THE FEATURES AND BENEFITS OF CUSTOMIZABLE PALS

With the use of free-form technology, customizable PALs offer patients lenses made specifically for the wearer.

LENS REVOLUTION Free-form technology is reshaping the way lenses are designed, manufactured, and processed, especially PALs.

PHOTO COURTESY OF SEIKO OPTICAL PRODUCTS OF AMERICA.

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COURSE DESCRIPTION

Customized free-form progressive addition lenses (PALs) are beginning to be introduced by a number of lens manufacturers. These lenses have abilities and benefits that traditional PALs do not have. This course explores the features and benefits of customized PALs and provides useful insights into how they perform.

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PERSONALIZED PALS

BY ERIC L. BRAN, OD, RANDALL L. SMITH, MED, ABOM, AND ED DE GENNARO, MED, ABOM

There has been a lot written about free-form technology in the last couple of years. While eyecare professionals (ECPs) may find this profusion of information a bit surprising, the clamor of excitement that surrounds this technology is well deserved. Free-form technology is reshaping the way lenses are designed, manufactured, and processed, especially progressive addition lenses (PALs). Using special computer software programs and sophisticated computer-aided machinery, free-form technology is beginning to take lenses to a whole new level of design and performance.

One aspect of this new technology is the ability for the lenses to be customized for the intended wearer. This kind of individualized crafting of lenses is made possible through innovative thinking and engineering on the part of lens manufacturers.

CUSTOMIZED VS. AVERAGE

There are many differences between traditionally designed and processed PALs and today's customized and personalized free-form progressive lenses. One of the major dissimilarities is that traditional PALs are designed on a limited number of base curves (usually five to seven) for a range of prescriptions (e.g., -8.00D to +5.00D with up to a -3.00D cylinder). This results in compromised prescription powers for nearly every wearer.

Since the base curve of a lens has a significant impact on the performance of the lens, it is important to have a wide control over it. Customized free-form PALs are capable of adjusting their designs to work in sync with the lens' base curve so that each wearer's prescription is optically refined to deliver the level of performance the manufacturer intended.

POWER ACCURACY

Another way of customizing a lens for a wearer is to deliver a power that is not rounded off to 0.25D units. If you were to refract a person with an autorefractor that has the ability to report the patient's refractive error in hundredths of diopters (0.01D), you would discover that nearly everyone has an Rx that is not in quarter steps.

Quarter diopters steps (e.g., -1.25D - 0.75D x 180) were developed for convenient manufacturing, not for the precise correction of vision. In addition, there are several fitting parameters for which PALs should be power compensated (see "Position of Wear" below), and these require lens powers to be produced in hundredth units, not quarters.

One of the great strengths of customized free-form processed lenses is power accuracy down to 0.01D, a considerable improvement over traditional surfacing which is correct to +/- 0.12D. This degree of accuracy means that vision can be corrected in a personalized way that more accurately provides the patient better visual acuity. PALs are showing up in ophthalmic office job trays with Rxs like -2.08D -1.15D x 173 (see "Take the Lab's Word for the Rx?," p. 7).

POSITION OF WEAR

Traditional PALs also use basic fitting parameters. In other words, they only consider two basic measurements, the patient's monocuclar pupillary distance and a fitting height for each eye. While these are surely essential for aligning the lenses properly in front of the eyes and for positioning the optics of the lenses, they ignore a number of other fitting parameters that have an effect on the power patients will experience through the lenses as well as the clarity and field of view they will receive.

PHOTO COURTESY OF SIGNET ARMORLITE.

POWER OF FREE-FORM One of the great strengths of customized free-form processed lenses is power accurace down to 0.01D.

An interesting concept that customized PALs use is known as position of wear, which is the position of the fitted lens relative to the wearer's eye and face. In order to determine this precise location, you need to specify the patient's monocular PD and segment height for each eye (as usual), and include the pantoscopic tilt, face-form wrap, and vertex distance of the lens, in addition to other parameters such as lens thickness, base curve, and index.

Spectacle prescriptions are primarily determined using a refractor (often called a phoropter) that is positioned perpendicular to the lines of sight of the patient's eyes. Eyewear frames are designed with 8° to 12º of pantoscopic tilt to more closely match the wearer's face plane and to align the optics of the lenses properly with the wearer's eyes. This means that the lenses the patient receives will be tilted.

Tilting a lens introduces unwanted cylinder into the prescription, which results in unwanted power changes across the lens. Since the lenses in the phoropter are not titled during an eye exam but the lenses you dispense to the patient will be, the patient can experience unwanted cylinder if the Rx is not compensated for this during surfacing. Remember, lens tilt can occur from both pantoscopic and face form. If both are present—and they usually are—an unwanted crossed cylinder effect will occur. Add this to the patient's astigmatic cylinder and resulting unwanted power can become pretty complicated.

The distance from the back surface of the lens to the eye also has a bearing on the power the patient experiences. The distance of the lenses in the phoropter sit in front of the patient's eyes is often different than the distance the final PAL lenses will sit in front of the eyes at the time of delivery. This shift in vertex distance causes a power error. While this error is small in low powers, it is another contributor to inaccurate lens powers. The way to avoid this is to compensate for it by adjusting the lens power for the difference in vertex from the examined lens location to the fitting location. That's why some customized lenses ask for vertex distance fitting information.

As you can see, the position of wear can have a significant impact upon the optical performance of a progressive lens, particularly the quality of vision through the central viewing zones. When the wearer's prescription, pantoscopic tilt, face-form wrap, and vertex distance are supplied, a progressive lens will be precisely customized for this exact position of wear. Wearers will therefore enjoy the best optical performance possible, regardless of their unique fitting requirements.

FRAMETIZATION

Free-form surfacing and advanced lens designs make it possible to customize and match the corridor length of the lens design to the fitting height required by the patient's chosen frame style. The optical performance and patient satisfaction of a progressive lens is greatly dependent on the length of the corridor.

If the corridor is too long for a given frame size, the ability to perform near tasks is greatly reduced. This is because the near zone is too far down the lens to be useful, or in some cases, may actually be cut away if the frame's B dimension is too shallow for the lens' design. If the corridor is too short, the optics of the lens design must be essentially "compressed," which can lead to usage problems for wearers, especially those who like to look farther down in their

PHOTO COURTESY OF CARL ZEISS VISION.

BACK TO THE FUTURE The personilization of progressive lenses will continue to advance and allow ECPs to deliver customized lenses to patients.

lenses. The corridor length of a progressive lens design should therefore be no shorter or longer than necessary to provide patients with lenses that will deliver the needed optics for their visual tasks.

Traditional PALs are produced in long or short corridor versions. This means that one corridor length is intended to serve the needs of all wearers. As you might suspect, this places a huge responsibility on the shoulders of the doctor or optician who recommends PALs to a patient because they have to determine the corridor length that the patient requires, then find a traditional PAL design that they like which has that parameter.

A better way to handle this is for the lens' design to adjust for more than one fitting height. In other words, why not let the lens adjust its entire design and its corridor length based on the size and shape of the frame the lens will go into? That's a good point, and one that customizable PALs have addressed.

You'll find that these lenses handle frametization in one of two ways: they either supply multiple corridor options (e.g., 14mm, 16mm, and 18mm), or they provide a range of corridor lengths (e.g., 13mm to 18mm). Either way, there are usually plenty of options. And the nice thing is that you don't even have to specify what fitting height you need, the laboratory software will do that for you. This is because it is not only adjusting the lens' corridor length or the frame's size and shape, but it is also adjusting the lens' entire

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design based on the frame's dimensions.

This is an important point because your control over the corridor length is not by telling the lab which one to use (as you have essentially done in the past by choosing a long or short corridor design); you are indirectly choosing the corridor length when you decide on the frame for a patient. This makes the frame selection process more important because if you choose a frame that is too narrow for the way a patient will use their eyes, the lens' optics will be fitted perfectly into it but the patient won't be able to use it. Choose frames with care when using customized free-form lenses.

MOLD MANIA

Traditional progressive lenses use traditional surfacing methods applied to semi-finished lens blanks produced by lens manufacturers. Typically each progressive lens design is available in semi-finished form for add powers from +1.00D to +3.50D in 0.25D increments. In order to produce these lenses, a series of molds must be produced. If the lens design is going to be available in more than one lens material, another set of molds and blanks are needed, creating a massive inventory situation. If a "short-corridor" version of the lens is available, that will require another set of molds and lens blanks to the array needed. This massive investment in inventory is expensive. It also has some serious limitations.

For example, lenses are often back ordered because the manufacturer has not produced enough of a particular lens in a particular base curve, add power, and lens option (like polarized) for the market. Because of this, labs and ECPs have to wait until the blanks are available. Labs have to stock huge quantities of diverse base curve, add power, and lens options, and hope they sell. If they don't, they essentially take a loss on them. »

Free-form PALs are customizable so their optics are created during the surfacing process. That means that they are not produced by mold making, which also means that they do not have to be stocked by the manufacturer or the lab. Instead, they are produced from single vision blanks that are usually readily available. The savings in inventory alone to manufacturers and labs are huge, and the ability to produce lenses "on the fly" is a major innovation that will revolutionize the laboratory business.

There is another advantage to free-form lenses that are customized this way—they can be updated just about any time. With traditional PALs that require molds to produce them, if you want to change the design, you have to change the molds. These limited subtle variations in optical design couldn't have been made from time to time because they would have been much too costly. With customizable free-form PALs, designs can be enhanced at anytime. All that's needed is for labs processing the lens to obtain the latest version of the surfacing software for that product.

CUSTOMIZED BY VISUAL HABITS

Every patient has a unique set of visual behaviors. In other words, all patients demonstrate unique head and eye movement behaviors in their daily activities such as during reading, using a computer, or participating in a sport. For example, some people move their head to look in their rear-view mirror when driving while others take a simple lateral glance with their eyes.

If patients actually use their vision as eye movers or head movers, then it stands to reason that the lens needed by an eye mover should be different than it should be for a head mover. This is the concept behind a customizing technique used by a couple of lens manufacturers who have developed lenses that are customized based on how a patient actually uses their eyes. One example is Essilor of America, Inc. which developed the FDA-approved VisionPrint System® for use with its Varilux® Ipseo™ lenses (Essilor just released its latest version, Varilux Ipseo IV™).

This diagnostic equipment measures the unique head and eye movements patients exhibit during a 90-second assessment. Using the VisionPrint instrument, the patient puts on an electronic frame and experiences a series of flashing lights from the instrument. The instrument assesses if she moved her eyes and/or head for each one, and the degree to which she moved them. The data obtained helps categorize the patient as an eye mover or a head mover and to what degree she falls into those categories.

PERSONALIZE ME, PLEASE! Customized free-form PALs are capable of adjusting their designs to work in sync with the lens' base curve

The patient's unique data can then be incorporated into the lens' design, along with vertex distance, pantoscopic tilt, etc., to create a lens that is based on the wearer's unique visual behaviors. Eye movers tend to benefit from progressive lens designs that have been customized with wider viewing zones. Head movers benefit from lens designs customized with softer gradients of power and astigmatism in order to minimize swim.

CUSTOMIZED USING WAVEFRONT

The latest technology that is aiding manufacturers in providing customized lenses for the wearer is wavefront technology. This technology is revolutionizing the way eye examinations are being performed and how lenses are being designed and produced. Wavefront analysis of the eye provides much more detail about refractive errors. These errors can be identified using sophisticated, automated instrumenta-

PHOTO COURTESY OF OPHTHONIX.

RIDE THE WAVE Using wavefront technology, lens manufacturers are now able to design lenses that more precisely correct the unique refractive errors of the intended wearer.

tion that assesses the way light waves travel through the eye. Using wavefront technology, lens manufacturers are now able to take this information and design lenses that more precisely correct the unique refractive errors of the intended wearer.

The aberrations and distortions of the eye measured using wavefront technology provide valuable information about vision errors and how to correct them. This is done using an instrument known as an aberrometer. Aberrometry measures how a wavefront of light passes through various refractive components of the eye and how much it is distorted from its original configuration.

Aberrometry is able to detect two types of refractive errors, lower and higher order. Lower order aberrations consist of sphere and cylinder powers. These are familiar to all ECPs because they are the components of the prescription the doctor writes. Lower order aberrations consist primarily of myopia, hyperopia, and astigmatism. They make up about 80% to 85% of all eye aberrations.

Higher order aberrations consist of a variety of aberrations that have increasing levels including coma, trefoil, and spherical aberration. Higher order aberrations comprise approximately 15% to 20% of the total number of aberrations in an eye. Higher order aberrations are associated with double vision, blurriness, ghost images, halos, and starbursts around bright lights, a reduction in visual contrast, and poor night vision.

Higher order aberration correction has been used in LASIK refractive surgery for several years to improve the visual experience of the patient after the procedure. In April 2005, the first wavefront-guided iZon® Single Vision spectacle that addresses the symptoms of vision problems caused by higher order aberrations of the eye was introduced by Ophthonix, Inc. In May 2006, the first wavefront-guided iZon Progressive Addition Lenses were released. Essilor's lenses that correct the higher order aberrations of the lens using wavefront principles are known as Varilux® Physio® and Varilux Physio 360º®.

Ophthonix creates iZon lenses using wavefront data obtained from the ECP using a Z-View® Aberrometer. The Z-View measures all second to sixth order aberrations that comprise the patient's optical fingerprint, or iPrint™. The output from the Z-View displays iPrint in graphic maps, as well as in diopter terms. Much like a fingerprint, this graphical display is unique to the patient. The incorporation of the iPrint and add power measured by the optometrist into the lens process is what makes these progressive lenses unique.

iZon High Resolution customized Progressive Addition Lens use "in-wear compensation" that include frame dimensions and fitting height in selecting the optimum progressive addition design (or corridor length) for the selected frame. The result is a lens that offers a zone-balanced system with wide distance, and optimum intermediate and near vision regions. The customized iZon PAL results in better distance vision under glare, varying contrast, low luminance conditions, and enhanced night vision. This creates a customized lens that addresses more than just the conventional refractive error of the patient's eyes. It essentially provides a new way of correcting vision.

The personalization of progressive lenses will continue to advance and allow ECPs to deliver customized lenses to patients. Lens customization is in its earliest stage of development. As improvements in lens design and the ability to produce them continues to evolve, customized lenses will make current traditional lenses look primitive. It should be really interesting to see what lens manufacturers have in store for us next. ◘

Eric L. Bran, Professional Editor for Vision Care Product News*, is in a private group practice at Ridgefield Family Eye Care and The Institute for Sports Vision in Ridgefield, CT.*

Randall L. Smith is the Opticianry Program Director at Baker College in Jackson, MI.

Ed De Gennaro is Director, Professional Content of First Vision Media Group.

TAKE THE LAB'S WORD FOR THE RX?

Since customized free-form lenses often come to your office with odd looking prescriptions such as -3.33D -1.43D x 98, the first question you're going to have is how to verify them.

Most eyecare professionals (ECPs) do not have the optical equipment that can read powers with this accuracy. Manual lensometers in most offices were designed to read lenses in 0.125D increments between a +/- 3.00D and 0.25D increments over those powers. Computerized lensometers can read 0.01D, 0.125D, or 0.25D, but their aperture is usually too large to obtain an accurate reading.

For example, the aperture on a manual lensometer is 9mm in diameter. Since customized PAL lenses are so highly aspherized, the lensometer in the typical ophthalmic office is going to average a lot of optical surface and deliver an answer that is not correct, even a modern computerized instrument. This is why ECPs are going to have to trust the lab's verification. Most ECPs won't like to hear this, but until the highly sophisticated instrumentation needed to read these lenses finds its way into the average eyecare office, this system will have to suffice. Check with each lens manufacturer to determine the best way to verify each lens brand that you use.

PROGRESSIVE LENSES

CE SELF-ASSESSMENT TEST

Please fill out the Answer Sheet at the end of this test. Respondents with a passing score will receive one (1) hour of CE credit. Respondents seeking COPE credit need to receive a passing score of 70 or more and should answer the first 10 questions only. Those seeking ABO credit need a passing score of 80 and must answer all 15 questions. This test is valid through October 1, 2009.

1. The position of wear can have a significant impact upon the optical performance of a progressive addition lens, particularly the quality of vision through the ______.

a. distance periphery zones
b. central viewing zones
c. corridor viewing zones
d. aspheric near zones

2. Which of the following categorizes describes a customized progressive addition lens (PAL) designed to adjust for several fitting heights?

a. compensated Rx
b. frametized
c. position of wear
d. wavefront enhanced

3. Higher order aberrations consist of a variety of aberrations that have increasing levels including coma, trefoil, and ___________.

a. chromatic aberration
b. distortion
c. spherical aberration
d. cylinder

4. Customizable free-form PALs can have their designs updated just about any time the manufacturer wants because _____________.

a. they are molded
b. they use position of wear parameters
c. their optics are applied to the lens during surfacing
d. they are designed using wavefront optics

ANSWER SHEET

Fill out and mail this portion to: *Progressive Lenses CE, c/o First Vision Media Group, Inc., 25 East Spring Valley Ave., Suite 290, Maywood, NJ 07607 or Fax to: 201-587-9464. Be sure to fill out form completely. This CE article is also available at TotallyOptical.com.*

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ANSWERS *Blacken the selected answer circle clearly and completely.*

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1. ⓐ ⓑ ⓒ ⓓ	6. ⓐ ⓑ ⓒ ⓓ	11. ⓐ ⓑ ⓒ ⓓ
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5. The manual lensometers in most offices are designed to read lenses in ________.

a. 0.125D increments between a +/- 3.00D and 0.25D increments over those powers
b. 0.125D increments for all powers between +/- 20.00 D
c. 0.25D increments for all powers
d. 0.01D increments between +/-3.00D and 0.12D increments over those powers

6. Higher order aberrations comprise approximately ______ of the total number of aberrations in an eye.

a. 5% to 10%
b. 15% to 20%
c. 25% to 30%
d. 45% to 50%

7. Lower order aberrations consist primarily of myopia, hyperopia, and _________.

a. astigmatism
b. chromatic aberration
c. coma
d. distortion

8. Typically customized free-form PAL designs are available in semi-finished form with add powers from __________.

a. +1.00D to +3.00D in 0.25D increments
b. +1.00D to +3.50D in 0.12D increments
c. +1.00D to +3.50D in 0.25D increments
d. +1.00D to +4.00D in 0.25D increments

9. Free-form PALs are customizable because their optics are created during _______.

a. the software design process
b. the mold making process
c. the surfacing process
d. the fitting process by the dispenser

10. You would specify the patient's monocular PD and segment height, pantoscopic tilt, face-form wrap, vertex distance, lens thickness, base curve, and index for what type of free-form PAL?

a. frametized
b. customized by eye movements
c. customized by wavefront
d. customized by position of wear

OPTICIANS ONLY. Please answer these five additional questions:

11. Based on the corridor lengths specified below, which of the following is not a frametized PAL?

a. 16mm
b. 13mm to 18mm
c. 10mm to 16mm
d. 16mm to 22mm

12. Tilting a lens introduces ________.

a. decreased central viewing zones
b. lower order aberration
c. higher order aberrations
d. unwanted cylinder power

13. What does aberrometry measure?

a. myopia, hyperopia, and astigmatism
b. pantoscopic tilt, face-form wrap, and vertex distance
c. the frame's B dimension
d. how a wavefront of light passes through various refractive components of the eye

14. Eyewear frames are designed with 8° to 12° of pantoscopic tilt to more closely match the _________.

a. phoropter
b. optical center drop of progressive lenses
c. wearer's face plane
d. patient's "iPrint™"

15. Eye movers tend to benefit from PAL designs that have been customized _____.

a. for position of wear
b. with wider viewing zones
c. with softer gradients of power and astigmatism
d. with diverse base curves, add powers, and lens options