Optical Connection, Inc. and Ophthonix, Inc.

Partners in the delivery of non-surgical vision optimization

www.opticonnection.com
www.ophthonix.com
The human eye has optical imperfections that can not be measured by conventional means, and are not correctable with today's lenses!

- Current examination technology leaves up to 20% of refractive error unmeasured.
- To optimize vision, we need to correct 100% of refractive error, including higher order aberrations.
Wavefront Technology

- Thorough analysis of the optics of the visual system – from cornea to retina.
- Low order aberrations of sphere and cylinder
- Unique combination of low and high order aberrations in each individual
- The goal: to produce an individually customized refractive correction
Optical Aberrations

- Low order aberrations
  - Tilt (prism)
  - Defocus (sphere)
  - Astigmatism (cylinder)
- High order aberrations
  - Spherical
  - Coma
  - Trefoil
  - Secondary Astigmatism
High order aberrations

- Irregular astigmatism: A complex shape that, due to its asymmetry, cannot be measured using conventional refractive methods

- The only option for correcting “irregular astigmatism” has been an RGP
Refractive correction

Today we correct a rotationally asymmetric eye with a perfectly symmetric contact or spectacle lens

Result: Up to 20% of refractive error may be left uncorrected
Subjects With High-Order Aberrations

Emmetropes: N = 47 eyes
- Amount of high-order aberrations:
  - >0.3 microns: 23%
  - 0.2 - 0.3 microns: 9%
  - 0.1 - 0.2 microns: 42%
  - <0.1 microns: 26%

Myopes: N = 26 eyes
- Amount of high-order aberrations:
  - 0.5-1.0 microns: 4%
  - 0.3-0.5 microns: 4%
  - 0.2 - 0.3 microns: 19%
  - 0.1 - 0.2 microns: 42%
  - <0.1 microns: 31%
Signs of non-optimized (normal) vision

- Double images
- Low contrast, lack of crispness
- Reduced color sensitivity
- Glare sensitivity
- Night driving problems
- “Halos,” “star burst patterns,” “comet’s tails” around lights at night
- Compromised far and near vision
Human Eye...An Imperfect Instrument

Many localized aberrations

“Optical fingerprint”
The Wavefront Solution

- A more precise, objective vision examination
  - The Ophthonix Z-View™ Aberrometer

- A fundamentally new form of refractive correction:
  - The individually customized iZon™ and iZon by Definition™ Contact Lens
    - Wavefront-guided
    - Fully customized
    - Fully optimized
Vision Examination

Today

Subjective, manual, discrete steps, 15 minutes

Ophthonix Z-View™

Objective, accurate results. Measures low and high order aberrations in one minute
The Z-View aberrometer creates a customized match for the “optical fingerprint” of the eye.

**Result:** 100% Refractive Error Measured

<table>
<thead>
<tr>
<th>Current Lenses</th>
<th>Ophthonix iZon™ Lens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphere</td>
<td>Perfect Match</td>
</tr>
<tr>
<td>Cylinder</td>
<td></td>
</tr>
</tbody>
</table>
Z-View™ Aberrometer Features

- Proprietary wavefront technology
- 11,300 points over 6mm pupil
- Pupil diameter measurement
- Pupillary distance measurement
- Designed for ease of use
- Binocular viewing
- Through-the-lens
- Internal fixation
- Internal reading target
- High correlation with manifest refraction ($R^2=0.988$)
- Efficient (Less than one minute)
iZon™ by Definition™
Wavefront-guided contact lens

A new category of contact lens correction
iZon™ by Definition™

- New contact lens that can be individualized to nanometer level of optical path difference (OPD)
- Can correct sphere and cylinder to 0.01D
- Is customized to individual on-eye lens movement and centration characteristics
- Corrects low and high order aberrations and distortions, including those aberrations induced by the lens itself
The ultimate custom contact lens

- Each eye is individually measured
- Each lens is individually designed and manufactured
- Each prescription is treated the same: sphere, toric, keratoconus, post-LASIK
The ultimate custom contact lens

- WaveTouch™ manufacturing assures absolute reproducibility
- Manufacturing process allows great flexibility in polymer selection and lens fit characteristics
On-eye lens stability requirement
Simulated Optical Performance of Custom Wavefront Soft Contact Lenses for Keratoconus


de Brabander, Chateau, Marin, Lopez-Gil,
van der Worp, Benito
On-eye lens stability

- Translation (movement and centration) should not exceed 0.5mm
- Rotation should not exceed +/- 10 deg
- Any of today’s **soft torics** meet these criteria

  de Brabander, et. al.
Soft lenses will work?!  

A wavefront contact lens must be well centered, stable and provide little movement. Soft lenses meet those criteria.
The Wavefront Process
**Wavefront Process**

**Step 1**
Wavefront Data Acquisition

Wavefront over refraction through trial lens

**Step 2**
Wavefront Contact Lens Production

Conversion of wavefront data into production code

**Step 3**
Wavefront Contact Lens Delivery

Direct delivery of custom lens – no inventory required

*WavefrontProcess™* Pat. Pending (Serial#60/407,316)
Step 1: Wavefront Data Acquisition

A “predicate” trial lens is placed on the eye; wavefront analysis is performed through the predicate lens.
Good Measurement! Press Rx to view / print.
Good Measurement, press advance to next eye button.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphere</td>
<td>0.62</td>
</tr>
<tr>
<td>Cylinder</td>
<td>-0.62</td>
</tr>
<tr>
<td>Axis</td>
<td>78</td>
</tr>
<tr>
<td>Pupil Size</td>
<td>5.14</td>
</tr>
<tr>
<td></td>
<td>O.D.</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td></td>
<td>ZView Rx</td>
</tr>
<tr>
<td>Sphere</td>
<td>-0.87 D</td>
</tr>
<tr>
<td>Cylinder</td>
<td>-1.25 D</td>
</tr>
<tr>
<td>Axis</td>
<td>160 Deg</td>
</tr>
<tr>
<td>Pupil Dia., Zernike Dia.</td>
<td>6.1 mm, 4.0 mm</td>
</tr>
<tr>
<td>Total High-Order</td>
<td>0.41 D</td>
</tr>
<tr>
<td>Trefoil</td>
<td>0.14 D</td>
</tr>
<tr>
<td>Coma</td>
<td>0.15 D</td>
</tr>
<tr>
<td>Spherical Aberration</td>
<td>0.25 D</td>
</tr>
<tr>
<td>Pupil Distance</td>
<td>35.3 mm</td>
</tr>
</tbody>
</table>
Wavefront Data Acquisition ~ continue

View of an eye with a predicate lens on
Wavefront Data Acquisition ~continue

Alignment of the axis and CL center with the markings

The lens position data acquired
Wavefront data (purely individual CL Rx in a form of Zernike coefficients) along with the lens positioning data are transmitted to the production lab.
The Wavefront contact lens prescription is more than a collection of Zernike Coefficients; it also includes patient-specific lens positioning data. The complete lens design is a file over 130 pages long!
Wavefront Contact Lens Production
~continue

Semi-mold production

The WaveTouch Process is performed on a blank identical to the predicate lens.
Step 3: Wavefront Contact Lens Delivery

- Custom Wavefront Contact Lenses are shipped to the ECP
- Fitting confirmation and payment
- Annual supply shipped directly to the patient

* Direct delivery of custom lens eliminates lens inventory at ECPs
Patient Benefits From iZon™ by Definition Lenses

- Fully optimized, high definition vision
- Provides refractive correction near the physiological limits of the human eye – 20/10 or better
- Significantly improved
  - visual acuity
  - low contrast visual acuity
  - contrast sensitivity
  - night vision, reduced glare
Target patient population?

- Regular Astigmatism
- Irregular astigmatism
- Surgical corneal irregularities (PK)
- Keratoconus
iZon™ Lens Product Family

- Continuous stream of product innovation
  - Premium iZon™ Wavefront-Guided Single Vision Spectacles (Q4 ’04)
  - iZon™ by Definition Wavefront-Guided Contact Lenses by Definition™ (Q1 ’05)
  - iZon™ Wavefront-Guided Progressive Addition Lens (Q4 ’05)
Thank you…