Zeiss Individual® Single Vision:

Precisely Personalized Lenses, Now in Single Vision

By Darryl Meister, ABOM

Although the design of progressive lenses has advanced rapidly over the past few decades, little has been done to advance the state of the art in single vision lens design. Until now. The company that invented the first modern single vision lens designs has introduced a new innovation in single vision technology: Zeiss Individual® Single Vision. Like the highly successful Zeiss Individual progressive lens, Zeiss Individual Single Vision can be fully customized for each and every wearer through the use of real-time optical design enabled by free-form manufacturing.

Limitations of Traditional Single Vision Lenses

For over a century, lens designers have understood that the field of clear vision through a spectacle lens is limited by various optical aberrations, particularly *oblique astigmatism*. These optical aberrations result in unwanted sphere and cylinder power changes from the desired prescription away from the center of the lens, reducing the quality of peripheral vision for the wearer. For spherical prescription powers, it is possible to minimize these optical aberrations either through the proper choice of front (base) curve or through the use of an aspheric lens design.

In order to eliminate these optical aberrations completely, however, a unique base curve or aspheric lens design would have to be used for each spherical prescription power. Unfortunately, this represents an impractical requirement for cost control and inventory management. Consequently, traditional single vision lenses have been produced from lens blanks that are factory-molded with a limited number of front (*base*) curves, upon which relatively broad prescription ranges must be grouped (Figure 1). Moreover, for prescriptions with cylinder power, no base curve or aspheric design can eliminate the optical aberrations produced simultaneously by both the sphere power meridian and cylinder power meridian.

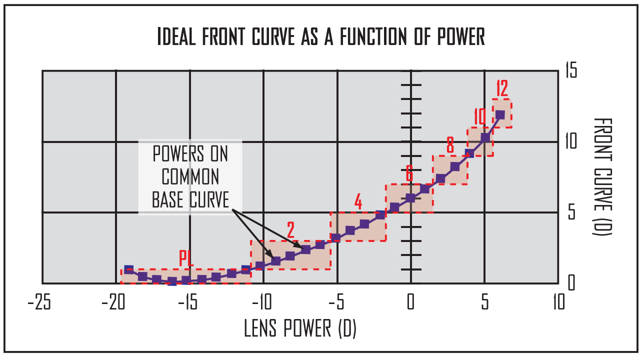


Figure 1. Each prescription power ideally requires a unique front (base) curve or aspheric design in order to eliminate optical aberrations, yet powers are generally grouped onto a limited number of base curves to minimize costs.

Additionally, the position of wear of the lens can also influence optics and vision quality. The position of wear represents the position of the fitted spectacle lens on the wearer, including the pantoscopic tilt, face-form wrap, and vertex distance. Tilting a lens also introduces oblique astigmatism, which results in unwanted cylinder power and changes to the sphere power (Figure 2).

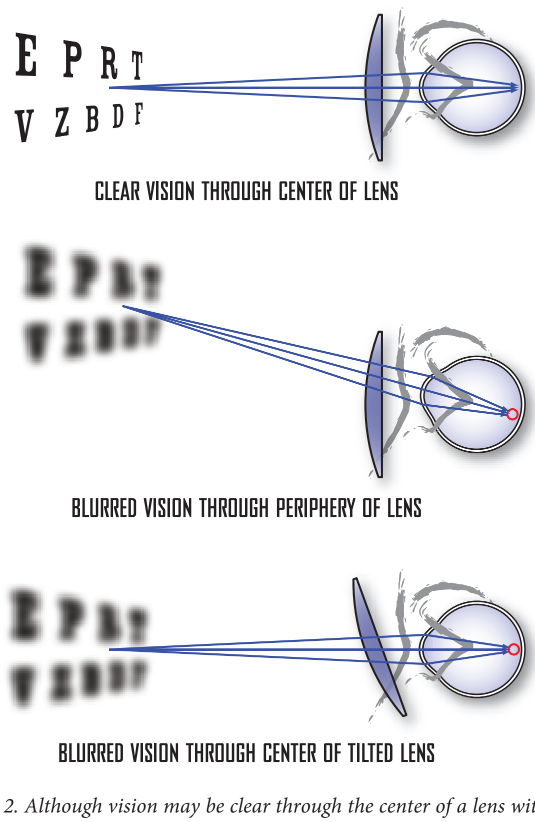


Figure 2. Although vision may be clear through the center of a lens with no tilt, vision is often blurred when viewing through the periphery of the lens or through the center of the lens when tilt has been added due to oblique astigmatism.

Fully Customized for the Wearer's Prescription

» Residual aberrations produce blur that restricts the field of clear vision

When the wearer looks obliquely through the peripheral regions of a spectacle lens, unwanted sphere and cylinder power errors from the desired prescription are introduced by oblique astigmatism and other aberrations. This results in errors from the desired focus of the lens. These unwanted power errors produce blur that degrades image quality and narrows the field of clear vision for the wearer (Figure 3). Lens aberrations can also cause the field of clear vision through the lenses to become distorted in shape, particularly in the presence of cylinder power, which impacts comfortable binocular vision and stereopsis.

With traditional single vision lenses, each base curve will typically deliver optimum optical performance only for sphere powers located near the center of the prescription range associated with that base curve (Figure 4). Other prescription powers will frequently suffer from residual aberrations in the periphery of the lens because of this optical compromise, which increase as the power deviates from the ideal prescription power.

Recall that a unique base curve of aspheric lens design is required in order to eliminate—or at least minimize—these aberrations in spectacle lenses with a spherical prescription power. Further, when the prescription contains cylinder power, no conventional base curve or aspheric design can eliminate the aberrations produced simultaneously by both the sphere *and* cylinder powers of the lens. Moreover, because prism effectively tilts the optical axis of the lens, prescribed prism also introduces oblique astigmatism.

The new Zeiss Individual® lenses are fully customized to the unique prescription requirements of each wearer. Every Zeiss Individual SV lens is optically optimized online by the ZEISS optical design engine using the wearer's exact prescription requirements.

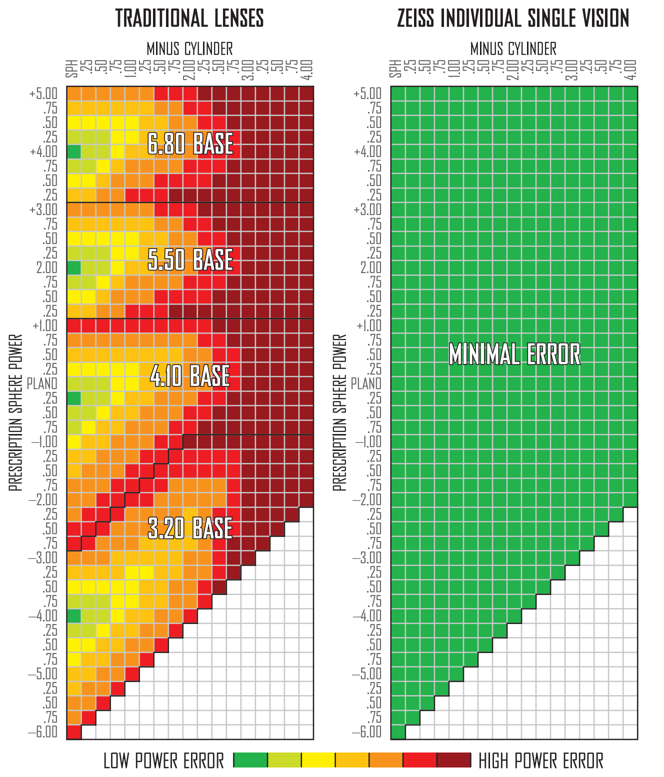


Figure 4. For many prescriptions, the field of clear vision may be significantly reduced and distorted in shape by uncorrected lens aberrations.

By fine-tuning the optical design of the lens for the exact prescription using a complex aspheric optical design, residual lens aberrations are virtually eliminated. As a result, Zeiss Individual lenses deliver up to 50% wider fields of clear vision compared to traditional lenses. Wearers will enjoy the widest fields of vision possible, regardless of prescription. Unwanted changes to the location and shape of the viewing zones are also eliminated, preserving the binocular utility of the lenses with wide, symmetrical fields of view (Figure 5).

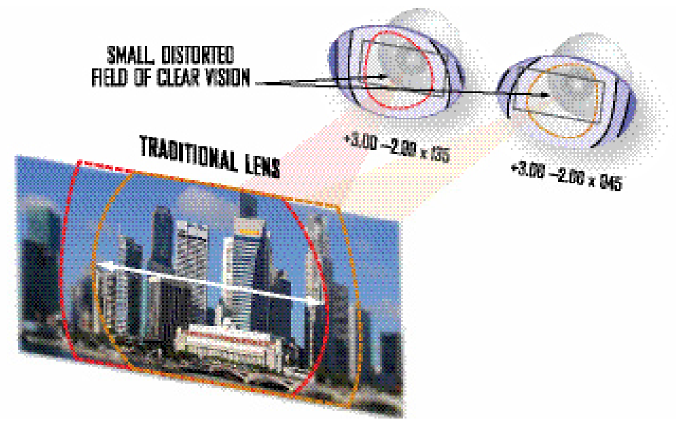


Figure 3. For many prescriptions, the field of clear vision may be significantly reduced and distorted in shape by uncorrected lens aberrations.

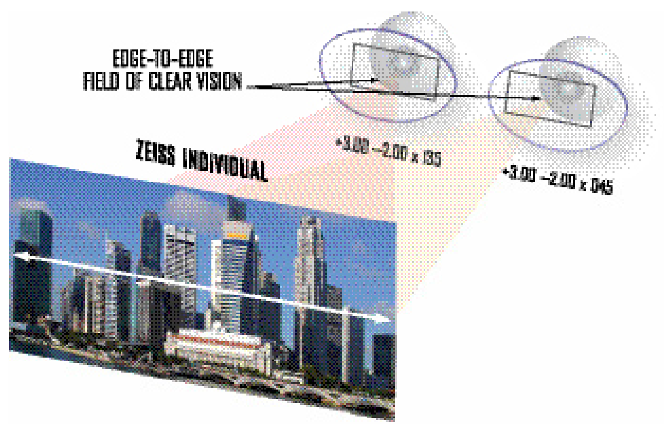


Figure 5. Zeiss Individual Single Vision is precisely customized for the wearer's exact prescription, which ensures wide, symmetrical fields of clear vision.

Fully Customized for the Wearer's Fitting Parameters

» The position of wear can have a significant impact upon optical performance

The *position of wear* is the position of the fitted lens relative to the actual wearer, including the pantoscopic tilt, face-form wrap, and vertex distance of the mounted lens. Spectacle prescriptions are typically determined using refractor-head or trial-frame lenses that are positioned perpendicular to the lines of sight. Unlike the lenses used during the ocular refraction procedure, however, eyeglass frames generally place the spectacle lenses at an angle with respect to the lines of sight once fitted to the wearer's face.

Unfortunately, tilting a lens introduces oblique astigmatism, which results in unwanted sphere and cylinder power changes across the lens that are proportional both to the power of the lens and to the magnitude of lens tilt. The position of wear can have a significant impact upon the optical performance of spectacle lenses, particularly upon the quality of straight-ahead vision (Figure 6). During the online optical design process used for Zeiss Individual Single Vision, however, the position of wear of the fitted lens is modeled using ray tracing in order to apply the necessary optical corrections across the lens surface.

If the wearer's pantoscopic tilt, face-form wrap, and vertex distance are supplied, the optics of each Zeiss Individual Single Vision lens design will be precisely customized by the ZEISS optical design engine for this exact position of wear (Figure 7). Wearers will therefore enjoy the best optical performance possible with Zeiss Individual SV lenses, regardless of their unique fitting requirements (Figure 8).

» The unwanted sphere (*Sph*) and cylinder (*Cyl*) powers introduced by tilting a thin sphere lens (*Power*) are given by:

$$Sph = Power\left(\frac{1 + \sin^2\theta}{2 \times n}\right)$$

$$Cyl = Sph \times \tan^2\theta$$

where n is the refractive index and θ is the tilt

Traditional spectacle lenses are often designed to exhibit the specified optical performance only when measured using a conventional *focimeter*, such as a lensometer. Because Zeiss Individual SV is designed to provide the *wearer* with the prescribed optical performance once the lens in the actual position of wear, small differences from the original prescription are required at the verification point of the lens. These power adjustments are supplied as a *compensated prescription*, which represents the correct lens powers to verify with focimeters in order to provide the actual wearer with the specified prescription.

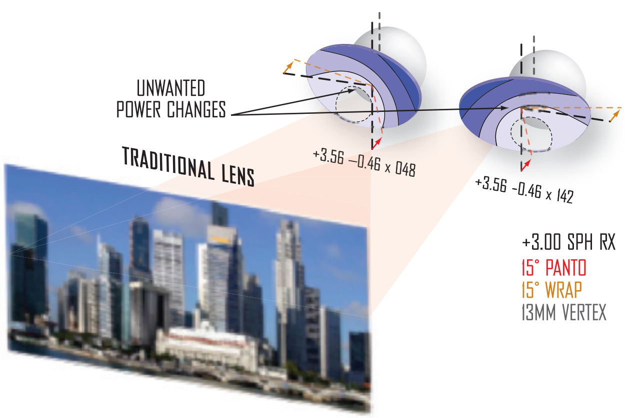


Figure 6. Vision may be significantly degraded by the position of the fitted lens on the eyeglass wearer.

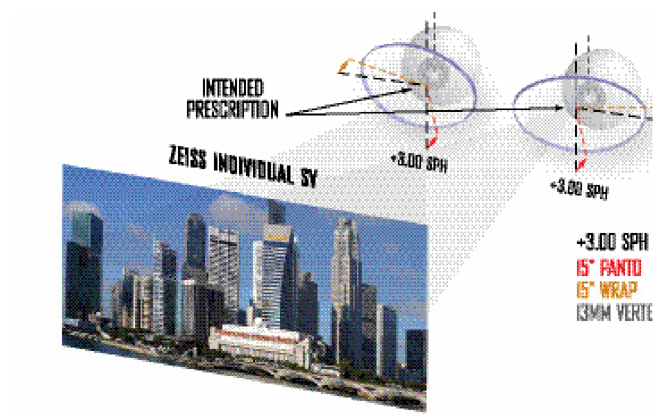
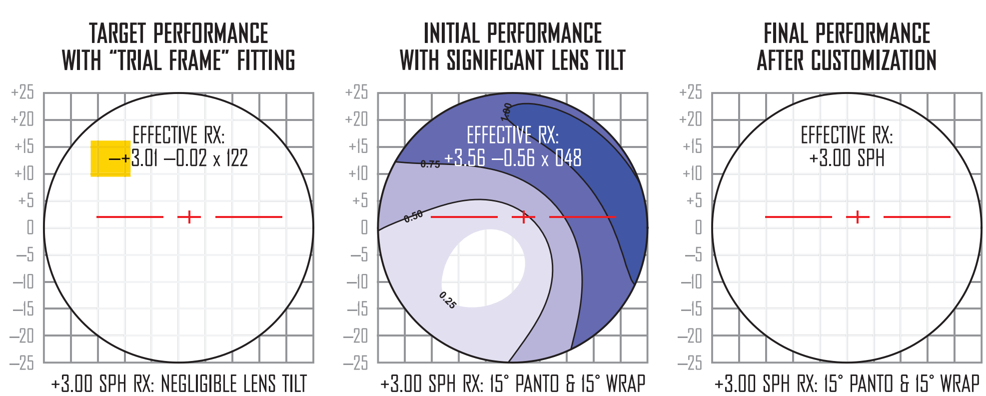


Figure 8. Zeiss Individual Single Vision is precisely customized for the wearer's exact fitting parameters, which ensures clear straight-ahead vision.

Figure 7. Ray-traced optical astigmatism comparison: Because each Zeiss Individual Single Vision lens is designed in real time, the optics of the lens design can also be precisely tailored to the exact fitting requirements of the wearer, ensuring that every lens performs exactly as intended, with no unwanted prescription changes that could otherwise degrade vision quality through the central viewing zones.



Edge-to-Edge Clarity Combined with Precision Fabrication

Until recently, the real-time optical design benefits afforded by "free-form" or "digital surfacing" technology were limited to progressive lenses. While presbyopes could enjoy the clearest, most comfortable vision possible, pre-presbyopes wearing single vision lenses were left to tolerate the inherent optical compromises of traditional, semi-finished lenses. Consequently, single vision lens wearers often endured reduced fields of clear vision or a reduction in visual acuity through the center of the lens.

In fact, because of optical aberrations introduced by the tilt and peripheral optical performance of the lens, the visual acuity of the wearer may be reduced from 20/20 to 20/40 or even worse. In addition to losing up to three or more lines of visual acuity on a Snellen chart, the wearer's appreciation of contrast is also greatly reduced, causing colors to lose sharpness and definition.

Zeiss Individual® SV lenses rely on an extremely sophisticated optical optimization process to refine points across the entire back surface, allowing the use of a thinner, flatter lens profile. The result of this optimization process is a complex "asphERIZATION" of the initial lens design (Figure 9). Wearers will experience the clearest optics possible in a lens that is flatter, thinner, and more attractive-looking than conventional lens designs that rely on steeper, spherical base curves to provide acceptable optical performance.

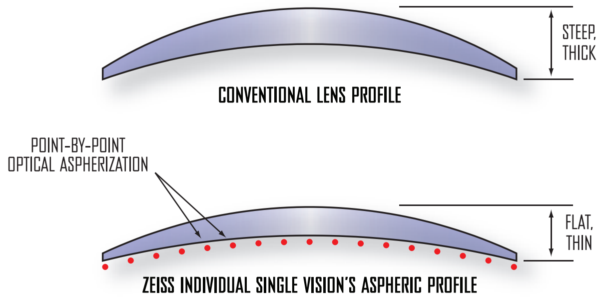


Figure 9. Zeiss Individual Single Vision employs point-by-point optical aspherization to deliver exceptional optical performance in a flat, slim lens.

Further, only Zeiss Individual and Zeiss Individual Single Vision are produced using Precise-Form™ by ZEISS, a proprietary technology that integrates extensive process engineering and quality control with back-side lens design technology. As with Zeiss Individual, each Zeiss Individual Single Vision lens is uniquely designed for the individual wearer using the exclusive ZEISS optical design engine once the lenses have been ordered from the laboratory.

Using parameters supplied by the eye care professional, including the wearer's prescription and fitting geometry, this powerful optical design engine performs complex calculations online in "real time" only after the lenses have been ordered.

- » Meticulous production
- » Back-side optics
- » Real-time optimization
- » Point-by-point control
- » Edge-to-edge clarity
- » Precise, natural vision

Precise-Form technology requires on meticulous process engineering and ongoing quality control. Because "free-form" or "digital" surfacing relies on the use of flexible lap tools, which may distort the lens surface if not carefully controlled, failure to ensure the production quality of a free-form surfacing process on a regular basis can lead to inferior optical quality even compared to traditional lens production methods. Free-form lenses from Carl Zeiss Vision, however, must meet stringent quality guidelines and optical design specifications using some of the most sophisticated equipment available (Figure 10). This ensures that every lens delivers the precise optical powers that the wearer requires.

Additionally, unlike traditional lenses, which seldom equal the prescribed power exactly due to limitations in the number of molds or surfacing tools, Zeiss Individual lenses are precisely surfaced to the exact prescription powers provided by the eye care professional in increments of 0.01 diopters. The final product of this extensive optical customization and precision fabrication are progressive and single vision lenses that have been precisely personalized to offer the best vision quality possible. **With Zeiss Individual lenses, both progressive and single vision, all of your patients can now enjoy up to 50% wider fields of clear vision as well as sharper, more natural straight-ahead vision.**

Figure 10. Engineers at Carl Zeiss Vision, a world leader in free-form lens production, rely on sophisticated tools to ensure superior quality and optics.

Carl Zeiss Vision
USA 1-800-358-8250
CAN 1-800-268-6489
www.vision.zeiss.com

000-0139-15630 03/10