findings; whereas those who had graduated from the private schools (ICO in Chicago, SCO in Memphis, and SCCO in Los Angeles) learned to use the OEP, or 'Analytical' method of analysis, which placed much more emphasis on vision therapy than did the Graphical method.

Fortunately, some of us who were in practice during that period had a background in both methods of analysis. Although having graduated from Ohio State, once I was in practice I routinely attended the "Zone Meetings" in Dayton, Ohio, in which the main topic of conversation was the OEP method of analysis. [For those who are not familiar with the OEP method -- also called the '21-point' method, the endpoint for the binocular subjective is '"twenty-twenty without a blur," whereas the binocular subjective endpoint for the Graphical method is "maximum plus for best visual acuity."] Although I participated in many discussions concerning which method was better, it usually occurred that when each method was performed correctly, there was little or no difference in the 'end-point' for the two methods. But, for binocular vision problems, the OEP method was likely to involve vision therapy for cases in which the Graphical method would involve the prescription of BI or BO prisms or, for nearpoint esophoria, added plus power at near.

There seemed to be two reasons for my decision to go back to Ohio State to obtain a Ph.D. and eventually become an optometric educator and researcher: A desire to learn more about binocular vision and other aspects of optometry, and (although I wouldn't admit this at that time) a desire to -- eventually -- sum up the existing knowledge of optometry in a textbook or two.

Upon receiving the Ph.D. degree in 1956, I obtained a position at the University of Houston College of Optometry, where Dr. Charles Stewart, also an Ohio State graduate, was the founding Dean. During the 1950s and 1960s, Houston was one of the few optometry schools where both the OEP and the Graphical methods of analysis were taught. The form on which students recorded their examination findings had two columns: one for the OEP 21-point method, and one for the Graphical method. Depending on which clinical instructor happened to be on duty, students were expected to complete -- and record -- the tests in either the OEP or the Graphical column. When I was on duty in the clinic, some students would complete -- and record -- the tests in both the OEP and the Graphical columns. As expected, there was usually very little difference in the results obtained by the two methods; except for the fact that the OEP method was more likely to result in vision therapy than the Graphical method.

During the decade of the 1950s, the need for textbooks in what we now call 'Primary Care Optometry' was met by Dr. Irvin Borish's *Clinical Refraction*, published by the Professional Press in Chicago. Although there was no textbook devoted specifically to the OEP method of analysis, for many years the Optometric Extension Program published the 'OEP Papers' which served the purpose of a textbook.

**Contact Lens Theory and Practice**

With the rapid development of corneal contact lens technology, it became obvious that the greatest need for textbooks was in the contact lens area. Initially, the contact lens teaching at Houston was done, on a part-time basis, by Dr. Bernard Mazow, a Houston practitioner whose practice was limited to contact lens work. But with the introduction of the corneal contact lens, it was obvious that the contact lens area required more than one instructor: This effort was led by Dean Stewart; and within a short period of time Drs. Chester Pheiffer, Darrell Carter, Jess Eskridge, John Levene, James Koetting, and I were all involved in contact lens teaching.

During the 1950s and 1950s, several contact lens textbooks were published, but by the 1960s it became obvious that a more comprehensive textbook was needed. We had some discussions at faculty meetings, in which I agreed to take on the task of writing the needed textbook. After a period of several months, I had completed the manuscript for *Contact Lens Theory and Practice*[1] which was published in 1963 by the Professional Press. I was fortunate that an optometry student, Don Woolery, was an accomplished draftsman (this was before computerized drawing programs were available) who did a really great job of providing numerous optical diagrams.

During the decade following the publication of *Contact Lens Theory and Practice,* contact lens technology continued to expand at a rapid pace. During that period, Dr. Robert Mandell published a more comprehensive textbook, much of which was based on research done by himself and others at the University of California. Although Martin Topaz, president of Professional Press, suggested that I write a revised edition of *Contact Lens Theory and Practice*, I was unable to do this because of the pressure of my teaching and administrative duties, as founding head of the Diploma in Optometry Programme at the University of Auckland, in New Zealand.

## Contemporary Contact Lens Practice

When *Contact Lens Theory and Practice* was published, in 1963, the only contact lenses available were made of the rigid *polymethyl methacrylate* (PMMA) material. However, with the development of soft, *hydrogel* materials for the manufacture of contact lenses, it seemed like a good idea to write a book, *Contemporary Contact Lens Practice*[2] which presented the latest developments in rigid contact lens fitting; with a final chapter concerned with the fitting of soft contact lenses. By that time, I had moved to the University of Waterloo in Ontario, Canada, where we had access to some newly-developed contact lens modalities that had not yet been approved by the FDA for distribution in the United States.

## Optometry Reconsidered

Many older practitioners will remember *The Optometric Weekly,* published by the Professional Press. During the 1970s, president Marty Topaz let it be known that he would like to recruit somebody to write a 'column' in the Optometric Weekly called *Optometry Reconsidered.* This seemed to me like a good idea, so I wrote a 2-3 page column---first in the *Optometric Weekly* and then in the *Optometric Monthly*---during the period from May, 1975 to June, 1981; for a total of several hundred columns. In each of these columns, I brought a specific area of Optometry (refraction, contact lens fitting, vision training, etc.) "up-to-date." I found this to be an interesting endeavor, and -- perhaps selfishly -- the areas that I selected were usually those in which I was currently teaching.

## Primary Care Optometry

Although Irv Borish's *Clinical Refraction* was still a very popular book --- having gone into several editions and gradually becoming more comprehensive over the years -- Peter Topaz, who was then president of Professional Press, suggested that I write a strictly *clinically-oriented* book -- a clinical manual. With the increasing emphasis of Optometry as a Primary Care profession, I chose the title *Primary Care Optometry, A Clinical Manual.*[3] I had the advantage of having written all of those 'Optometry Reconsidered' columns, many of which could be used as the basis for a chapter in the new book, published in 1992. At that time, legislation for the optometric use of diagnostic pharmaceutial agents (DPA's) had been enacted in some states, and was under consideration in others -- but in many sates, optometrists still had to examine the fundus through an undilated pupil, and could relax the patient's accommodation only by 'fogging' with convex lenses.

When the second edition of *Primary Care Optometry*[4] was published, in 1989, legislation allowing the optometric use of DPA's had been enacted in virtually all of the 50 states; and legislation allowing the use of therapeutic pharmaceutical agents (TPA's) had been enacted in several states; so more emphasis was placed on the use of these pharmaceutical agents. In addition, increased emphasis was placed on the control of myopia by various methods including vision training, bifocals or reading glasses, and the wearing of rigid contact lenses. Also, newly-developed methods of reducing the existing amount of myopia with contact lenses --*orthokeratology* -- were described.

By the time the third edition of *Primary Care Optometry*[5] was published, in 1996, many new diagnostic procedures were available including testing for disability glare, contrast sensitivity and low-contrast visual acuity testing, static perimetry, photokeratoscopy, and videokeratoscopy. Perhaps more importantly, several methods of refractive surgery had been introduced, and optometrists were (and still are) in a position to interact with refractive surgeons in the care of these patients.

Not long after I retired in the year 2000 and Betty and I moved to the northwest, I was contacted by the Butterworth-Heinemann editor concerning the possibility of writing a 4th edition of Primary Care Optometry. I accepted the challenge, and arranged to visit the Pacific University College of Optometry at Forest Grove, Oregon, to consult with faculty members concerning the content of the 4th edition and, of course, to spend many hours in their library. On my first visit to Forest Grove I was offered a position as an Adjunct Professor -- a position with no duties and no pay! I gratefully accepted, and have found this relationship to be extremely satisfying. The 4th edition,[6] published in the year 2002, differed from previous editions in placing even greater emphasis on methods for the management of myopia, both non-surgical and surgical methods; and -- with the aging of the population -- the management of age-related vision problems.

Although I had expected that further editions of Primary Care Optometry, if any, would have other authors, in the year 2005 I was contacted by the managing editor of Elsevier, Inc., inviting me to write a 5th edition of Primary Care Optometry, which would go on sale 25 years after the first edition was published. Again, I accepted the challenge. During the 5-year period since the publication of the 4th edition, optometry's horizons had continued to expand; particularly in regard to *age-related changes* -- having personally experienced a retinal detachment (right eye), macular degeneration (left eye) and cataract extraction followed by IOL implantation (both eyes). In the 5th Edition,[7] which is now in print, more emphasis is placed on these age-related changes; along with discussions of newly-developed instrumentation for autorefraction, biomicroscopy, visual field evaluation and other procedures.

I can't end this discussion without emphasizing an important fact: With the increased dependency on autorefractors and the tendency for some practitioners to forego retinoscopy, with or without cycloplegia, *latent hyperopia* in children and young adults often goes undetected: For this reason, in the fifth edition, increased attention is given to 'the neglected hyperope.'

**Clinical Optics, with Troy Fannin**

At the University of Houston, Dr.Troy Fannin had taught Clinical Optics for many years, during which an up-to-date textbook on the subject had not been available. Many readers of *Hindsight* will recall that in years past, several textbooks on optics were written by authors in the United Kingdom: Southall, Fincham, Bennett, Jalie, to name a few. Although textbooks covering various aspects of optics had been written by optometric educators in the United States in more recent years, none of them provided information on all of the topics that were included in Dr. Fannin's Clinical Optics course.

Over a period of years, he had accumulated many pages of hand-written lecture notes; so our method of producing the textbook was for him to supply me with the notes, together with the necessary optical diagrams, and for me to enter them into a computer program in the form of a textbook. [Of course I also had some input, having taught an occasional Optics course.] It was an interesting challenge for both of us! The first edition[8] was published by Butterworth-Heinemann in 1987, and a second edition[9] was published, also by Butterworth-Heinemann, in 1996. In each of the two editions, the first several chapters cover the 'nuts and bolts' of optics: the Sign Convention, Nomenclature, Characteristics of Ophthalmic Lenses, Power Specification and Measurement, Prisms and Decentration, etc., whereas the remaining chapters deal with the more clinically-oriented subjects such as The Correction of Ametropia, Absorptive Lenses and Lens Coatings, Multifocal Lenses, Eyewear Design and Dispensing, Lenses for High Refractive Errors, Optical Principles of Lenses for Low Vision, and Optics of Contact Lenses.

**Refractive Anomalies: Research and Clinical Applications, with Merton Flom**

This book was written during the 1980s, when Dr. Merton Flom and I were both on the Optometry faculty at the University of Houston. Many years previously Drs. Frank Weymouth and Monroe Hirsch, working together at the Stanford University Vision Laboratory, had reviewed more than 3,000 articles and abstracts with the intention of writing a book on myopia. In 1960, when Weymouth came to Berkeley to collaborate on a research project with Flom, he spent several spare hours revising the first several chapters that he and Hirsch had written. Unfortunately, due to Weymouth's death in 1963 and Hirsch's prolonged illness prior to his death in 1982, the book was never published.

It was fortunate that Flom was in possession of these introductory chapters: We used them as the first three chapters of *Refractive Anomalies, Research and Clinical Applications,*[10] with the remaining 21 chapters being written by 25 optometrists and vision scientists, each an expert in his or her area. Although the major thrust of the book has to do with myopia, there are also chapters on hyperopia, astigmatism, anisometropia, and experimentally-induced myopia in birds and mammals. In spite of the fact that this book was published almost a decade ago, I am aware that it is used as a text or reference book in some optometry schools.

**Clinical Management of Myopia, with David Goss**

The need for a book on the Clinical Management of Myopia[11] was suggested by Dr. Rodger Kame, an avid myopia researcher, mainly in the area of Orthokeratology. Sadly, he became ill and did not live to see the finished product. After a Foreword by Dr. Henry Hofstetter, the text is organized into two Sections, with a total of 11 Chapters:

I. General Principles: Epidemiology of Myopia; Etiology of Myopia; Clinical Examination; Prescribing for Myopia.

II. Methods of Myopia Control and Reduction: Vision Therapy; Control With Added Plus Power for Near Work; Myopia Control with Pharmaceutical Agents; Corneal

Topography Measurement; Myopia Control or Reduction with Rigid Contact Lenses; Keratorefractive Surgery; Refractive Surgery Involving the Lens.

**Foreign Language Translations**

Although totally unexpected, two of the textbooks have been translated into foreign languages: The fourth edition of *Primary Care Optometry* was translated into Spanish, with the title: *Optometria De Atencion Primaria*; published by Masson S.A., Barcelona; Spain; and *Clinical Management of Myopia* was translated into Chinese by Ho-Chi Book Publishing Co., Taipei, Taiwan.

**Self-Published Books**

During the 1990s, when I was enjoying a half-time 'post-retirement' position at Indiana University, it occurred to me that there were very few books on vision intended for the 'general public.' I was particularly concerned about myopia, having personally observed the almost complete lack of myopia in Melanesian children in the Pacific island nation of Vanuatu, where only 3% of children between the ages 14 and 15 years were myopic,[12] as compared to the 70% prevalence of myopia reported for Asian children of the same age in Taiwan.[13]

The title I chose for my first self-published book was *The Myopia Epidemic: Near-sightedness, Vision Impairment and Other Vision Problems*.[14] After completing the 138-page manuscript, in 12-point Geneva typeface and 8.5" x 11" format, I found no publisher was interested in a book for "the general public." After retiring and moving to Ferndale, Washington, I formed a company, Twenty Twenty Publications, and arranged for a local printer to print 1,000 copies of the book. But then I found that it is easier to write a self-published book than to market it.

Meanwhile, I had completed the manuscript for a second self-published book, *Vision After 50: Preventing Age-Related Vision Loss*,[15] also in 12 pt Geneva typeface, but in 5.5" x 8.5" format. I looked into the possibility of having the two books 'marketed,' in hard-copy or electronic form, but in either situation the cost would have been too high to make the enterprise worth the effort. So I soon concluded that the best way to 'distribute' the books was to give them away, treating them as income tax deductions!

**Postscript**

*Occasionally, somebody asks me "How---or why---do you write all those books?" My usual answer is "Because I learned to use a keyboard when I was in high school, on a 1934 Remington Portable typewriter." Other optometrists I know who used a typewriter before the 'computer era' are Irv Borish and Jerome Rosner. If I hadn't been able to use a typewriter, I would have had to dictate to a stenographer or write legibly with a pencil or a pen.*

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# Landmarks in the History of Optometry

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***Abstract***

*This article discusses some selected important events and achievements in the history of optometry. The purpose of the article is not to provide an inclusive, comprehensive list of developments related to optometry, but rather to present a discussion of representative events of significance or of interest. For the last two centuries, emphasis is on developments in the United States.*

***Key words:*** *history of optometry, optometry, optometric education.*

A reasonable place to start a discussion of the history of optometry is to consider when optometry began. While there are many influences that have led to the optometry of the present, some commentators suggest the invention of spectacles as the time that can be identified as the beginning of optometry.[1-3] The fact that physicians and medical practitioners for many years did not incorporate the use of spectacles among their treatment methods allowed the development of an occupation of spectacle making and prescribing independent of medicine.

There are no existing records of the invention of spectacles. Hofstetter[4] suggested that the invention could not have been before 1270 because spectacles were not mentioned in the comprehensive book on optics published about that time by the famous Polish scientist Witelo. It is likely that the inventor was an unknown craftsman in northern Italy who kept his manufacturing methods secret in order to try to protect the profits derived from the sale of spectacles.[5-8] The most exhaustive study on the invention of spectacles is the work of Rosen.[5] He concluded that spectacles were invented probably in Pisa in about 1286.

Other persons quickly copied the work of the inventor of spectacles and by about 1300, there were spectacle manufacturing businesses in Nuremberg in Germany, Haarlem in the Netherlands, and Venice in Italy.[4] At that time, the lenses in spectacles were plus spheres for presbyopia. When the first spectacles for the correction of myopia were worn is uncertain, but probably sometime in the fifteenth century. There is evidence of spectacle makers guilds in France in 1465, in Nuremberg in 1483, and in England in 1563.[4] In the first few centuries of spectacle making, there were, of course, changes and improvements in frame and lens materials and construction methods.

An understanding of the basic optics of hyperopia and myopia started to emerge in the sixteenth century. The 1554 work by Francesco Maurolyco (1494-1575) included a discussion of the optics of lenses correcting hyperopia and myopia. He wrote that "...when spectacles are used to correct the defects of nature, they do this only by converging the rays which have been spread out or by spreading the rays which are too closely assembled: and experience shows that convex lenses will correct the error of long-sightedness and concave lenses that of short-sightedness. It follows therefore that, in the case of those who are troubled with too long vision, the visual rays ought to be gathered together: while in the short-sighted, they should be spread apart."[9] Maurolyco attributed refractive errors to variations in the curvature of the crystalline lens.[10]

The great physicist Johannes Kepler (1571-1630) published his important works in optics in 1604 and 1611. Kepler's work is sometimes hailed as the being largely the geometric optics taught today with, of course, changes in terminology, units, etc. Among other things, he showed that the image on the retina was inverted. Kepler said that "...vision is brought about by a picture of the thing seen being formed on the concave surface of the retina. That which is to the right outside is depicted on the left on the retina, that to the left on the right, that above below, and that below above."[11] Incidentally, Kepler may have been the first to publish a hypothesized connection of near work and myopia, when he wrote that "a life spent sitting indoors, bent over a book or a fine manual task, leads to nearsightedness..."[12]

The first book devoted to optometric procedures and analysis was published in Spain in 1623. An English translation of the title of the book by Benito Daza de Valdes is *Use of Spectacles for all kinds of sight.*[13] The topics in the book included optics, ocular anatomy, and the use and fitting of spectacles.[14] Daza de Valdes included a system of lens grades for lens power, and he presented a table of lens grades according to age in presbyopia. He suggested that minus lenses for myopia should not be so powerful as to cause perceived reduction in image size, a common principle used in determining endpoints on subjective refraction today. One part of the book was entitled "Dialogues Between Various Persons and a Master Maker of Spectacles,"[15] and contained what we would recognize as case reports.

Another book which covered the optometry of its time was published in 1692 by William Molyneux of Dublin.[16] Molyneux discussed the optics of plus and minus lenses and how lenses and spectacles can be used to improve vision. He suggested using the weakest power lenses to remedy the visual problem in question. He noted that in presbyopia there was a relation between the power of lenses and the distance of the object being viewed. Molyneux discussed the occasional near point problems of myopes when they get new glasses. And he described the use of telescopic and microscopic systems for persons with failing eyesight.

If we jump forward to the eighteenth century, the year 1783 is significant in American optometry because the purchase of a number of spectacles by John McAllister, Sr., of Philadelphia, may be viewed as the beginning of the American optical industry. Before that time it is thought that spectacles in America were imported from Europe. But soon after McAllister began selling glasses, he started making them. His son, John McAllister, Jr., joined him in business in 1811. The McAllister family of opticians continued through John McAllister, Jr.'s son, William Young McAllister, and grandson, James Cook McAllister.

The early American spectacle makers became the first refractionists in America. In 1913, James Cook McAllister, who at that time had been working as an optician for 43 years, testified that his grandfather, John McAllister, Jr. was the first person to perform refractions in the state of Pennsylvania.[17] The McAllister family taught refraction and the optical business to various people, as for example, James W. Queen, who started his own business in 1853. According to the testimony of James Cook McAllister, his father, William Young McAllister, and James W. Queen were the first to teach the medical eye practitioners in Philadelphia, then known as oculists, how to refract.[17]

Other prominent early American optometrists (who at the time called themselves opticians) were Benjamin Pike, who came to the United States in the early 1800s, and James Prentice, who emigrated in 1847. They both learned optics in England, and they both trained their sons in optics. James Prentice's son was Charles Prentice, who received further training in optics and engineering in Germany and became a leader in organized optometry. Charles Prentice published works on optics that were well received in both optometry and ophthalmology and he coined the term prism diopter. The formula for calculation of the prismatic effect of the decentration of lenses, Prentice's Rule, still carries his name.

One of the hallmarks of maturation and acceptance of a profession is formal licensure. We could also identify the charge of a fee for services rather than just obtaining a profit by sales of goods as another sign of professionalization. The first attempt to pass an optometry licensure law in the United States occurred in New York in 1897. This effort was, in part, a consequence of threats to Charles Prentice from ophthalmologists for charging a fee for a vision examination.[18] This initial effort in New York was unsuccessful, but the first passage of an American optometry licensure law occurred shortly after that in Minnesota in 1901. By 1924, all states and the District of Columbia had passed optometry licensure laws.

The last years of the nineteenth century and the first years of the twentieth century were also marked by efforts to form optometric organizations and associations. Many state optometric associations were established in those years. The American Optometric Association recognizes 1898 as its year of formation.[19,20] It was first known as the American Association of Opticians. In 1910, the name was changed to the American Optical Association. By that time, many opticians who did vision testing were calling what they did optometry and were calling themselves optometrists. In 1919, the American Optical Association changed its name to the American Optometric Association. The first two presidents of the American Optometric Association were Charles Lembke, who served in that capacity from 1898 to 1900, and Andrew J. Cross, who was president from 1900 to 1901. In addition to his organizational activities nationally and in the state of New York, Cross was also known for his work in the development of dynamic retinoscopy and for being an influential optometry instructor at Columbia University from 1911 to 1924.[21]

The American Academy of Optometry was founded in 1922.[22,23] Today it publishes the respected journal *Optometry and Vision Science.* The journal assumed that title in 1989. From 1941 to 1973, the journal was known as the *American Journal of Optometry and Archives of the American Academy of Optometry*, and from 1974 to 1988, its title was *American Journal of Optometry and Physiological Optics.* The journal can trace its lineage (and its volume numbering) back to the *Northwest Journal of Optometry*, first published in 1924 as the journal of the Minnesota, North Dakota, and South Dakota state optometric associations. In August, 1925, the journal title was changed to *American Journal of Optometry.* By 1928, the journal was the journal of eleven state associations and in May of that year it became the official news outlet of the American Academy of Optometry. Starting in 1934, there was no mention in its pages of its use as an official publication by any state associations.[24] The editor of the journal from 1924 to 1968 was Carel C. Koch.[24,25] From 1948 to 1973, Koch was also Secretary of the American Academy of Optometry.[26]

A claim for the earliest exclusively optometric periodical was made by J. Milton Johnston (1844-1930) for the *Johnston Eye-Echo*, first published in 1886. Johnston wrote a series of lessons for the journal. The journal was published under the sponsorship of the Johnston Optical Company, which had been founded by J. Milton's brother George.[27] The first established periodical to start publishing material on ophthalmic optics regularly appears to have been the *Jeweler's Circular.* Dates for the beginning of the optical department in that periodical have been reported variously as June, 1882 or January, 1886.[27] A young employee of the publisher of that publication was Frederick Boger (1866-1936), who would go on the found a periodical entitled *The Optician.*

The oldest surviving optometry periodical is *Review of Optometry*, which can be traced back to the *The Optician*, founded in 1891, and *The Optical Review*, started in 1907. Boger ceased publication of *The Optician* in 1894, but started another monthly periodical, *The Optical Journal*, in 1895. *The Optical Review* is thought to have been derived from the optical section of the *Jeweler's Circular.*[27] *The Optical Journal* and *The Optical Review* joined in 1910 to form *The Optical Journal and Review of Optometry,* the periodical's title until 1977, when it changed to *Review of Optometry.*[27]

Another long-standing optometry periodical, but one which is now defunct, was started in 1910 and was published for more than seven decades under various titles, including *Practical Optician, Practical Optometrist and Optician, Optometric Weekly, and Optometric Monthly.*[28] Like *Review of Optometry, Optometric Weekly* published mostly new items, technical information, and clinical review articles rather than peer reviewed research papers.

In addition to licensure and the founding of professional journals, another sign of professionalization is the formation and standardization of rigorous educational programs. Optometry was learned largely by apprenticeship until the late nineteenth century. At that time privately owned schools, usually known by the owner's name, began to appear. It is thought that there were more than 60 of these schools and training clinics in operation in the late nineteenth century and early twentieth century.[29,30] Some of the courses were only one to two weeks in length. Academic prerequisites were minimal. Some of the schools were operated by optical companies, such as the Spencer Optical Company, which offered a two-week course for $25, and the King Optical Company of Cleveland, Ohio. The Foster School of Optics, started in 1888 in Boston, offered onsite classes and correspondence classes. The Philadelphia Optical College also offered a correspondence course. Some of the other early optometry schools were the McCormick Optical College and the Johnston Optical Institute in Chicago, The College of Optics in South Bend, Indiana, Southwestern Optical College in Kansas City, Missouri, Syracuse School of Optics in Syracuse, New York, and Kellam and Moore's College of Optics in Georgia.[30-32]

In the mid 1920s, there were about 40 optometry schools in operation and the curricula were usually two years in length. As optometric organizations worked toward the standardization of curricula, weaker schools went out of business, and by 1936, there were ten optometry schools and the optometry curricula were generally three years. Schools had reduced enrollments during World War II and some closed, but by 1946, there were again ten schools in operation with three of them requiring a total of five years of education including pre-optometry university work. Educational requirements gradually increased to two years of pre-optometry and four years of optometry school in all the schools by the 1960s and then to the present-day levels of three to four years of pre-optometry university work and four years of optometry school. By 1970, all American optometry schools had adopted the Doctor of Optometry (O.D.) as the degree granted at the successful completion of optometry school.

The first university to open an optometry school was Columbia University, where optometry classes were offered from 1910 to 1954. The existing university-based optometry schools and their years of origin are: The Ohio State University, 1914; University of California Berkeley, 1923; Pacific University, 1945 (although it was a continuation of a private school, North Pacific College of Optometry which originated in 1921 and closed during World War II); Indiana University, founded in 1951 with pre-optometry classes beginning in 1951 and optometry classes beginning in 1953; University of Houston, 1952; University of Alabama Birmingham, 1969; State University of New York, 1970; Ferris State University (Michigan), 1974; Northeastern State University (Oklahoma), 1979; University of Missouri St. Louis, 1980; Inter-American University of Puerto Rico, 1981; and Nova Southeastern University (Florida), 1989.[33-35]

The existing independent optometry schools are: Illinois College of Optometry, which traces its lineage back to the Northern Illinois College of Ophthalmology and Otology founded in 1872 and through predecessor schools which include the Needles Institute, Northern Illinois College of Optometry, Monroe College of Optometry, and the Chicago College of Optometry; New England College of Optometry, previously known as the Massachusetts College of Optometry, which traces its roots back to the Klein

School of Optics which started in 1894; Southern California College of Optometry, which started in 1904 as the Los Angeles Medical School of Ophthalmology and was later known as the Los Angeles College of Optometry; Pennsylvania College of Optometry, founded in 1919 as the Pennsylvania State College of Optometry, and Southern College of Optometry, begun in 1932.[32,33, 36-38]

Through most of the existence of optometry most of work done by optometrists was vision testing and dispensing of spectacles. In the twentieth century there was an increase in the frequency of use of treatments other than spectacles and a broadening of the scope of practice. Examples of the former are increased use of vision training, contact lenses, and low vision devices. The latter is exemplified by passage of laws to permit the use of diagnostic and therapeutic pharmaceutical agents by optometrists. The first state law passed to allow use of diagnostic pharmaceutical agents was in 1971 in Rhode Island and the first for therapeutic pharmaceutical agents was in 1976 in West Virginia.[39,40]

The twentieth century also saw the founding of graduate programs for the M.S. and Ph.D. degrees in physiological optics and vision science. The graduates of these programs have elevated the research efforts in optometry and have been an important part of the faculty of optometry schools. The Ohio State University started a graduate program in physiological optics in the 1930s. The first persons to receive M.S. degrees from that program were Howard Haines and Herbert Mote in 1938. In 1942, Henry Hofstetter received the Ph.D. degree in physiological optics from Ohio State, the first Ph.D. in physiological optics granted by a graduate program offered at an optometry school.[41] Several other schools have established graduate programs in physiological optics and vision science, with Ohio State, University of California Berkeley, Indiana University, and University of Houston having the greatest numbers of Ph.D. graduates among the American schools.

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# Book Review: Borish

**Borish. William R. Baldwin. Springfield, MA: Bassette, 2006. Pages: xiv + 444. ISBN-10: 1-4243-1888-2. ISBN-13: 978-1-4243-1888-9. Hardcover.**

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Given the exceptional achievements and remarkably long career of Irvin M. Borish and the pivotal role he played in encouraging and nurturing many developments in optometric education and practice, it is appropriate that someone should attempt a book-length biography. Bill Baldwin has achieved that and has done it well in this book.

Borish was born in 1913 in Philadelphia. His childhood was spent in Philadelphia and in Liberty, New York under humble circumstances. He studied for a while at Temple University with thoughts of a career in literature. Due in part to the influence of an uncle, he decided instead to pursue optometry, and attended Northern Illinois College of Optometry (NICO) in Chicago. He graduated from NICO with highest honors in January of 1934. After a brief period of time in optometry practice in Chicago, he became a full-time faculty member at Northern Illinois College of Optometry in January of 1936. His teaching and administrative responsibilities increased at NICO until he left in 1944 to start an optometry practice in Kokomo, Indiana. From 1973 to 1983, Borish was a full-time faculty member at Indiana University. In 1983, he became Benedict Professor of Optometric Practice at the University of Houston. In 1989, Borish retired from Houston, but continued to write, lecture, and work for the enhancement and advancement of the optometric profession.

Into that biographical framework Baldwin weaves details of Borish's family and friends, colleagues, professional activities, artistic endeavors, community contributions, travels, personality, and philosophy. It makes an interesting story. Baldwin captures the insight, intelligence, and drive that allowed Borish to rise to the top of his profession.

The fifteen chapters in the book are organized thematically, each one addressing a common grouping of activities. The successive chapters form an overlapping chronology. The years considered in each of the chapters are part of the chapter titles, which are as follows: 1) The Early Years, 1913-34; 2) Courtship and Marriage, 1932-43; 3) Northern Illinois College of Optometry, 1936-44; 4) Early Service to Optometry, 1940-50; 5) Early Years in Kokomo, 1944-50; 6) Two Triumphs, 1945-51; 7) Achieving Prominence in the Community, 1950-56; 8) The Advent of Corneal Contact Lenses, 1952-62; 9) National and State Health Care Legislation, 1962-82; 10) Personal Health History, 1925-2006; 11) Bloomington, 1973-83; 12) Houston, 1983-89; 13) Optometry Abroad, 1976-87; 14) Essilor, 1977-95; and 15) The Borish Version of Retirement, 1990-2006.

The topics discussed in each chapter can probably be guessed from the chapter titles with the possible exception of Chapter 6, "Two Triumphs, 1945-51." It deals with the efforts to start the optometry school at Indiana University and with the writing of the first edition of *Clinical Refraction.*

Borish worked with many prominent people in optometry through the years, so the book contains references to many such individuals. And the book contains photographs of many of them. For example, in the chapter on NICO (chapter 3), one can find mention and photographs of William Needles, Carl Shepard, William Zoethout, and Eugene Freeman. In the chapter "The Advent of Corneal Contact Lenses" (chapter 8), one can read about, and see pictures of, persons such as William Feinbloom, Newton Wesley, George Jessen, Neal Bailey, and Joe Goldberg.

The book includes three appendices. Appendix A, "Borish Views His Profession," contains excerpts of essays and articles that he wrote on the optometric profession. The dates of these writings range from 1941 to 1993. Appendix B, "Borish's Wit and Wisdom," consists of some anecdotes that he has used to emphasize particular points made in his lectures. In Appendix C, there are tributes from four of his friends and colleagues and a listing of some of the most prestigious awards that he has received.

In researching this book, Baldwin used extensive interviews with Borish, interviews of several of Borish's colleagues, his own personal knowledge of Borish, and information gained from a number of optometry schools and organizations. The book contains more than 170 black and white photographs of Borish, his family, friends, and colleagues, places that he worked, and places that he visited. There is an index and an eight-page color section of Borish's paintings. Some of Borish's paintings also adorn the back and the flaps of the dust jacket. Persons who want to learn more about Irvin M. Borish or about the history of optometry in the twentieth century will find much of interest in this book.

Because of gifts from Essilor and from an anonymous donor, proceeds from the sale of the book go to the Borish Center for Ophthalmic Research at Indiana University. A copy of the book signed and with a personal message from Borish can be obtained for $200. A book with a greeting and signed by Borish can be obtained for $100. The cost of the book is partially tax deductible. Checks should be made payable to Indiana University and sent to: Optometry Budget Office, IU School of Optometry, 800 East Atwater Avenue, Bloomington, IN 47405. A form for ordering the book can be found at www.opt.indiana.edu/bcor/borishbook/BORISH.pdf. Additional information about the book can be obtained at www.opt.indiana.edu/bcor/borishbook/index.htm, or by contacting Hillary Person (812-855-0351 or hlheflin@indiana.edu) at the Indiana University School of Optometry.