Getting Personal with Progressive Lenses

Emerging technology has made the design and manufacture of PALs more personalized and customized.

(Photo courtesy of Essilor of America.)

The 'personal' progressive represents the future of all progressive lenses.

By Randall L. Smith, MEd, ABOM

Arguably the most significant advancement in the development of personalized progressive addition lenses (PALs) is free-form technology. In fact, it has made a huge impact on the design and manufacture of these lenses. Free-form progressive lenses provide options for patients and correct optical errors previously not addressed due to design and manufacturing limitations.

FREE-FORM DEFINED

Free-form technology is composed of two elements—lens design and manufacturing. On the design side, computer software programs aid designers in developing progressive designs. What makes this process different from previous technologies is that free-form-designed lenses can use the superior accuracy of the free-form manufacturing process. Because of this highly precise manufacturing capability, the lenses can be designed to remarkably stringent parameters. This ability enables the designer to address aberrations and provide visual features that were not possible before.

ERRORS AND ACCURACY

The traditional method of surfacing a lens produces simple spherical and cylindrical curves that are not precisely accurate because of something called "elliptical error." This error is induced by the grinding process in the grinding wheel. Its circular shape is almost always grinding the lens at an angle which induces the error. The primary technique for reducing this error is by performing a "fining" step after it has had the rough lens curves ground into it by a generator. The roughly generated surface is smoothed using a grinding compound with a fairly minute particle size. A polishing step completes the process.

Free-form generators use two types of diamond cutters—a rough cutting set and a diamond "point" tool. After the lens is rough cut, the point tool completes the generation process with microscopic accuracy. Because it uses a point and not a circular wheel to create the curves, no elliptical error is produced. For this reason, lenses surfaced with free-form equipment require no laps or fining when they emerge from the generator. Instead, the lens goes directly to polishing, and depending on the generator used, this may be a one- or two-step polish process. Some free-form generators create a polishing tool as they produce the lens while others use a polishing wheel to finish the lenses. Both techniques reduce production time.

ACCURACY

One of the great strengths of free-form

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This course has been approved for one hour of free continuing education credit by the American Board of Opticianry (ABO).

COURSE DESCRIPTION:
After nearly 50 years, technical innovations continue to positively impact the design of progressive addition lenses (PALs). Since their introduction in 1959 by Essilor in France with the Varilux® I lens, lens designers have strived to develop increasingly more sophisticated lenses that provide sharper optics, wider fields-of-view, greater comfort, and more individualized features. That quest has led manufacturers to develop some wonderfully creative and capable individualized and customized lenses that utilize the latest in visual science, optical science, and engineering.

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PERSONALIZED PALS

(Photo courtesy of Signet Armorlite.)

Progressive lens technology is evolving and will, no doubt, bring on countless other innovations and improvements.

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equipment is that it has the capacity to produce lenses with curve power accuracy down to 0.01D. This is a considerable improvement over traditional surfacing which is accurate to +/- 0.12D. This is no esoteric issue. Accuracy of this caliber means that the visual can be corrected more accurately than with previous surfacing technology.

Even more importantly, free-form equipment can provide surface accuracy to the micron level. This means that just about any surface that can be imagined can be created. Using software, designers can now address lens aberrations more effectively with this kind of lens surface accuracy. They can also concentrate on lens aberrations that they were unable to attack due to a lack of surface accuracy.

GETTING PERSONAL

Lens manufacturers that produce personalized progressive lenses use free-form software and incorporate the patient's individualized information into it so that the program can alter the lens design to more precisely provide the wearer with a highly accurate and personalized Rx correction while optimizing the lenses for their needs.

For example, traditional PALs ask the eyecare professional (ECP) to supply the patient's distance PD and fitting height measurement when ordering her lens. Personalized progressives ask for additional parameters that have a bearing on the lens' power and zone widths. Parameters such as vertex distance, the lens' base curve, pantoscopic tilt, and frame wrap (face-form tilt) all have an impact on the actual powers the wearer experiences when the lenses are completed, set into the frame, and adjusted in front of her eyes. By incorporating these variables into the progressive lens design, the ultimate personalized Rx lens is created.

Personalization of this type is done by having the software construct the aspheric and atoric curvatures needed for the front and/or back surfaces of the lens, and having that data sent to free-form surfacing equipment which creates the surfaces.

THE FLIP SIDE

Nearly all traditional progressives have their progressive optics on the front of the lens. This allows the surfacing laboratory to grind the Rx powers on the basic surface using traditional methods.

Most free-form progressive addition lenses have their progressive optics on the back side of the lens along with the patient's Rx powers. Moving the progressive optics to the lens' back side widens the field-of-view for all zones due to the "keyhole effect." When the eye is close to the keyhole in a door, the view that the viewer receives is wide. When the viewer moves away from the keyhole, it rapidly narrows proportionally. Back-side progressives have this keyhole advantage.

One progressive lens has its progressive optics on the back surface of the lens but splits the add power so some is on the front and some is on the back of the lens. Another lens has the progressive optics on both sides of the lens.

Some newer progressive lens designs are individualized for the wearer by using frame data. In these lenses, the frame's parameters (for example, the A, B, DBL, and ED measurements) are considered in the lens calculations. What results is a modification of the lens' design so that it provides maximum utility to the wearer based on the frame he will actually wear. This is a clever method for ensuring that every patient receives the maximum benefits of a lens' design regardless of the frame he chooses.

As you can see, progressive lens technology is evolving and will, no doubt, bring on countless other innovations and improvements.

To help you better understand the merits of personal progressive lenses, the following provides details of some of these lenses from some of the leading lens manufacturers.

CARL ZEISS VISION INC.

The Gradal® Individual and Gradal Short i progressive lens designs are created using free-form technology. ECPs supply typical lens ordering data, including the patient's prescription and PD, and the lens design is then optimized for that individual patient. For the most complete customization, ECPs can also provide fitting height, back vertex distance, pantoscopic tilt, near working distance, and frame shape, and the design will be customized for these parameters as well.

After lens calculations, the progressive design is three-dimensionally free-form diamond cut to shape (on the back surface for most prescriptions), polished, and an anti-reflective treatment is applied to complete the customization of the lens. A Zeiss Gradal Individual Fitting Tool is available to ECPs to enable them to measure the back vertex distance as well as the pantoscopic tilt.

PERSONALIZED PALS

The SOLAOne™ HD progressive lenses capitalize on free-form technology combined with customization to create an all-purpose PAL. The lens balances central and peripheral vision based on 10 years of wearer trials and ongoing studies designed to understand progressive lens wearer's visual task requirements. Incorporating SOLA's Design by Prescription technology, the lens design is adjusted by base curve and add power.

The SOLA Compact ULTRA™ HD also takes advantage of free-from technology to create a short corridor lens with a 13mm minimum fitting height.

ESSILOR OF AMERICA, INC.

Varilux® Ipseo® lenses are designed based on the wearer's natural, unique physiological criteria plus her prescription parameters. To determine a wearer's eye and head movement behavior, Essilor provides the ECP with a VisionPrint System® (VPS). Consisting of a frame-like device worn by the patient and an electronic lighted visual display, the wearer is given a 90-second assessment that maps her visual behavior. The results determine whether the patient is an eye mover or a head mover and to what degree she exhibits these behaviors by defining an eye/head movement ratio and a stability coefficient.

These measurements are incorporated into the lens calculations with the patient's prescription so the software can personalize the lens for the wearer. This is advanced technology because it not only personalizes the lenses for eye and head movements, it also modifies the corridor length and position to compensate for the prismatic effects of the distance Rx and add powers.

DEFINITY™ PALs provide sharp vision with wide fields-of-view through the use of proprietary digital surfacing design and production processes. DEFINITY uses DUAL ADD® Technology to reduce unwanted astigmatism by dividing and offsetting the add and unwanted astigmatism between the front and back surfaces of the lens.

DEFINITY™ also features the GROUND VIEW ADVANTAGE™, a gradual decrease in add power below the near zone, which minimizes distortion for a flattened, more natural field of vision. What results is clearer vision when patients look down.

Arguably the most significant advancement in the development of personalized PALs is free-form technology.

HOYA VISION CARE, NORTH AMERICA

Hoyalux iD is the world's first Integrated Double Surface Progressive lens design. This design concept splits the functionality and performance of the front and back surfaces by placing vertical and horizontal progressive powers on completely separate lens surfaces. Using HOYA free-form surfacing technology, the horizontal progressive components are surfaced on the back surface. The benefit of this placement is that it offers the wearer wider fields of view in the near zone and virtually eliminates swimming and swaying sensations. Conversely, the vertical progressive components are surfaced on the front side of the lens. The benefit of this placement is that it shortens the eye-rotation between distance and near viewing by placing it farther from the eye. Hoyalux iD also employs HOYA's unique Balanced View Control. Balanced View Control brings vision and perception into balance through a unique calculation technique that insures stability and control in the near and peripheral zones of the lens by eliminating unwanted skew distortion. This feature provides the wearer with an unsurpassed level of comfort and a completely natural visual experience.

In order to provide more flexibility and choice for the wearer and eyecare professional, Hoyalux iD can be customized to fit a frame with a minimum fitting height as low as 14mm.

Beginning with its introduction in May 2007, Hoyalux iD LifeStyle represents the next step in the Hoyalux iD design family, making Hoya free-form technology available to a broader audience. Hoyalux iD LifeStyle's Rotation Angle Based Design offers a smooth and natural transition between all visual zones by precisely mapping each point on the lens in reference to the eye rotation. Hoyalux iD LifeStyle also utilizes HOYA's patented Balanced View Control technology. Balanced View Control brings vision and perception into balance through a unique calculation technique that ensures stability and control in the near and peripheral zones of the lens by eliminating unwanted skew distortion. This feature provides the wearer with a high level of comfort and a natural visual experience. Hoyalux iD LifeStyle is available in three lens materials: HOYA Hilux 1.50, HOYA Phoenix and HOYA Eynoa 1.67. Hoyalux iD Lifestyle is also available in a short-corridor option, Hoyalux iD LifeStyle CD, with a minimum fitting height of 14mm.

(Photo courtesy of HOYA.)

Free-form lenses can be designed to remarkably stringent parameters.

INDO LENS US

EyeMADE® progressive lens applies a wearer's individual viewing behavior to his prescription and frame parameters to create a lens specifically for him.

Using VisualMap DEVELOPER®, the patient's eyes follow a luminous stimulus that moves across two screens to create a VISUAL MAP®. The VISUAL MAP® technology creates a graphic representation of the natural coordinated movements of the user's head and eyes. Once the design has been determined, the lens is made using free-form manufacturing.

PENTAX VISION

The Pentax Perfas Internal Free-Form™ is a patented, technologically advanced progressive addition lens that combines

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PERSONALIZED PALS

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Retina Forward Design with back-surface progressive power, placing 100% of the patient's prescription on the back side of the lens. Pentax's Retina Forward Design® takes into account how lenses are actually worn.

Computer modeling calculates the surface power at 5,000 points on each lens to optimize optical performance in the "as-worn" position. This reduces aberrations caused by pantoscopic tilt, vertex distance, and object distance variations. When combined with back-surface progressive design and aspheric compensation in all visual fields, Perfas' Retina Forward Design creates a more natural viewing experience.

RODENSTOCK NORTH AMERICA

MultigressivILT is created using a computer-driven mathematical formula, which determines the precise combination of curves to optimize each lens. MultigressivILT lenses feature a fully aspheric front surface and atoric curves on the back surface, providing a smooth transition from distant to near, a wider reading area, and enhanced peripheral vision. These general-purpose lenses are suited for patients with progressive adaptation difficulties, strong Rx's, or those who want the best possible lens correction.

ProgressivILT XS is a short corridor lens design that takes into consideration fitting factors such as vertex distance, pantoscopic tilt, and more. The lens' optics are calculated for each individual patient and processed on individual base curves for maximum visual performance. By offering a custom design, these position-of-wear lenses offer the wide, crisp field-of-view, no matter how the lens is used.

SEIKO OPTICAL PRODUCTS OF AMERICA

Seiko's 1.67 Proceed III SUPER SHORT, Proceed II SHORT, and Proceed lenses are aspheric and asymmetric progressive lenses. Proceed PALs combine Seiko's Multi-Division Aspheric design (MDA), Progressive Prism Variation (PPV), and Vertical Prism Control (VPC) technologies. The result is an exceptional level of optical performance and a lens that's comfortable and easy to wear.

Succeed Internal Free-Form™ Progressive Addition Lenses utilize technology that places the patient's entire Rx onto the back surface of the lens, which leaves the front surface as a perfect sphere. This significantly expands the fields-of-view, since the corrective surface is placed closer to the eye, and it alleviates the "swim and sway" effect caused when the progressive power is on the front surface. It is custom-made to each patient's exact prescription using the latest in surfacing equipment. With this lens, patients get a multifocal lens that feels like a single vision lens.

SHAMIR INSIGHT, INC.

The Autograph® progressive utilizes Shamir's advanced Freeform Technology® combined with EyePoint Technology®, a software program that designs a lens using an exact simulation of the human eye. Autograph lenses provide individualized design for every viewing angle, vision zone, and prescription, resulting in enhanced peripheral vision, binocular vision, and visual clarity.

SIGNET ARMORLITE, INC.

The KODAK Unique Lens uses free-form technology to create lenses that have tolerances of up to 1/100 of a diopter. Unique is one of the newer progressive designs that automatically customizes the lens' design based on the patient's frame selection. ECPs supply the monocular PD, frame dimensions, and fitting height, and the frame should allow at least 10mm above the fitting point for distance and a 13mm minimum fitting.

WAVEFRONT TECHNOLOGY

The latest technology that is aiding manufacturers in providing personalized lenses for the wearer is wavefront technology which is revolutionizing the way eye examinations are being performed and how lenses are being designed and produced. Wavefront analysis provides much more detail about refractive errors. These errors can be automatically identified using sophisticated instrumentation that assess the way light waves travel through the eye. 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 measured using wavefront technology with the eye 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

(Photo courtesy of Carl Zeiss Vision.)

The latest technology that is aiding manufacturers in providing personalized lenses for the wearer is wavefront technology.

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; these include coma, trefoil, and spherical aberration. Their mathematical expressions are called Zernike polynomials. Higher order aberrations comprise approximately 15% to 20% of the total number of aberrations in an eye. They are associated with double vision, blurriness, ghost images, halos, starbursts around bright lights, a reduction in visual contrast, and poor night vision.

OPHTHONIX, INC.

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 2005 the first spectacle to correct for higher order aberrations was introduced by Ophthonix, Inc. Known as the iZon® High Resolution Lens, this single vision lens was the first lens to apply wavefront principles to the measurement of eye aberrations and correct using a spectacle lens modality. Last year the company introduced its iZon Progressive Addition Lens.

Ophthonix creates these lenses using wavefront data obtained from the ECP utilizing an aberrometer the company manufactures. The Z-View® Aberrometer collects data, processes it, and then uses it to create the patient's iPrint™. This is a unique map of the patient's lower and higher order eye aberrations. Much like a fingerprint, this graphical display is unique to the patient, and its incorporation into the lens formation is what makes these progressive lenses distinctive.

Like its single vision companion, iZon Progressive Addition Lenses are produced as a sophisticated wafer system. The front and back wafers of the lens are made of 1.60 index plastic. The center layer is composed of a liquid polymer known as iZonik™.

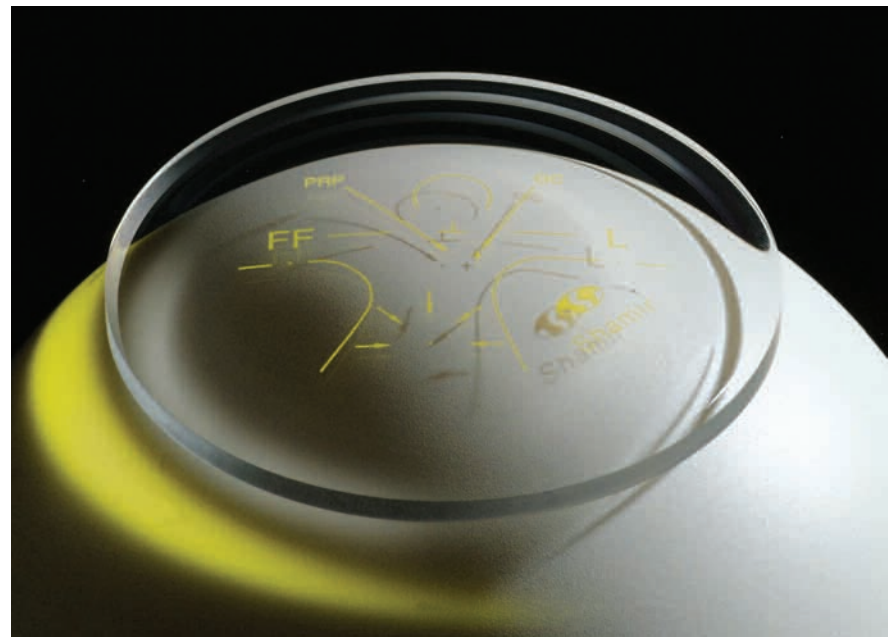
The front wafer contains no power while the back wafer has the Rx powers for the sphere, cylinder, and add power. These are produced using free-form technology to precisely control surface power accuracy to 0.01D. The progressive optics is also placed on the back surface using free-form technology. The patient's iPrint information is translated from the Z-View Aberrometer and sent to Ophthonix which incorporates the information into the lens calculations.

iZon Progressive Addition Lenses are further customized by optimizing the design for the dimensions of the patient's frame. When you send an order in for one of these lenses, software analyzes frame parameters and uses this data to customize the lens. Along with fitting heights, decentration, pantoscopic tilt, and vertex distance, the software calculates the widths and lengths of the distance, intermediate and near zones, and alters them to provide the best option for that data set. The result is a lens that offers maximum viewing zones, increased contrast, better depth perception, and enhanced night vision.

ESSILOR

The company was the first to introduce a wavefront-guided progressive lens with its Varilux Physio™ and Varilux Physio 360°™ lenses. Proprietary wavefront technology known as W.A.V.E. Technology: Wavefront Advanced Vision Enhancement™ used in Varilux Physio and Varilux Physio 360° lenses helps eliminate certain vision distortions commonly associated with or not corrected by conventional lenses.

W.A.V.E. Technology consists of a proprietary digital surfacing manufacturing process and calculations to produce the lenses. Varilux engineers are now able to analyze an entire beam of light, allowing them to identify distortions and correct them using digital surfacing (a type of free-form technology) over the surface of the lens. W.A.V.E. Technology eliminates or greatly reduces lower and higher order aberrations that are present in traditionally designed and processed progressive lenses.



(Photo courtesy of Shamir Insight, Inc.)

Free-form progressive lenses provide options for patients and correct optical errors previously not addressed due to design and manufacturing limitations.

The Varilux Physio lenses are produced using front molds designed and created using W.A.V.E. Technology. The back surface is made using traditional surfacing. Varilux Physio 360° uses W.A.V.E. Technology molds for its front surface and a proprietary digital surfacing on the back surface of the lens.

Both Varilux Physio and Varilux Physio 360° are general-purpose progressives that offer improved vision in all fields because of W.A.V.E. Technology. Varilux Physio 360° is recommended for patients who have complex Rx parameters, non-adapts to other progressives, those who want the sharpest vision possible, or those who want the latest in lens technology.

The age of the "personal" progressive lens is just in its infancy. Keep your eye on this lens category. It represents the future of all progressive lenses. ■

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