Interview with Dr. Gordon Heath
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Electronic Spectacles for the 21st Century
Spinning the Web at the IU School of Optometry
From the Editor

For this issue we are pleased to present an interview with Gordon Heath, the second director of the optometry program at Indiana University. Dr. Heath talks about some of his recollections of his years at IU, particularly his years as Dean.

Profiled in this issue are Larry Thibos and Donald Miller, who are doing some exciting research in visual optics. They also present some speculations on what spectacles may be like in the future based on some of their research efforts.

Also in this issue are a description of some of the world wide web sites operated at the Indiana University School of Optometry, an overview of a journal article that may change the mode of treatment of a significant ocular condition of interest to practitioners, and some news items from the FDA and the IU School of Optometry.

We are anxious to find out whether you, the readers, feel that we are achieving our stated purpose of providing information on the School and on new developments in optometry and vision care. Please give us your feedback and suggestions.

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Cover Photo: Visualization of the array of liquid crystal cells in an adaptive optics device programmed to function as a +1 diopter spherical lens.

This journal is also available on the world wide web at:
http://www.opt.indiana.edu/IndJOpt/home.html

Please contact us with your comments or suggestions by calling 812-855-4440 or emailing us at IndJOpt@indiana.edu.
Gordon G. Heath attended the University of California at Berkeley and the University of Southern California. He served in the Navy in World War II before enrolling in the Los Angeles College of Optometry in 1948. After completion of optometry school, he earned M.S. and Ph.D. degrees in physiological optics from the University of California Berkeley.

In 1955 Dr. Heath joined the faculty of Indiana University. He has made significant and lasting contributions to the Indiana University School of Optometry by serving in many different roles, including Clinic Director (1955-1960), Director of the Physiological Optics Graduate Program (1960-1970 and 1988-1992), Dean (1970-1988), instructor, and researcher. Dr. Heath was president of the Association of Schools and Colleges of Optometry from 1963 to 1965, and president of the American Academy of Optometry in 1983 and 1984. He has been a consultant to several agencies, institutes, and committees.

Dr. Heath is well respected in research circles, having made important contributions to the literature in areas such as color vision and photoreceptor orientation. He has nurtured many graduate students. On December 4 and December 22, 1998, Dr. Heath was interviewed in his optometry school office by the editor of the journal in order to present to the readers some of Dr. Heath’s insights on his years as Dean.

IJO: What are some of the things you did at Indiana University before becoming Dean?

Physiological optics laboratory at Tenth and Union Streets.

Heath: My first administrative responsibility when I first came to IU in 1955 was Clinic Director. The clinic space was then in Jordan Hall. I had an office on the 5th floor which I shared with Ingeborg Schmidt and Neal Bailey. At that time I also taught Geometrical Optics in the basement of the old Student Health Center that was located behind Jordan Hall. There was laboratory space there also. Through the years I have taught several different courses, including courses in the Geometrical Optics, Physiological Optics, and Clinical Optometry sequences.

In 1960 I became responsible for the graduate program in physiological optics. Graduate student quarters were in an old residence building on South Fess. There were about five or six graduate students at the time. We did a lot of personalized mentoring of the graduate students. The first significant physiological optics laboratory was set up by Donald Pitts at 10th and Union Streets.

In the 1960s, I assumed responsibility for design of the present optometry building and was the liaison for working with the local architect Bill Strain. We spent many hours meeting to assess needs. Our first question was the needed square footage. We found that the projection of our needs far exceeded the guidelines for a program of this size. Fortunately, we were able to justify the space needed. Some of the space needs that we put into the plan were for laboratories that we did not yet have, but for which we foresaw a need in the future. Planning for that space made it possible to establish many of those programs, and has allowed this building to adequately serve the needs of the optometry program for more than 30 years now.

IJO: What were the biggest challenges you faced
as Dean?

**Heath:** The goal of making students both good scientists and good clinicians was a difficult challenge. Different persons throw themselves wholeheartedly for one or the other aspect, and don’t seem to be able to see a balance. Proper funding and proper equipment were often significant challenges. We often were able to find ingenious solutions to extend our manpower and resources.

**IJO:** Are there particular students that you remember?

**Heath:** There are many, but a few in particular come to mind. We had a student who had problems with a neighbor’s barking dog bothering him while studying for finals. He must have appreciated our support during that problem, because he later became a significant alumni donor. I can recall a student having particular difficulty with one concept in the accommodation and convergence relationship, in which the phoria line persisted in falling outside the zone of clear binocular vision. This became known as the Gribble syndrome to his classmates. I remember several military optometrists who came to IU for graduate school and who were good researchers. I also remember Bill Baldwin’s efforts trying to get equipment and a laboratory set up for axial length measurements of the eye.

In 1988, some of my former graduate students and some of the IU optometry faculty and administrative staff organized a symposium entitled “Vision Science Symposium - A Tribute to Gordon G. Heath.” Some of the many people involved in organizing the symposium were Ray Applegate, Bill Baldwin, Bob Massof, and Gary Trick. Fifteen graduates of our M.S. and Ph.D. programs in physiological optics gave papers on their research. The symposium was attended by optometrists and vision scientists. Some lively discussion was generated by several of the papers, and the festivities included an evening banquet. A book of the symposium papers was published through funding from Bell Optical Laboratories and CIBA Vision Corporation. It was a very pleasant occasion, and it is very flattering that so much effort was made by so many people.

Many alumni, such as Mike Obremkey, Fred Sprunger, Bob Corns, Dick Hall, John Ashman, and Jim Saladin, to name just a few, have been involved in supporting the school and have helped push us forward.

**IJO:** Through the years IU has shifted from primarily state-funded to primarily attendee-funded. Did that shift start during your years as Dean and what challenges did it present?

**Heath:** Yes, it did. However, even though there was a higher level of state funding at the time I became Dean, the tuition was still a significant burden for many students. We were able to get some supplementary funding from external sources to ease the tuition burden somewhat. We got involved with other units on campus in exchanging information concerning funding.

**IJO:** What satellite clinics were developed during your Deanship?

**Heath:** There had been discussion of external clinics for several years. Increases in class size necessitated the development of clinics outside of the Atwater Avenue building. The westside clinic (Community Eye Care Center) was the first major movement out of the main building clinically. The idea of an external clinic was a new one, and there weren’t many examples from other schools. The main challenge was to develop a facility that would fill our needs as well as the needs of the community. There were many considerations such as scheduling that we had to approach creatively. I marvel that it all turned out as well as it did.

Several years after that the Indianapolis clinic started. It opened in 1976. At its beginning two to
four student interns were overseen by Dr. Jim Hunter. The motivation was to increase the patient base. It also allowed the development of low vision services through a grant from Indiana Rehabilitation Services. The clinic started as a small clinical facility close to the IUPUI campus. One of our difficulties was finding instruction in some of the medical aspects. We were able to recruit an ophthalmologist from Cincinnati, Frank Nance, who commuted weekly from there to instruct our students in ocular disease.

We also developed external rotations in various settings such as major metropolitan optometric centers, an Army eye clinic, and a Veterans Administration hospital. Funding was always a problem for our external clinics and rotations. Funding from the Department of Health, Education, and Welfare and other federal programs, as well as a variety of private sources were helpful.

**IJO:** How did the research efforts in the School of Optometry change during your Deanship?

**Heath:** The program had many satisfactory aspects from its beginning. We were able to develop a fair record of published papers and had a significant number of Ph.D. students. During my years as Dean we were successful in recruiting a number of research faculty, such as Hiro Noda, Lee Guth, Bob Devoe, Larry Thibos, Arthur Bradley, and Doug Horner. A satisfying aspect of the research program was the informal positive relationships between the research faculty and the graduate students.

**IJO:** What skills are important for being a Dean?

**Heath:** Patience, broad understanding of other persons' points of view, a reasonable grasp of the operating principles of your program, and being able to pick out the good ideas from many different points of view.

**IJO:** What were your major accomplishments as Dean?

**Heath:** I guess I could answer survival! Many times it felt like we were just trying to survive, but often we were able to embellish the curriculum and do some innovative things. Much of what is labeled as progress is often just day to day hard work and communication in trying to respond to existing needs and changing environments.

We have already touched on some accomplishments such as development of external clinics and recruitment of research faculty. Another thing we were successful in doing in the mid to late 1970s was the recruitment of ethnic minority students. The annual Summer Institute in the Health Professions was directed for many years by Ed Marshall. That program brought minority and disadvantaged students from Indiana high schools and from colleges across the nation to the Bloomington campus, where they gained first-hand information about the health professions. Several of those students later attended optometry school.

In June of 1975 the program changed from the Division of Optometry within the College Arts and Sciences to the School of Optometry. Prior to that, optometry students were registered in the College of Arts and Sciences their first two years and then in the Graduate School their last two years. The change to School status allowed greater autonomy in the design of our curriculum, and with that greater responsibility. At the time of the change in status, we had shortages in the number of faculty needed to have effective preceptorship in the clinic and shortages in full-time clerical staff. Over time we were able to take care of those problems.

In the late 1970s, I served as a consultant for the development of the optometry school at the University of Missouri-St. Louis. One of the responsibilities was applying for funding for the development of the school. A grant was approved to support the establishment of the school. For this effort I received the Outstanding Service Award from the Missouri Optometric Association.

**IJO:** Are there any other things that you would like our readers to know about your years as Dean?

**Heath:** There are many other details and other persons that could be mentioned if we had more time. Eighteen years of activities are just too many to cover adequately or even sparingly in an interview of this nature. Many of the things that a Dean accomplishes are collaborative efforts, and I appreciate the hard work of many people who enabled us to make good progress over so long a time. It has been a marvelous experience and I can’t express my deep appreciation to the many who did a great share of the planning and hard work.

The four Directors/Deans of the School (l to r), Gerald Loutcher, Henry Hofstetter, Gordon Heath, and Jack Bennett, gathered at the Hofstetter Symposium held on April 27, 1999, in Bloomington.
Profile: Larry N. Thibos, Ph.D., and Donald T. Miller, Ph.D. by Arthur Bradley, Ph.D.

Professor Larry N. Thibos arrived at Indiana University 14 years ago after training as an engineer at the University of Michigan, and as a neurophysiologist at the University of California Berkeley School of Optometry and the Australian National University. At Indiana University he has been responsible for teaching the visual neurophysiology curriculum in the O.D. program.

Not long after arriving in Bloomington, Dr. Thibos's interest in optics began to develop. His interest in the optics of the eye has led to more than 40 research articles and book chapters, including papers that define new methods for analyzing refractive error data and on new model eyes, as well as a variety of studies on the visual impact of optical aberrations. He has rapidly become an authority on the optics of the eye and has been elected a Fellow of the Optical Society of America. In 1997, the American Academy of Optometry and the American Optometric Foundation presented him with the Glenn Fry Award for his ongoing research contributions. In 1998 he was honored as Indiana University's Distinguished Research Lecturer. Since the retirement of Dr. Ron Everson, Dr. Thibos has taught visual optics in the professional O.D. curriculum.

Dr. Donald Miller earned a B.S. degree in applied physics from Xavier University, and was trained as an optical engineer at the University of Rochester where he received his Ph.D. His doctoral research was performed within the Center for Vision Science where he was the first to successfully view individual photoreceptors in the living human eye. The clinical and scientific importance of this result prompted articles in the New York Times and Scientific American. He has recently joined the Indiana University School of Optometry faculty, and he has brought the theory and technology for high resolution fundus imaging to Bloomington.

Positions he held before coming to IU include a postdoctoral research appointment at the University of Rochester and a position as a National Research Council Research Associate in the Electro Optics Sensor Technology branch at Wright Patterson Air Force Base in Dayton, Ohio. He was recruited to IU to help teach in our optics curriculum and advance our optical research program.

Optics is a rapidly changing discipline with new technologies emerging every year. Within this dynamic field, Dr. Thibos has been a pioneer in the application of cutting edge optical technologies to the profession of optometry. Dr. Miller's research has shown that an adaptive optical element that can be altered to correct for aberrations of the eye is a key component of high resolution fundus imaging. Among the most exciting technologies that have emerged in recent years are electronically controlled lenses, which are being investigated by Thibos and Miller. Their article in this issue discusses the potential future application of electronically controlled lenses to human use.
Electronic Spectacles for the 21st Century

by Larry N. Thibos, Ph.D., and Donald T. Miller, Ph.D.

Optometric practitioners routinely measure and correct just three types of optical imperfections of eyes: defocus, astigmatism, and prismatic deviation. Not surprisingly, the biological optical system of the eye has numerous other refractive aberrations such as coma, spherical aberration, and oblique astigmatism, plus many other irregular anomalies peculiar to each individual eye. Although many of these "higher-order" refractive aberrations have been measured in research laboratories using a variety of psychophysical and objective techniques, they have been largely ignored by the optometric profession for two main reasons. First, these diagnostic methods used in the laboratory are too demanding for routine clinical practice and, second, suitable ophthalmic lenses for correcting these higher-order aberrations have been unavailable. However, recent advances in visual optics research have shown a way to overcome both of these limitations to current optometric practice. These advances pave the way for an expanded scope of practice in optometry's traditional domain of strength in visual optics and ophthalmic corrective lenses.

The most promising of the new methodologies for characterizing eyes obtains a detailed measurement of a hundred or more refractive aberrations in addition to the three fundamental aberrations of defocus, astigmatism, and prismatic deviation. All this information may be obtained in the fraction of a second required to take a single flash photograph of reflected light from a laser beam focused on the retina. This dramatic increase in the scope of ophthalmic evaluation of eyes is achieved using a new type of objective aberrometer based on the Shack-Hartmann principle of optical metrology. Developed extensively by astronomers for measuring the optical aberrations of the atmosphere which interfere with terrestrial telescopes, the Shack-Hartmann technique was adapted recently for measuring aberrations of eyes by Liang et al. Since then the technique has undergone further refinement and evaluation at research laboratories at the University of Rochester, the University of Waterloo, and in our laboratories at Indiana University. In the near future we expect to see these research efforts yield new clinical instruments that will allow fast, patient-friendly, detailed measurement of the refractive anomalies of human eyes on a routine clinical basis.

Given these exciting prospects for routine comprehensive measurement of refractive errors of eyes, our attention shifts to the question of aberration correction. Fortunately, there are several new technologies, collectively known as "adaptive optics", which have the potential to correct even the highly irregular, idiosyncratic aberrations of human eyes. One of these technologies uses a deformable mirror placed in the optical path from eye to object. This is the same technology used in astronomy to correct atmospheric aberrations. Although deformable mirrors are currently too expensive and bulky to be considered for clinical use, they have been used successfully in the research laboratory to demonstrate the feasibility of correcting the higher-order aberrations of eyes. Previously, one of us (Miller) had shown that the eye's optical aberrations are the primary limiting factor which prevents high-resolution diagnostic imaging of the human fundus. This conclusion was demonstrated dramatically when, for the first time, individual human photoreceptors in living human eyes were photographed with a specially designed, high-resolution fundus camera. Those initial results were obtained from eyes with unusually small optical aberrations but subsequently the fundus camera has been augmented with adaptive optics, making it possible to achieve high-resolution images also in eyes with more typical levels of aberrations. Furthermore, when the fundus camera was replaced by a visual test pattern so that the patient was given the opportunity to experience vision through an eye corrected by the adaptive optical system, dramatic improvements in visual contrast sensitivity were obtained. As a result of this aberration correction by adaptive optics, the observer achieved super-normal visual performance that approached the ultimate limit expected of an optical system limited only by diffraction.

Although deformable mirrors and other reflective technologies (such as micro-mirrors and reflective liquid crystals of the kind used in digital watches and laptop computer screens) may have a bright future in the creation of a new generation of ophthalmic instruments, they seem unlikely to develop into the spectacles of the next century. However, at least one new technology does have the potential for providing an entirely new kind of optical element for 21st century spectacles. This technology uses transparent liquid-crystals deposited on a glass substrate to produce an optical medium with variable refractive-index. At Indiana University we have been exploring the potential of this technology for producing a new kind of "electronic spectacle" based on a programmable optical element that can dynamically alter its characteristics as required by the patient (e.g., to obtain a "variable-add" for presbyopic individuals). Furthermore, when the crystals are subdivided into an
array of cells that can be individually addressed by an integrated circuit controller, it becomes possible to conceive of an advanced spectacle lens which will correct not only the traditional parameters of sphere, cylinder, and prism, but also the higher order, irregular aberrations peculiar to any individual eye. Thus the electronic spectacles of the future may provide a customized correction of the refractive anomalies of the patient's eye. If successful, the result will serve optometry in two major ways. First, when used in a clinical environment, it will provide the clinician with a high-resolution diagnostic view of the internal structures of the patient's eye. Second, when used by the patient for daily wear, it will provide an exceptionally high contrast view of the world implicit in the term "super-normal vision".

**Design Principle for Electronic Spectacles**

The principle of operation of a lens fabricated from an array of liquid crystals is contrasted with a conventional lens in Fig. 1. A conventional lens is an optical medium of variable thickness formed from a transparent material of constant refractive index. This variable-thickness feature of conventional lenses causes planar wavefronts of light from a distant object point to be re-shaped into spherical wavefronts so that they will focus onto a point image. To understand how this re-shaping of the wavefront happens, we must first recall that a wavefront of light is defined as the locus of points which are equidistant from the source, where distance is measured in terms of wavelengths of light. Since the wavelength of light shortens when the light enters a medium with a higher refractive index, we need to measure optical distances with a ruler that takes refractive index into account. For this reason the concept of an "optical path length" is defined as the product of physical distance and refractive index. For example, a physical distance of 1 meter in air (n = 1.0) has the same optical path length as 2/3 meter in a medium with refractive index n = 3/2 because in both cases light must oscillate the same number of times to traverse the distance.

To see how a wavefront changes shape as it propagates through a conventional lens, we trace a ray from each point on a given wavefront and follow it for a fixed optical path distance. The terminal ends of these rays locate the wavefront at some later point in time. For example, to see how a planar wavefront that is tangent to the lens at its vertex emerges from the lens, we trace all rays that have an optical path length equal to ns, where n is the refractive index of the material and s is the thickness of the lens at the vertex. For an off-axis ray, the path has three segments as shown in Fig. 1. Segments a and c are in air, while segment b is in the medium of the lens. Thus the optical path length for these rays is nd = a + nb + c. Clearly the physical distance a + b + c must be larger than the physical distance d because the refractive index n is greater than 1 for the lens.

Furthermore this inequality grows larger as the ray gets further from the optical axis of the lens, hence the emerging wavefront must be curved. Further analysis would be required to verify that the curved wavefront has a spherical shape, but the main point of our argument is that a lens is able to focus light by using its shape to create a medium of variable optical path length.

An intermediate step to lenses fabricated from liquid crystals is shown in the middle diagram of Fig. 1. Contrary to the lens example just described, this optical element has constant thickness but has a refractive index which varies systematically with distance from the optical axis. Computing optical path length in this case is a little more complicated because a ray will follow a curved path as it propagates through the gradient-index material. Nevertheless, the concept of an optical path length still applies and is computed by integrating the product of refractive index and the infinitesimal distance along the curved path a. Given the appropriate gradient of the refractive index, the optical path length for each ray could be made the same as for corresponding rays in a conventional lens. Thus it is clear that curved surfaces usually associated with optical lenses are not strictly required for focusing light since a gradient-index lens achieves the same end by varying refractive index rather than thickness to control the optical path length.

A lens built from an array of cells filled with liquid crystals is shown in the bottom diagram of Fig. 1. Each cell contains a thin layer of liquid crystal molecules sandwiched between two parallel glass plates. The molecules are oriented in parallel, as in a crystal, which causes the cell to be birefringent. Consequently, when light passes through the crystal it is subjected to a different refractive index when polarized in a direction parallel to the molecules, compared to when it is polarized in the orthogonal direction. The molecules
are free to rotate, as in a liquid, by increasing amounts when an electric field of increasing strength is applied to transparent, conductive electrodes located on the inside of the glass plates. Consequently, an applied voltage can be used to vary the refractive index experienced by light of fixed polarization when transmitted through the cell. Thus when programmed to be a simple lens, each cell will have a different refractive index similar to the gradient-index lens. The difference is that each individual cell has finite size and a fixed refractive index, which means that the gradient of refractive index follows a step-wise profile rather than a smooth, continuous profile. Thus the emerging wavefront has a segmented appearance, which would make an increasingly accurate approximation to a smooth, spherical wavefront as the density of the cells increases. Although not shown in the diagram, the step-wise discontinuities are also smoothed by diffraction effects as the wavefront propagates forward.

A photograph of the prototype liquid-crystal lens we have been evaluating at Indiana University is shown in the cover illustration. The device was manufactured by Meadowlark Optics of Longmont, CO and has 127 individual cells packed in an hexagonal array. Since the device is completely transparent, to obtain the photo we sandwiched it between crossed polarizing filters in order to visualize the cells and to display their refractive index with a grey-scale code. Although the electrical connections to each cell are visible in the photo, they would normally be eliminated from the light path with a circular mask. The photo was taken when the device was programmed to be a +1 diopter lens inside a 3 mm pupil, which requires that the optical path length through the center of the lens be 2 wavelengths longer than the optical path at the margin of the lens. Our experiments have verified that the device works well as a simple spherical or cylindrical lens, provided it is programmed to provide no more than 1.5 diopters of refractive power. This practical limitation is set by the number of individual cells in the array and therefore we can expect to see a wider operating range achieved as the manufacturing process improves to produce future generations of the device with higher spatial density of cells.

**Clinical Applications**

We suspect that the most useful form of the liquid-crystal technology for ophthalmic applications may be a hybrid lens, rather like a doublet, in which ordinary glass is used to correct the spherico-cylindrical refractive error of an eye and the liquid crystals are used to correct the residual, higher order aberrations. One of the first applications of such a lens would be to provide high-resolution diagnostic imaging of the internal structures of the eye. As illustrated in Fig. 2, wavefronts reflected from anatomical structures of interest are defocused and aberrated as a result of the imperfections of the patient's eye. By passing these distorted wavefronts through the hybrid liquid-crystal lens, the wavefront can be reshaped into a perfect wavefront for imaging by an ophthalmoscope or fundus camera. To use the same lens to correct the patient's vision, wavefronts from visual objects would be pre-distorted by the liquid-crystal lens by an amount which is equal, but opposite, to the aberrations in the eye. In this way the optical path length of light passing through all points in the pupil will be equal, thus ensuring aberration-free retinal images limited only by the unavoidable diffraction effects of a finite pupil size. Because the power of the lens is electronically programmable, the liquid-crystal lens seems particularly well suited for auto-focus applications such as correcting presbyopia or perhaps for a new generation of computer-controlled, electronic phoropters. One aim of future research will be to overcome potential problems (e.g. alignment and control of the variable-focus spectacle lens) associated with various potential applications.

The correction of higher-order aberrations offers the possibility of increased visual acuity for everyone, perhaps beyond typical limit of 20/15. In theory, diffraction-limited optical cutoffs for 3 mm and 8 mm pupils would be high enough to yield retinal images of letter targets as small as 20/6.7 and 20/2.5, respectively. To illustrate what the retinal image would be like with super-normal optics, imagine yourself viewing the Statue of Liberty at a distance of 3 kilometers from a boat in the New York Bay. Under optimal viewing conditions and 20/15 vision (i.e., a normal 3 mm pupil), your retinal image of the statue would look like Fig. 3A. If you view the statue through the liquid-crystal lens, programmed to fully correct all ocular aberrations across your 3 mm pupil, then the retinal image of the statue would look like Fig. 3B. Notice the finer detail and higher contrast in the retinal image when the eye's aberrations are corrected. This illustrates that retinal image quality can be noticeably increased even for pupil sizes as small
larger than their radius (Minimum Angle of Detection = 1° at 30° eccentricity). To the contrary, only a twofold difference between detection acuity and resolution acuity would be expected in the fovea because foveal cones are tightly packed, which makes the spacing between cones just twice their radius.

Although there are many potential benefits of super-normal visual optics, there is at least one expected penalty. Given a dramatic increase in optical quality of the retinal image, the photoreceptor mosaic will appear relatively coarse by comparison, as shown in Fig. 4. As a result of this mismatch, very fine spatial details in the retinal image will be smaller than the distance between neighboring cones and therefore will not be registered properly in the neural image. This mis-representation of the image due to neural undersampling by a relatively coarse array of photoreceptors is called "aliasing". Research indicates that the ambiguity introduced by aliasing is the primary factor which limits resolution acuity in normal peripheral vision, and the same is true for central vision when optical limitations are removed. However, for everyday vision the penalty of aliasing is likely to be outweighed by the reward of higher contrast sensitivity and higher detection acuity.

Therefore we anticipate that correcting the eye’s optical aberrations will yield a net increase in the quality of the patient’s visual experience and therefore is worth pursuing. Indeed, our preliminary observations indicate that stimuli seen through adaptive optics have a strikingly crisp appearance expected of an eye with supernormal optical quality, which is consistent with the sixfold increase in contrast sensitivity measured experimentally.

Conclusion
In summary, we forecast major advances in spectacle lenses in the early part of the 21st century.
which will combine the power of adaptive optics technologies with the flexibility of electronic circuitry. The result will be a new generation of “smart spectacles” capable of adapting to the specific requirements of individual eyes to produce customized optical correction of unprecedented quality. However, to make this prediction come true will require an optometric community that is committed to building upon its traditional strength in visual optics by supporting research aimed at applying modern technologies to solve important optometric problems.

References
Eye Opener:  *Spinning the Web at the*  
*IU School of Optometry*  
by Bill B. Rainey, O.D., M.S.

The Internet and the World Wide Web (also known simply as "the Web") have become efficient, effective, and HUGE methods of communication and information exchange. It is estimated that over 70 million Americans have access to the Internet, over 100 million people worldwide, with the number of Internet users doubling over the past year. It is expected that over half a BILLION people worldwide will have access to the Internet over the next two years! Indiana University has been a leader in the development and use of the Internet system, and the IU School of Optometry has taken advantage of this amazing technology by creating several Web 'sites' available to anyone with a computer and an Internet connection. So, grab a cup of coffee, point and click your mouse on the following addresses, and "surf" the IU School of Optometry on the World Wide Web.

**www.opt.indiana.edu**

This is the 'Home Page' of the IU School of Optometry. Here you will find detailed information about the School, its faculty, the clinic, research projects, the library, employment opportunities, and a wealth of other topics. Also included here are links to many other optometry-related Web sites of interest.

**www.indiana.edu/~pietsch/home.html**

Here is the award winning ShuffleBrain page of Professor Emeritus Dr. Paul Pietsch. This site has had over one million 'hits' (visitors) since it was created three years ago. Enjoy this terrific site, but beware - it's addictive!

**research.opt.indiana.edu**

The Visual Sciences Group of the IU School of Optometry has created this guide to optometric research. In addition to describing research projects at the School and elsewhere, this site contains many links to related sites, for those who are interested in the latest clinical and basic science information.

**www.opt.indiana.edu/bcor/bcor.html**

Speaking of research, this is the home page of the Borish Center for Ophthalmic Research (BCOR). Here you can find specific details about ongoing and planned research projects at this important center of clinical research.

**www.opt.indiana.edu/v755/home.html**

Many of the courses offered at the IU School of Optometry are using the Web for instructional purposes, from course syllabus and grade postings to complete lecture notes. An example of this application of the Internet is V755, Basic Vision Therapy. With this Web site, students can access complete and up-to-date course information from anywhere in the world (or in the universe, for that matter!)

**www.opt.indiana.edu/oxyopia/schedule.html**

In addition to providing continuing education to practicing optometrists, School of Optometry faculty and graduate students also present seminars on their research activities to interested scientists, clinicians, and students. Researchers and faculty members from outside of the School also speak at these seminars. Check this Web site for a current schedule of speakers and topics. Remember, everyone is invited, so mark your calendars. Some seminars are approved for CE credit.

**www.opt.indiana.edu/vtlit/vtlit.html**

Optometrists are often faced with challenges to provide evidence of the effectiveness and appropriateness of their therapies and procedures, especially when it comes to binocular vision and vision training. On this page you will find a complete listing of scientific studies supporting the efficacy of this important aspect of the profession.

**www.opt.indiana.edu/education.html**

Three patient education modules are presently available on the website – keratoconus, age-related macular degeneration, and the eye examination. Additional modules are in the development stage. This can be a good source of information for your patients.

**www.opt.indiana.edu/Lowther/Websites.htm**

This segment of the optometry web site is a listing of numerous links to educational programs, companies, organizations, and related sites of interest to vision care practitioners.
**Article of Interest:**  Review by Victor Malinovsky, O.D.

**Oral Acyclovir Reported to Prevent Recurrence of Herpes**


Ocular herpes simplex virus disease is one of the leading causes of corneal blindness in the United States. Once a patient develops ocular herpes, there is a 50% chance of recurrence. The recurrence can happen weeks, months, or years after the initial attack.

Herpes simplex virus disease can manifest as various anterior segment conditions: blepharitis, conjunctivitis, keratitis, and stromal keratitis. Stromal keratitis is a severe form of ocular herpes which often causes scarring of the cornea, sometimes leading to loss of vision. Stromal keratitis are often difficult to treat with topical antivirals and topical steroids often used in its management.

**Study Findings**

This paper reported that the drug acyclovir taken orally reduced by 41% the return rate of any form of herpes of the eye in patients infected within the previous year. The researchers also noted a 50% reduction in the rate of recurrence of stromal keratitis in patients who had had ocular herpes infection in the past year.

Investigators at 74 clinical sites followed 703 patients who had experienced ocular herpes—in one or both eyes during the preceding year. Seventy-one percent of the subjects had experienced multiple previous re-occurrences of ocular herpes. None of the subjects had an active case of keratitis at the time of the study. The 357 treatment group subjects received 400 mg of oral acyclovir twice daily for 12 months. The control group consisted of 346 subjects who took placebo capsules.

The investigators found that the probability of recurrence of any form of herpes eye disease during the treatment period was significantly lower in the acyclovir group (19%) than in the placebo group (32%), representing a 41% reduction. Among the 703 subjects, 337 had a prior history of stromal keratitis. Oral acyclovir reduced the rate of stromal keratitis recurrence from 28% to 14%. The researchers also noted that the oral acyclovir reduced the risk of herpes infections in other parts of the body, particularly those of the mouth and face, from 36% to 19%.

Only 4% of the patients in the acyclovir group and 5% in the placebo group stopped treatment because of side effects. About one-half of the side effects were gastrointestinal upset. Some subjects may have been intolerant to the lactose contained in the capsules. The benefit of the acyclovir treatment was not sustained after cessation of treatment. There was no acute rebound effect.

**Comments**

The results of this study encourage us to consider a change in the treatment of our patients with recurring ocular herpes infection. Which patients with ocular herpes should we treat with oral acyclovir? I feel that patients with ocular herpes epithelial keratitis who have had three or more recurrences within the last year or any patient with stromal keratitis should be advised of the results of this study. I provide my patients with a copy of the news release about this study. It is available on the NEI website at http://www.nei.nih.gov/news/hedsII.htm.

During return visits I discuss the results of this study with them, and we talk about how they would like to proceed with the management of their ocular herpes. The greatest clinical benefit of this form of treatment is that it reduced the likelihood of corneal scarring, loss of vision, and side effects of topical antivirals and steroids.

The disadvantages are that it is expensive, must be taken every day, and some insurance companies may not cover its cost. A detailed letter with a copy of the news release of study results sent to the patient's primary care physician may be helpful in working with the physician.

The treatment regimen used in this study was empirically selected on the basis of previous trials of prophylaxis against monocular herpes simplex virus disease. It is not known whether a shorter treatment period, a different dose of acyclovir, or another antiviral agent would provide similar results. It is hoped that the clinical application of this treatment modality will prevent loss of vision and improve the quality of life of patients who have suffered from ocular herpes simplex infections.
Book Review

by David A. Goss, O.D., Ph.D.

In Search of My Husband’s Mind


I decided to read this book because it was about Monroe Hirsch, a man whose papers on refractive development published between the late 1940s and the early 1970s are classics in the field. I already knew that he had attended optometry school at the University of California Berkeley and received a Ph.D. in physiology from Stanford. He practiced optometry in a small town in California, and became mayor of the town. He served on the faculty at Berkeley, and was made Dean of the optometry school. He was editor of the American Journal of Optometry and co-editor of three books. I knew that he was admired and respected by many people, and that he received the prestigious Prentice Medal from the American Academy of Optometry shortly after he retired due to illness.

Those things were in the book, but were not its main emphasis. I was unprepared for the main focus of this book. It was very unsettling, but suspenseful, riveting, and engaging. I couldn’t put it down.

Mostly the book chronicles the struggles of a wife caring for a terminally ill husband and her desperate attempts to understand the sudden indifference to life and behavior that were uncharacteristic of the man she had known for so many years. She is faced with callous, insensitive, and duplicitous physicians and health care workers. Only through dogged persistence and finally finding health care providers that would listen to her is she ultimately able to discover and accept what has happened to her husband.

This is a book of the first-hand experiences of Monroe Hirsch’s widow, Winnie. It has many important lessons for both patients and health care providers. Health care consumers must be prepared to be advocates for proper care for themselves and their families. Health care providers must truly listen to their patients and their patients’ families. Above all, a prerequisite for any worker in a patient care setting is compassion for one’s fellow human being.

The book is available in the Indiana University School of Optometry Library, or can be purchased from the publisher: Pathfinder Publishing of California, 458 Dorothy Avenue, Ventura, CA 93003; (805) 642-9278.
The responsibility for ensuring that ineffective and hazardous medical products do not reach the market place rests primarily on the Federal Drug Administration (FDA) in Washington. Although their title implies a rather narrow scope (pharmaceutical products), in reality they control the market access for most medical products including those used by optometrists. The Ophthalmic Devices Division is a part of the center for Medical Devices within the FDA, and they are responsible for overseeing the market access for new (and some old) ophthalmic products ranging from new contact lens materials to high power photorefractive lasers.

In addition to the scientific, technical and clinical staff at the FDA, the Ophthalmic Devices Division convenes an advisory panel of clinicians and scientists from the ophthalmic professions to review proposed new devices and to advise the FDA on action regarding these devices. Although this committee is dominated by ophthalmologists, Indiana University School of Optometry has played and continues to play an important role. Dr. Sarita Soni was a panel member from 1994 to 1997, and continues as a consultant. Dr. Arthur Bradley joined the panel in 1996. At the last panel meeting the panel was made up of 13 ophthalmologists, two optometrists (from The Ohio State University School of Optometry and Illinois College of Optometry), and one Ph.D. from an optometry school (Dr. Bradley from Indiana University).

Our role on the panel is really two-fold: In addition to the primary role of representing the patient, we also represent the profession of optometry. Our primary directive is to ensure that only safe and effective products are marketed in the U.S.

As panel members we only get to see device marketing applications for which the FDA needs expert advice. With new innovative technologies, many products fall somewhere into the “gray zone” where either the efficacy or safety is in doubt. It is here that the analysis and opinions of the panel members become very important.

Before certain medical devices can be marketed in the U.S., the manufacturer must demonstrate reasonable assurance of safety and effectiveness through pre-market clinical studies. Each manufacturer must collect careful clinical and scientific data to establish the safety and efficacy of their product. The FDA staff oversees the study design and data collection and generally assists the manufacturer in this process. The panel will review these data, selected members of the panel will write a formal analysis, and the entire panel will discuss the results of the studies and the analysis. The discussions are held in a public forum at which the manufacturers, professional organizations, media, and other interested parties are represented. Anyone can address the panel, and in this way the review process is open. Individual clinicians and patients will often travel to Washington to make a short presentation on a given product.

The goal of this column is to summarize some of the recent products that have undergone FDA review and to provide some insight into the future products that will become available to eye-care clinicians including optometrists.

Web address for the Ophthalmic Devices Division in the Center for Devices and Radiological Health: http://www.fda.gov/cdrh/function/1253_9.html

Although multifocal contact lenses have been on the market for over a decade, Allergan recently sought FDA approval for a multifocal intraocular lenses (IOL). They completed a detailed clinical trial on a large number of patients which included traditional measures of visual acuity and more complex studies of night and day driving abilities in a state-of-the-art simulator. A major concern expressed by Dr. Bradley with this product comes from the extensive experience that optometrists have had with multifocal contact lenses. First, although VAs can be quite good, patients often reject a multifocal lens for more traditional bifocals or monovision. Second, although optometrists can adopt a safe “try it and see” approach to multifocals with their patients, the ophthalmologist considering a relatively permanent surgical insertion of a multifocal IOL cannot. Allergan was aware of these problems, and it generated computer simulations of vision through its multifocal IOL. The goal was to have patients view such simulations such that a surgeon can obtain informed consent for this elective surgical procedure. However, the ability to obtain informed consent in this way depends critically upon the accuracy of the computer model. At the panel meeting, Dr. Bradley argued that their model was unrealistically optimistic in that it produced images of higher quality than might really exist. Dr. Bradley’s own research at the Indiana University School of Optometry gave him a special insight into this clinical and scientific problem. Some examples of his computer simulations of simultaneous vision bifocals are shown in Figure 1.

Surgical strategies for correcting ametropia have dominated the panel’s agenda during the last five years. Three primary technologies have been examined by the FDA. First, two types of photo-ablative methods in which corneal material is removed to reshape the cornea and change its refractive properties: PhotoRefractive Keratectomy (PRK) in which the anterior corneal
issues especially since the laser was used on otherwise healthy corneas. As a voting panel member Dr. Soni always wanted to be assured that the patients, who seek refractive correction with lasers, will receive extensive information on the successes and failures so that the patients are able to make educated choices. There continue to be many unanswered questions regarding the post-treatment refractive stability: can long term contact lens wearers be treated soon after removing their lenses or should they have to wait until their corneas stabilize, and how long of a wait is necessary? No doubt over the next few years we will have answers to many of these questions.

The recent development of phakic IOLs has raised safety concerns primarily related to mechanical stimulation of cataractogenesis, corneal endothelial cell damage, and small possibilities of other surgical problems that can develop. IOLs are routinely inserted to replace cataractous natural lenses and thus the general risks of such surgeries are well known and low. However, at the October 1998 panel meeting Dr. Bradley raised the issue that safety standards for IOL insertion for ametropia correction need to be higher than that for cataract correction because safe alternatives already exist for the correction of ametropia (e.g. contact lenses, spectacles, etc.).

Contact lenses and lens care products have been moving quite smoothly through the FDA evaluations. Recent approval of the Contex OK-3 lens for orthokeratology is a good example of the FDA and contact lens industry working for a common goal of providing the people of this country with safe and effective drugs and devices.

News from the
IU School of Optometry

Larry Thibos, Ph.D., Professor of Optometry, was invited to present the prestigious 1999 Distinguished Faculty Research Lecture in April. This is quite an honor for Dr. Thibos and the IU School of Optometry. He received the honor not only because of his personal achievements as a research scholar, but as an outstanding representative of the community of scholars at Indiana University. This annual lecture provides an opportunity for research scholars to share their work with scholars from across the university community and provides the university with an occasion to pay tribute to its most distinguished researchers.

The title of Dr. Thibos’ lecture was “Perfecting the Optical System of the Human Eye.” The lecture focused on the eye as an image-forming device and the exciting new approaches to the measurement and
correction of its imperfections that are being developed at the IU School of Optometry.

David A. Goss, O.D., Ph.D., was the principal author of the American Optometric Association Clinical Practice Guideline on Care of the Patient with Myopia. Theodore Grosvenor, O.D., Ph.D., was on the consensus panel for the development of the 58-page guideline recently distributed by the AOA.

Drs. Grosvenor and Goss are authors of a new book entitled Clinical Management of Myopia. The book was published by Butterworth-Heinemann and includes a foreword by Henry W. Hofstetter, O.D., Ph.D.

In another new book on myopia, Myopia and Nearwork (co-edited by Mark Rosenfield and Bernard Gilmartin), Drs. Grosvenor and Goss were contributing authors on two chapters.

Arthur Bradley, Ph.D., and Larry Tibos, Ph.D., contributed a chapter to a book for optical designers of visual instrumentation. The title of the book is Visual Instrumentation: Optical Design and Engineering Principles edited by Dr. Pantazis Mouroulis from the Jet Propulsion Laboratory at NASA.

Graeme Wilson, Ph.D., will be a visiting professor at Glasgow Caledonian University, Scotland, for six weeks this spring. Dr. Wilson and Carolyn Begley, O.D., M.S., have also been invited to speak at the British Contact Lens Association meeting in Birmingham, England, in May.

Edwin C. Marshall, O.D., M.S., presented a paper titled "Preliminary Analysis of the Need for Optometry Manpower in Asia" at the Asia-Pacific Optometric Congress in the Philippines in March.

Gerald E. Lowther, O.D., Ph.D., taught a contact lens fitting course to over 200 ophthalmologists in Poland in April. On the same trip, he was an invited participant in the "CIBA Vision: The Future in Sight" program in Barcelona, Spain.

Larry Tibos, Ph.D., is chairing a task force of vision scientists from around the world to define standards for reporting data on optical aberrations of the eye. They met in February during a conference on vision science and its applications sponsored by the Optical Society of America.

The following students have recently finished their graduate degrees in Visual Sciences and Physiological Optics: David Evans earned his Ph.D., and Kevin Liedel, John Buch, and Colleen Riley earned their M.S. degrees.

Nicole Himbeangb, O.D., received a Bausch & Lomb/Exel Fellowship and Tonya Thomas, O.D., received an Exel Fellowship for further graduate study.

Don Miller, Ph.D., and Shaban Demirel, Ph.D., both received summer faculty fellowships from Indiana University.

The Chancellor's Scholar for the School of Optometry for 1999-2000, selected by vote of faculty and classmates, is Julie A. May. The person selected is the best overall student in the third year class - the student who has not only performed well academically but who has also excelled in leadership roles, undergraduate research, and - in the case of the School of Optometry - in clinical service. The Chancellor's Scholars are a very unique group on the Bloomington campus, and will receive rewards and recognition for their selection. Throughout 1999-2000 they will serve on an advisory committee for Vice-Chancellor Gros Louis.

Alumni may remember this program as the Vice- Presidential Scholar Program, which began in 1983 with Diane M. Gilmore, O.D. ('84), as the first recipient of this award.

Individuals in Photo Identified

Dr. Lon EuDaly, IU optometry class of 1982, writes:

"The picture on page 21 of the Fall '98 Indiana Journal of Optometry shows Dr. Henry Hofstetter with an unidentified student and patient. My father, Dr. James EuDaly, was in the class of '56 and he believes the student is Milt Brockman, also of the class of '56."

Also, Jack Hedrick identified the student as Milt Brockman and the seated person as Dr. Ingeborg Schmidt.
SATURDAY, JULY 10, 1999
How, When & Why Use Oral Medications in Ocular Disease? (OLDPAC)
1 1/2 cr. hrs. - Dr. Jane Ann Grogg

New Topicals - Are They Better? (OLDPAC)
1 1/2 cr. hrs. - Dr. Neil Pence

What's the Big Deal About Phorias?
1 cr. hr. - Dr. Bill Rainey

Anterior and Posterior Segment Grand Rounds - You Make the Diagnosis (OLDPAC)
3 cr. hrs. - Dr. Victor Malinovsky and Dr. Jane Ann Grogg

SUNDAY, JULY 11, 1999
Tight Control in the Diabetic Patient: Does it Matter?
1 cr. hr. - Dr. Lee (Endocrinologist)

Optometric Management of the Diabetic Patient
Case Presentations - 2 cr. hrs. - Dr. Victor Malinovsky

Why Does My Patient See Double?
2 cr. hrs. - Dr. Douglas Horner

What's New in Diabetic Retinopathy Treatment (OLDPAC)
1 cr. hr. - Drs. Danis and Cuilla

Evaluation & Management of Wet Macular Degeneration - What Works (OLDPAC)
1 cr. hr. - Drs. Danis and Cuilla

WEDNESDAY, JULY 14, 1999
Contact Lens Update 3 cr. hrs. - Dr. Neil Pence

Management of Clinical Dermatology & Treatment
(OLDPAC) 2 cr. hrs. - Dr. Richard Meetz

Visual Fields (Case Presentations) 2 cr. hrs. - Dr. Shaban Demirel and Dr. Patty Henderson

SATURDAY, JULY 17, 1999
Ocular Trauma (OLDPAC) 2 cr. hrs. - Dr. Patty Henderson, Dr. Steve Hitzeman, Dr. Kash Tonekaboni, Dr. Richard Meetz

Vision Training 1 cr. hr. - Dr. Bill Rainey

Sports Vision Workshop 2 cr. hrs. - Dr. Steve Hitzeman

Physical Assessment of Your Patient
2 cr. hrs. - Dr. Richard Meetz (OLDPAC)

SUNDAY, JULY 18, 1999
Aqueous Humor Production - Soft or Hard Eyes
1 cr. hr. - Dr. Joseph Bonanno

New Glaucoma Meds (OLDPAC)
1 cr. hr. - Dr. Victor Malinovsky

1 cr. hr. - Dr. Shaban Demirel

Glaucoma Grand Rounds - How Would You Treat?
(OLDPAC) 3 cr. hrs. - Dr. Victor Malinovsky

Glaucoma Studies - What's Hot (OLDPAC)
1 cr. hr. - Melanie Garrett

SATURDAY, JULY 24, 1999
Keratoconus: Can You Make the Diagnosis? (OLDPAC)
2 cr. hrs. - Drs. Gerald Lowther, Neil Pence, Colleen Riley

Contact Lens Complications (RGP only or soft contact lens only) (OLDPAC)
2 cr. hrs. - Dr. Neil Pence

Keratoconus Workshop 2 cr. hrs. - Drs. Colleen Riley, Neil Pence, and Gerald Lowther

SUNDAY, JULY 25, 1999
What's New - Media Detection 1 cr. hr. - Dr. Larry Thibos

Management of the Amblyopia Patient
1 cr. hr. - Dr. Bill Rainey

Sports Vision Update 1 cr. hr. - Dr. Steve Hitzeman

Anterior Segment Management (OLDPAC)
4 cr. hrs. - Drs. Victor Malinovsky, Jane Ann Grogg, and Susan Kovacich

SUNDAY, SEPTEMBER 12, 1999
Refractive Surgery 3 cr. hrs. - Eye Specialists of Indiana

Corneal Mapping 1 cr. hr. - Dr. Douglas Horner

Contact Lens Fitting of the Irregular Cornea 1 cr. hr. - Dr. Colleen Riley

Extended Wear Contact Lens 1 cr. hr. - Dr. Neil A. Pence

TUESDAY, DECEMBER 28, 1999
Applied Ocular Therapeutics - Part I 6 hrs. (OLDPAC)

Indianapolis Location
a. Glaucoma Meds - Dr. Jim Hunter
b. Glaucoma Visual Fields - Dr. Jim Hunter
c. Topical and Oral Antibiotics - Dr. Jane Grogg
d. Antiviral Meds - Dr. Victor Malinovsky
e. Topical Steroids and Combination Meds - Dr. Glenn Kirk

SUNDAY, MARCH 19, 2000
Applied Ocular Therapeutics - Part II 6 hrs. (OLDPAC)
a. Vitamins - Dr. Victor Malinovsky
b. Allergy Meds - Dr. Jane Ann Grogg
c. Dry Eye Meds/Dyes - Dr. Carolyn Begley
d. NSAIDS and Pain Meds - Dr. Neil Pence
e. Mydriatics and Cycloplegics - Dr. Richard Meetz
f. Injectables - Guest Lecture