PRO TO PRO
CONTINUING EDUCATION

PRODUCT SPOTLIGHT – CAMBER: BREAKTHROUGH TECHNOLOGY AND DESIGN

MERGING COMPLEX CURVES

Front Surface Innovation for Free-form Progressive Lens Optimization

By Deborah Kotob, ABOM

[1 CE CREDIT]

In this course, you will learn about patented breakthrough lens form and design technologies for better optimization of free-form progressive lenses. As ECPs, our objective is to improve the progressive lens patient's visual experience. Even with free-form technology, progressive lenses continue to present challenges for some patients. As a fan of free-form technology, I was intrigued to know about a technology that could improve free-form outcomes. Free-form was a technological leap forward, allowing for greater precision application of lens design and the optimization of the lens surface topography. In addition, it opened up the opportunity to compensate for individual "as worn" frame fit parameters. The Rx design computation occurs in real time and in unison with other parameters. Even high wrap sports frames can be compensated. So free-form is great! But can it be made better? The answer is yes. You will learn in this course that the single vision blanks used in standard backside free-form progressive lens technology are not the ideal lens form foundation upon which to build a digital progressive lens design and why. You will learn about the Camber variable curve lens blank, an innovative front surface technology that improves free-form progressive lens optimization over a standard single vision lens blank. Ultimately, it is the merging of complex curves on the front and back surfaces of a progressive lens that produces the best lens form and optical performance. Lens designers/engineers prefer to work with two surfaces for a reason. A sophisticated variable curve blank is the correct foundation upon which to build the back surface design, but the merging of complex curves from both surfaces also requires an advanced design technology. In this course, you will learn about the optical fundamentals behind the unique Camber progressive lens blank and the unique patented Camber Steady Methodology technology. With this technology, progressive lens design reduces not only unwanted cylinder to its mathematical limits but also reduces mean sphere power and its contribution to lateral defocus in the lens.

LEARNING OBJECTIVES:

Upon completion of this program, the participant should be able to:

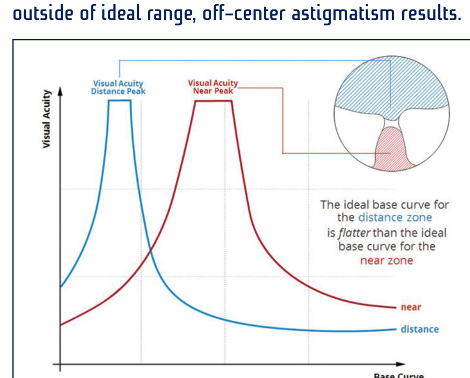
1. Learn the importance of matching Rx power with a compatible optically-correct base curve.
2. Learn how a progressive lens blank with a variable base curve front surface improves upon the single vision blanks typically used in free-form surfacing.
3. Learn why variable base curves can improve the optical characteristics, range and cosmetics of progressive digital lenses.
4. Learn about the contribution of mean sphere power to produce lateral defocus in a progressive lens and learn about a breakthrough patented PAL design technology that minimizes its effect for greater image stability.

Credit: This course is approved for one (1) hour of CE credit by the American Board of Opticianry (ABO). Technical Level 2 Course STWJHI1010-2

BACK TO OPTICAL BASICS– EVERY LENS POWER HAS AN IDEAL BASE CURVE FOR BEST-FORM OPTICS

In our excitement over state-of-the-art digital free-form lens technology, we ignored a very important optical design premise. We ignored the basic optical rule that "every lens power has an ideal base curve," for best lens form and off-axis optical performance. And if the lens is a progressive design, then the ideal base curve

FIG. 1 Acuity drops off quickly when we deviate from the ideal base curve range. When the base curve falls outside of ideal range, off-center astigmatism results.



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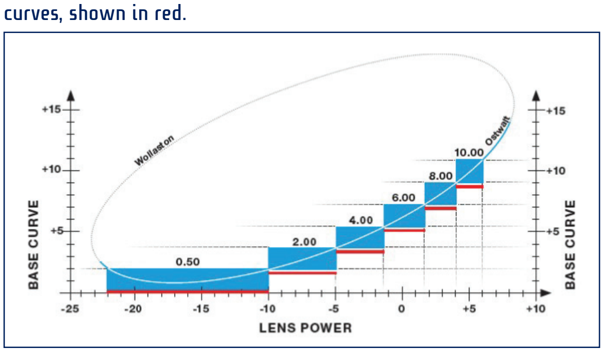
for the distance zone will be different from the ideal base curve for the near zones.

Visual acuity falls off very quickly when we deviate from the ideal base curve range, as shown in Fig. 1.

THE IDEA OF IDEAL BASE CURVES

According to Wollaston and Oswalt, for every lens prescription power, there is an ideal base curve that reduces oblique astigmatism and provides the best off-axis lens performance. Lens optical performance is dependent on the merging of the correct base curve with the Rx power curves. Standardized lens bases were designed to span the range of dioptric powers that conforms to Oswalt's equation (shown in blue in Fig. 2). Modern base curves have shifted further downward (flatter) for better cosmetics (shown in red in Fig. 2). Simple enough in a single vision lens; match the correct base (front) curve with the Rx power (back) curve(s). Not so simple with a progressive lens where the power, hence the base curves need to change from flatter in the distance zone to steeper in the near zones. One curve on the front does not suffice. One curve can match the distance but will not be the ideal curve for the near zone. This can mean that the near zone power is not appropriately matched to its ideal base curve. And since the near zone is viewed obliquely, this mismatch is of greater consequence, further reducing near optical performance. Optical designers must first correct the optical problems created by a single vision front curve. Design tools are used for curve correction compensation rather than integrating the best design enhancements for the patient. While we are on the topic of returning to fundamental optical principles to improve free-form progressive lens optimization, it's a good time to reflect on the fact that the key to a great visual experience for the progressive lens wearer only happens when all the components come together: optically correct base curves, a great design, correct refraction and measurements. Precision in all steps is vital, as no amount of digital design wizardry will produce a good visual experience for the patient if the refraction is incorrect or the frame and fit metrics are wrong.

FIG. 2 Tscherning Ellipse combines the Wollaston and Ostwalt suggested base curves for reduced oblique astigmatism. The optical industry adopted Ostwalt's flatter curves but now use even flatter curves, shown in red.



THE CHALLENGES FOR SINGLE VISION FRONT FREE-FORM BACKSIDE PROGRESSIVE LENS FORM

Reading challenges: Free-form, digital design, computational analysis and precision application is a significant advancement in ophthalmic lens technology, but the single vision front curve presents challenges. In a conventional progressive, the increased curvature of the progressive addition on the molded front surface increases the magnification in the reading area. Magnification in the near zone can improve acuity and enhance the reading experience in a progressive lens. Conversely single vision front, backside free-form progressives do not produce this same magnification with their flatter curves in the near zone. As a result, a patient might complain that they can't read as well. Another factor that affects near vision quality in a progressive lens is eye rotation and angle. A flatter lens in the near zone forms a more oblique angle to the visual axis. In a back-surface digital progressive, increased digital compensation is required to correct for that off-axis oblique angle in the near zone. Camber blank technology provides the optically correct steeper curve at near in a free-form lens.

Keyhole effect argument: One of the purported claims is that putting the progressive on the back places the corridor closer to the eye and due to the keyhole effect provides a wider field of view in the near zone. (The keyhole effect is the increased field of view experienced when looking through a keyhole close to the eye versus the view through a keyhole that's positioned away from the eye.) While this may be true, it is not without controversy. Others suggest that if the eye is closer to the corridor, the vertical eye rotation spans a shorter arc, so the corridor length needs to be shorter. A shorter corridor produces more peripheral astigmatism and is narrower. Also, some designers argue that the vertex distance reduction achieved by moving the progressive to the back surface is so nominal as to have no discernible keyhole effect.

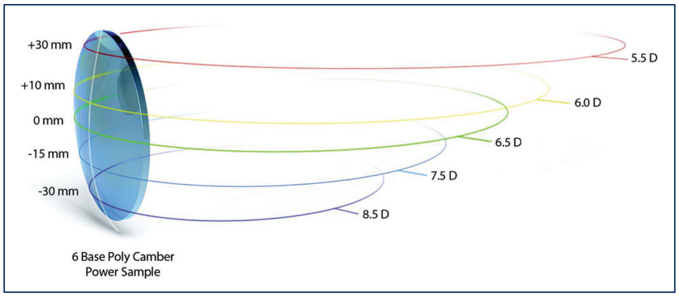
Cosmetic issues (mainly in plus prescriptions): One of the problems of using a single vision front with a backside progressive is that high plus prescriptions can look worse in the frame than if using a front side molded progressive with a variable front curvature. One can empathize with the ECPs who avoid using single vision front free-form for high plus prescriptions. A free-form backside PAL can be too curved and even bi-convex in the near region for high plus prescriptions, and if it is a significant high plus power, it will become too convex to be cosmetically appealing, or even beyond the ability of the lab to fabricate!

Comfort issues: While a short vertex distance is good, having the prescription too close to the face can cause the eyelashes to touch the back surface of the lens, often referred to as "lash-crash." This can result in discomfort and irritation. If significantly high plus power, the lens may require a convex add, which reduces its cosmetic appeal and may even be impossible for the lab to fabricate.

Only back optical surface to work with: The front surface cannot be used for design purposes since it is just a single vision lens; this places limitations for the optical designer. For this reason, optical designers prefer to achieve optical corrections by using more than one surface.

One size does NOT fit all: A single vision curve is not optically correct for all of the progressive power zones. As mentioned, for every power, there is a corresponding closely aligned base curve to achieve optimal optics and minimize peripheral distortion and oblique astigmatism.

FIG. 3 Stacking of spheres



Direct to surface free-form backside progressives start with a single curve on the front which does not provide the separate and ideal base curves needed for the distance, intermediate and near zones, independently. Starting with a single vision blank for free-form progressive results in optical errors that must be digitally corrected/compensated. Reducing the need to compensate for the errors produced when a single curve spherical blank is used expands the lens' personalization and optimization opportunities in free-form lens design. Optical designers must utilize digital compensation to correct the optical errors inherent when single vision blanks are used in free-form, rather than focusing design decisions on achieving a fully personalized lens. Utilizing the patented Camber variable base curve blank technology reduces the need for compensation correction so that the designer can use design optimization to refine and customize the design for the wearer.

Camber's front lens surface with variable base curves addresses all of the above concerns. The steeper curvature in the near zone provides increased magnification for user-preferred near vision comfort. The technology delivers a cosmetically more attractive lens with flatter front curves in plus powers. Camber blanks return to the fundamental optical principle of matching the power of the different viewing zones with an optically correct base curve to maximize the benefits offered by advanced digital design and surfacing technology.

How does the Camber blank technology improve progressive lens optimization over the single vision blanks used in free-form backside progressive lens technology?

FRONT SURFACE INNOVATION

The "stacking of consecutive spheres," as illustrated in Fig. 3, is unique to Camber lenses. Studies have demonstrated that the use of a Camber variable base curve blank improves user satisfaction mainly in the near area due to an increase in the width of the undistorted near visual field. The Camber lens blank is designed with a variable base curve front surface to provide optically correct base curves in all progressive zones.

From the top of the lens blank to the bottom, the base curve increases up to three diopters. There are eight available base curves (0.5, 2, 3, 4, 5, 6, 7 and 8). Each of these comes from a successive section of a spiral-shaped curve, which is shaped almost like an elephant's trunk (Fig. 4). This means that the Camber front surface increases in curvature from top to bottom, with flatter curves in the distance zone and steeper curves in the reading zone. Fig. 3 illustrates the variable front curves of a Camber 6 base lens blank. This "stacking of the spheres" is a patented technology unique to Camber lenses.

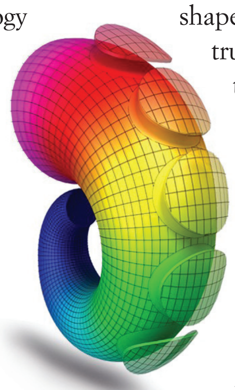


FIG. 4

The variable front curve umbilic line (shown in white) has a progressive rate of curve/power increase from top to bottom. As shown in Fig. 3, a 6-base Camber blank is 5.50 D at the top of the lens, 6.50 D through the horizontal middle and 8.50 D in the bottom of the lens blank. This equates to an average of a 3D difference from top to bottom. In steeper base curves, the total increase is greater.

The unique, continuously steepening surface curvature of the specially designed Camber lens blank when combined with a sophisticated digitally optimized back surface, expands reading zones and improves peripheral vision in the lens. The design elements work synergistically to produce user-preferred near vision performance, in a cosmetically attractive lens with an expanded prescription range. Reducing the need to compensate expands the lens' personalization and optimization opportunities.

MERGING COMPLEX CURVES

Camber front surface innovation + Camber design technology: Camber's innovative optically correct front surface technology is designed to work synergistically with Camber PAL design technologies.

Three part synergy for enhanced lens performance: A Camber finished lens is made up of three synergistic components. A great finished product must start with: 1. A great foundation, the Camber Variable Base Curve blank. 2. Rx final design computation, and 3. Customization based on individual frame and fit parameters.

The Camber Family of digital back surface design technologies work synergistically with the Camber blank variable curve front for optimal lens performance.

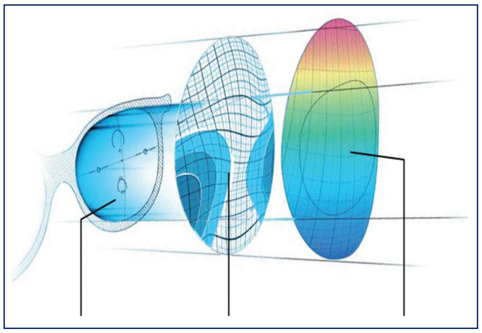
DIGITALLY OPTIMIZED AND INDIVIDUALIZED BACK

When combined with a sophisticated back-surface digital design that utilizes Ray-Path technology, both surfaces work synergistically to expand the Rx range, provide better cosmetics (flatter) for many prescriptions and deliver user-preferred near vision performance. To produce Camber prescription lenses, cutting files are optimized using "Digital Ray-Path," a lens design software by IOT (Indizen Optical Technologies S.I.). The software analyzes and computes the point by point surface profile across the lens to best accommodate the prescription and frame/fit parameters, and to minimize lateral and oblique aberrations.

PROGRESSIVE LENS DESIGN TECHNOLOGY BREAKTHROUGH

Progressive lenses have been available for over 50 years. Despite advancements made in progressive lens design, some patients still experience a "swim" effect while wearing them, espe-

FIG. 5 Camber Steady

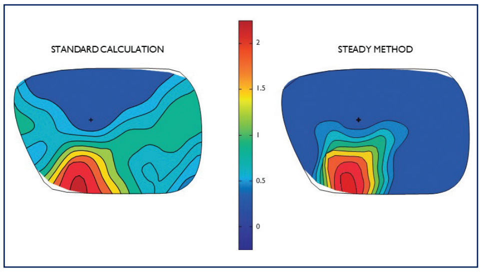


cially in dynamic conditions. The swim effect is image instability, where the perception of surroundings appears distorted and appears to move. This effect in progressive lenses causes discomfort, makes adaptation more difficult and reduces overall lens satisfaction. Herein lies the beauty of the Camber Steady design breakthrough. Inspired by the Steadicam, a stabilizer for motion picture cameras that allows for a smooth shot, even if the camera moves over irregular surfaces, Camber Steady design delivers superior image stability to the wearer the same way that Steadicam allows a camera to capture sharp and stable footage while it is in motion. With superior image stability comes better peripheral vision and the ability to capture detail even in dynamic conditions.

How does it work? Camber Steady is the result of approaching lens design development from a completely new angle based on measurable information.

The standard historical approach to progressive lens design attempted to control unwanted cylinder power but did not address sphere mean power which IOT researchers uncovered contributes to defocus in the lateral portion of the lens. Camber Steady goes one step further than past progressive lens designs by taking the unwanted spherical power of the lens into account in the design process.

FIG. 6 Compare mean sphere power error in standard design versus Camber Steady Method



Camber Steady methodology virtually eliminates positive mean power and its associated defocus in the lateral portion of the lens, while still providing a lower level and smooth distribution of unwanted cylinder error; which along with the reduced mean sphere, reduces swim effect. The result is a lens with superior image stability for the wearer. In wearer trials, a 14 percent increase in the distance visual field was seen.

STEADY METHOD FOR LATERAL DEFOCUS CONTROL IN PAL LENSES

The gradual increase of power from the top to the bottom of a progressive lens leads to defocus in the peripheral areas of the lens. It is attributable to induced unwanted sphero-cylindrical power error inherent on either side of the progressive corridor. It is not possible to develop a progressive lens with zero peripheral distortion due to geometrical limitations, as explained by the Minkwitz theorem.

The progressive lens designer's goal is to minimize these distortions to their geometrical limits. Steady Method design computes the powers that will achieve the lowest level of distortion, minimal swim effect and superior image stability without a reduction in progressive lens optical performance.

The following is a list of other technologies used to refine the final Camber Steady design.

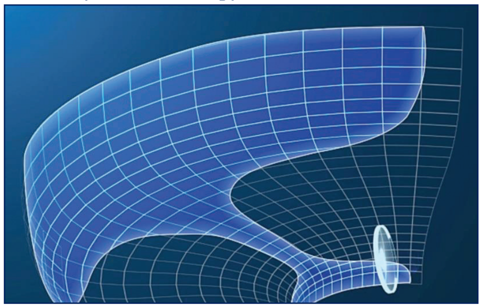
VARIABLE BASE CURVE BY CAMBER TECHNOLOGY

Camber Steady design works synergistically with the Camber variable base curve blank. This improvement of the front surface profile gives each viewing zone a base curve matched to its function. The width of undistorted near vision is a major improvement over single vision front free-form progressive designs.

PERSONALIZATION OF THE LENS BY DIGITAL RAY-PATH TECHNOLOGY

Ray–Path technology calculates the real lens position relative to the eye for all gaze angles (Fig. 7). Oblique astigmatism is compensated for every gaze direction using a complete eye-lens system simulation. The result is a unique lens completely compensated and personalized for each patient. Digital Ray-Path improves visual acuity in the lateral areas of the lens.

FIG. 7 Ray-Path Technology



INSET OPTIMIZATION

The position of the near area is calculated for each user according to the patient's individual parameters, allowing the wearer expanded binocular near vision.

VARIABLE MINIMUM FITTING HEIGHT

Camber Steady lenses are available in multiple corridor lengths adaptable to any pupil height. These lenses are available in minimum fitting heights from 14 to 18 mm in steps of 1 mm.

THICKNESS CONTROL

Optimization of the final diameter according to the real contour of the frame provides the thinnest possible lenses without affecting optics.

The Camber Family of progressive and office lens designs addresses the diverse visual demands of our modern lifestyles. Vision solutions should be as varied as our vision needs; after all, we don't live in a one-size-fits-all world.

In summary, conventional molded PALs successfully utilize optically correct variable front curves. However, they have other limitations that free-form technology has overcome. Combining the Camber optically correct variable curve front surface with the sophisticated computational analysis and design optimization software of the Camber Family of digital designs gives us the best lens form with the most advanced design and surfacing technology for the merging of complex curves. ■