



Parallax shift on Progressive Lenses ----- with Concave Engravings -----

Overview:

Many operations in the optical lab require the exact positioning of features on the Progressive Lens Surface in order to determine proper measurement points (PRP, DRP, NRP), engraving positions, ink markings, finish blocking placement, frame alignment, etc.

The positioning of those features is determined by their relation to the permanent reference markings located along the horizontal axis, 34 mm apart. The Prism Reference Point (PRP) is located on the 3D convex surface of the lens along the same axis as the permanent reference marks, half way between them. The origin of the prescription axes is located at the PRP.

Hereafter one finds a more precise definition in use for classical progressive addition lenses to define the position of every measurement point:

“The PRP is a point which belongs to the convex surface and that is viewed at the center of the two engravings by an observer looking at the convex surface of the lens, positioned at an infinite distance from the lens and with its viewing axis perpendicular to the convex surface at PRP. It results that whatever the position and inclination of the lens in the system; the defined PRP is always located exactly at the same point of the surface.

This PRP is the origin of the coordinate system. The Z-axis is the external unit vector normal to the front surface at the PRP.

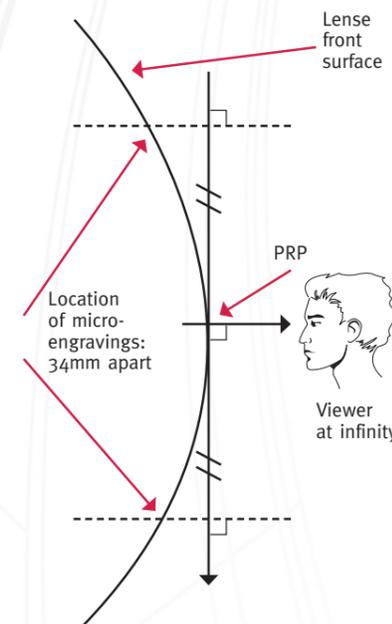
The X-axis is the unit vector supporting the line which is the intersection of the tangent plane at the PRP and the plane ω passing through the two engravings and including the normal vector at the PRP.

The AXIS quantity follows the TABO convention which = 0 for the X-axis direction.

The Y-axis is computed from the two last vectors.”

Regarding the case of concave engravings, one simple definition according to the engravings is not considered by many manufacturers. One key factor that has often been overlooked when permanent reference markings for progressive lenses are engraved on the concave side of the lens is the effect of parallax shift.

Parallax Shift Classic PRP:



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After receiving his PhD in the fields of Instrumentation and Measurement at the University of Liege in Belgium, Dr. Christian Laurent has been focusing on the conception and development of various proprietary inspection and accurate measurement devices based on optics and artificial vision. Dr. Laurent is has been director of research and development for automation and robotics at A&R since 1988.

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Comment regarding parallax effect or parallax shift:

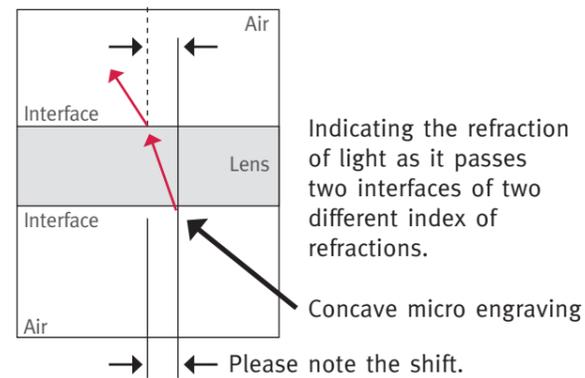
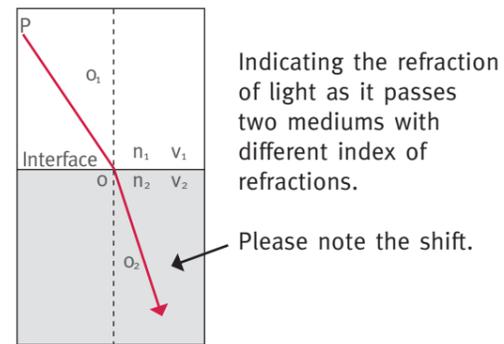
Parallax effect influences the apparent relative position of where objects appear according to the observer position. So in the case of progressive lenses, parallax effect exists when one considers an observer checking the relative position of the Prism Reference Point (PRP) and the two micro engraved fitting marks on the convex surface. This is because the PRP and the two marks are not located in the same plane (cx surface = 3D shape).

That is why the observer position must be defined at infinity, on the normal to the convex surface at the PRP.

The situation inducing parallax in case of concave engravings is more complex. Refraction through the lens leads to additional shifts; the distance between the PRP and the line between the engravings is higher and has more impact on the apparent location of the micro engravings based upon the observer's position.

Due to the more complex light travel and the higher distance between the PRP and the line between the engravings, the effects are higher and the situation with concave engravings is much more critical

Parallax Shift Snell's Law



Problem:

Regarding the definition to be used in case of concave engravings, the situation is not always clear.

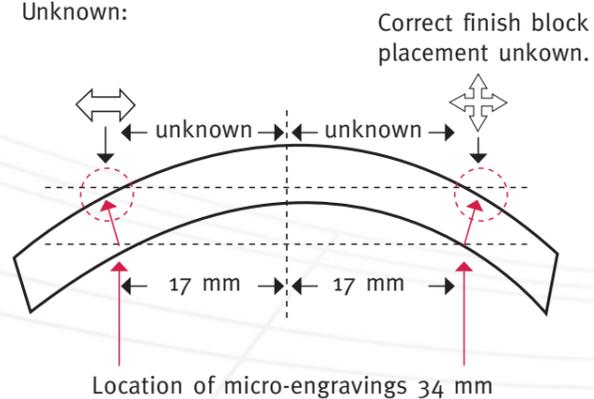
The concave engravings are often viewed through the lens from convex side, inducing a parallax effect shift due to refraction. The permanent reference marks appear to be in a different location than they really are, resulting in an error. The amount of the error depends on the observer position (distance and viewing direction), the characteristics of the lens design and prescription, including prism.

The optician is accustomed to use references defined from the convex side of the lens. The lens is pad printed on the convex side and centered in the frame using the finishing block positioned on the convex surface. But in the case of concave engravings, although the processes are similar to those for convex engravings, the reference marks appear to be shifted and actually cannot be defined.

Like spearing for fish the image of the fish is not where the fish is actually located in the water. This is a parallax shift.

Parallax Shift

Free-form PRP:
Unknown:



Summary:

In the case of progressive lenses marked on the concave surface, the PRP on the front surface is undefined because the permanent reference marks when viewed through the lens cannot be defined, but the optician must use this point to serve as the reference location for finish block placement and fitting marks when the frame is positioned on the patient's face.

Three Suggestions:

1. In order to position the PRP on the convex surface, the same rule can be applied as for the convex engravings, checking the engravings through the lens from an infinite distance from the lens and with the viewing axis perpendicular to the convex surface at PRP (located on the convex surface). In this configuration, the PRP is assumed to be viewed at the center of the two engravings. Any inaccuracy in the viewing conditions during the positioning operations will lead to much higher parallax effects in case of concave engravings.
2. Or the coordinates of the PRP and reference axes orientation according to the engravings positions are provided with the lens file by the lens designer. Any inaccuracy in the viewing conditions during the positioning operations will lead to much higher parallax effects in case of concave engravings.
3. Or the permanent reference marks for progressive lenses should be applied on the convex (front) surface of the lens, rather than the concave surface.

Applying the rule defining the exact set-up or position of the observer is much more critical with concave engravings than with convex engravings.