Hoyalux iD Lifestyle design

In the first of two articles, **Professor Mo Jalie** discusses the development and structure of a new integrated bi-atoric progressive lens

A new integrated double surface progressive power lens was launched at Opti München 2007 in January. While retaining the design improvements of the Hoyalux iD design, its structure offers speedier processing and delivery of the lens to practitioners. Blanks are used with a predetermined, free-form, convex surface incorporating the vertical progressive component and a unique free-form atoroidal surface incorporating the horizontal progressive component is then worked on the back.

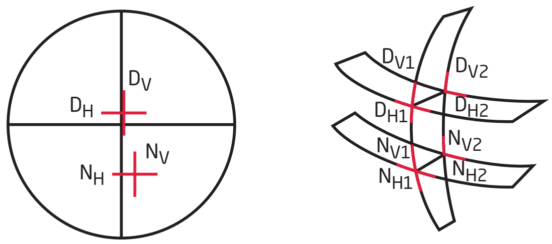

Figure 1 The principal meridians of the bi-toroidal convex and concave progressive surfaces of the Hoyalux iD design. Note that, when the lens thickness is neglected:
$D_V = D_{V1} + D_{V2}$
$N_V = N_{V1} + N_{V2}$
$D_H = D_{H1} + D_{H2}$
$N_H = N_{H1} + N_{H2}$

The background

The first, commercially successful, glass progressive power lens, Varilux 1 was made with the progressive surface on the front. Although the first plastics version of Varilux, the Variplas design, introduced in 1965, had a concave progressive surface (due to the ability to mould these from a convex progressive mould), the progressive surface was to be incorporated on the convex side of the lens for the next 30 years. The distribution chain then followed that of most other lens designs where the final lens power was obtained by working a spherical or toroidal surface on the concave side of the lens.

The modern back surface progressive lens did not appear until 1998 when Seiko introduced its design with the progressive surface incorporated on the concave side of the lens. The original Seiko concave surface progressive lens was produced initially only for minus prescriptions with a shallow base spherical convex side and a back surface which incorporated both the progressive power and any correction for astigmatism.

This lens was also the first of the modern generation to employ an atoroidal progressive surface. The manufacturing process for this design was revolutionary. Seiko could not start to manufacture the progressive surface until the full specification for the final lens was received and since all manufacturing took place in Japan, modern communication and distribution methods had to be employed to ensure rapid delivery of the finished uncuts from Japan to their final destination.

The surfacing method has become known as free-form surfacing. A computer numerical control (CNC) generator fed with thousands of data points which define the surface, produces a very finely ground surface of exactly the required shape and of such a finish that it is immediately ready for polishing, either by floating pads or, now, by CNC methods.

In 2000, Rodenstock and Zeiss introduced progressive power lens designs which were produced by free-form surfacing methods. The Rodenstock, Impression design also transferred the progressive surface to the concave side of the lens incorporating any cylindrical correction in an atoroidal progressive surface.

Today, all the major lens manufacturers offer free-form designs which can be personalised in one way or another. Essilor's flagship designs, for example the Ipseo and Physio designs are also made using the latest free-form technology, although Essilor refers to the production method as 'Digital Surfacing'.

In 2003, Johnson & Johnson launched a new progressive power spectacle lens in the US, the Definity design. This was the first progressive lens to share its near addition between both

TABLE 1
Different forms of progressive lens structure for the power 0.00 Add +3.00

	D_{V1}	D_{H1}	N_{V1}	N_{H1}	D_{V2}	D_{H2}	N_{V2}	N_{H2}
CV surface progressive	+4.00	+4.00	+7.00	+7.00	-4.00	-4.00	-4.00	-4.00
CC surface progressive	+5.50	+5.50	+5.50	+5.50	-5.50	-5.50	-2.50	-2.50
Double side progressive	+4.75	+4.75	+6.25	+6.25	-4.75	-4.75	-3.25	-3.25
Example 1	+4.75	+4.75	+7.75	+4.75	-4.75	-4.75	-4.75	-1.75
Example 2	+5.50	+4.00	+8.50	+4.00	-5.50	-4.00	-5.50	-1.00

D_{V1} = DP curve in vertical meridian on convex side of lens
D_{H1} = DP curve in horizontal meridian on convex side of lens
N_{V1} = RP curve in vertical meridian on convex side of lens
N_{H1} = RP curve in horizontal meridian on convex side of lens
D_{V2} = DP curve in vertical meridian on concave side of lens
D_{H2} = DP curve in horizontal meridian on concave side of lens
N_{V2} = RP curve in vertical meridian on concave side of lens
N_{H2} = RP curve in horizontal meridian on concave side of lens

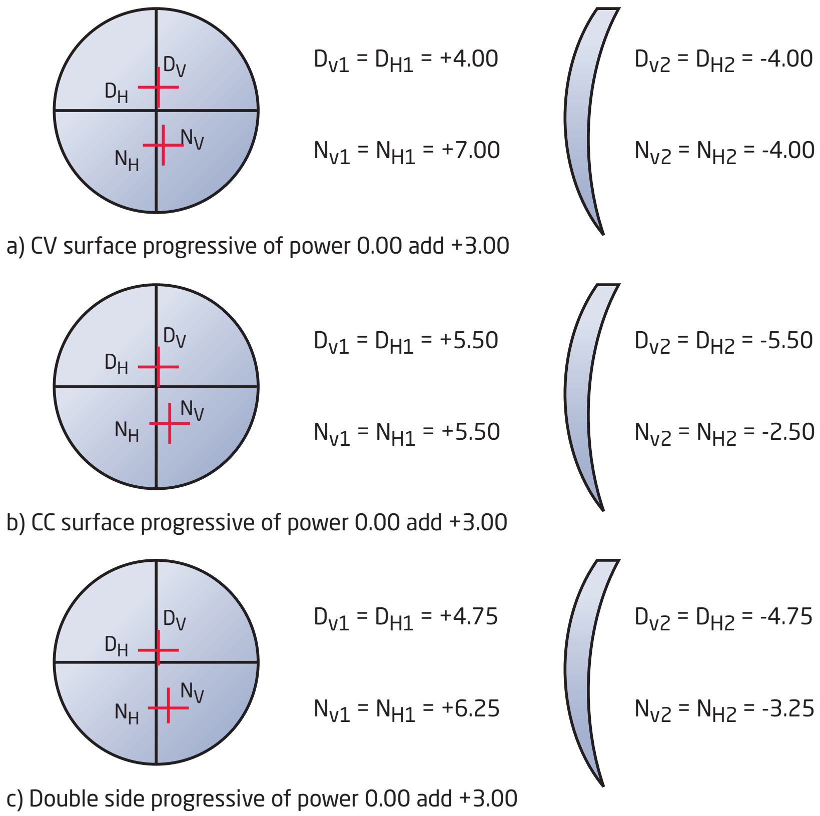

Figure 2 Comparison of convex, concave and double surface progressive lens designs for power 0.00 Add +3.00

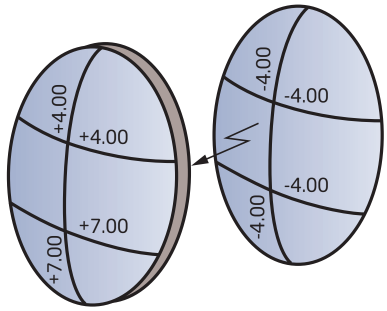

Figure 3 Surface powers of a convex surface progressive design for power 0.00 Add +3.00

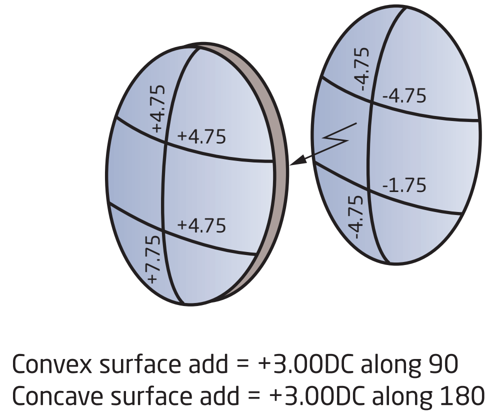

Figure 4 Surface powers for the progressive design, Example 1 (Table 1) for power 0.00 Add +3.00

its surfaces. Described as a 'Dual Add' design, an addition of +2.00 DS for near is provided by incorporating +1.25 DS on the convex surface and +0.75 D on the concave surface.

Johnson & Johnson argued that by sharing the addition between the two surfaces they can produce a lens that has less combined aberration than a similar power lens with all its addition on just one surface. The Definity design was bought by Essilor in 2005 and is currently available in the US under the same brand name. The Hoyalux iD design, which was launched in Europe in 2004, also shares the near addition between its two surfaces but in a completely different way.

Structure of the original Hoyalux iD lens

Described as an integrated double surface design, the original Hoyalux iD design was bi-toric in construction with aspherical and atoroidal surfaces incorporating different progressive components on each side of the lens. The front surface of the lens incorporates the progressive component that gives rise to a vertical change in power and the progressive component that gives rise to the horizontal change in power is incorporated on the concave surface of the lens. A comparison of the difference in its structure from other progressive designs can be seen in Table 1 which has been adapted from Figure 7 of the original US patent[1] granted to the Hoyalux iD lens.

The first three lens forms described are examples of prior art progressive lens designs. The CV (convex) surface progressive is typical of a progressive lens where the progressive power is worked on the convex surface of the design (for example, the Varilux Comfort lens). The CC (concave) surface progressive is typical of a progressive lens where the progressive power is worked on the concave surface of the design (for example, the Seiko Epson P-1SY lens).

The double side progressive is typical of a progressive lens where the progressive power is shared by both surfaces and probably refers to the Definity design. Examples 1 and 2 relate to the Hoyalux iD lens. Figure 1 illustrates the various meridians, D_{V1}, D_{H1}, N_{V1}, N_{H1} and so on.

D is used to denote surface powers relating to the distance portion and N to surface powers relating to the near portion. The progression zone lies between D and N. The suffices V and H relate to the 90 and 180 meridians of the surface, and 1 and 2 to the convex and concave surfaces respectively. So N_{H2}, for example, represents the reading portion curve along the horizontal meridian on the concave surface of the lens.

For illustration purposes it is assumed that the total power of the lens along the vertical meridian of the distance portion, D_V is equal to the sum of the surface contributions, $D_{V1} + D_{V2}$. Naturally, in practice, one or both of these curves would need to be compensated for the lens thickness.

The differences in the structure of the prior art lens designs described in Table 1 are shown in Figure 2.

Figure 2 (a) illustrates one of the many progressive designs where the progression is worked on the convex surface of the lens, the lens having the prescription, 0.00 Add +3.00. The power of the lens is found simply by adding the vertical and horizontal surface power ▶

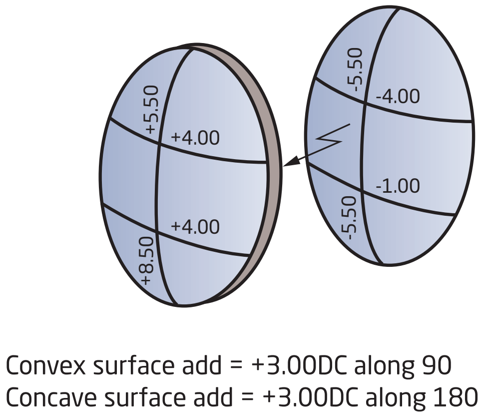

Figure 5 Surface powers for the progressive design, Example 2 (Table 1) for power 0.00 Add +3.00

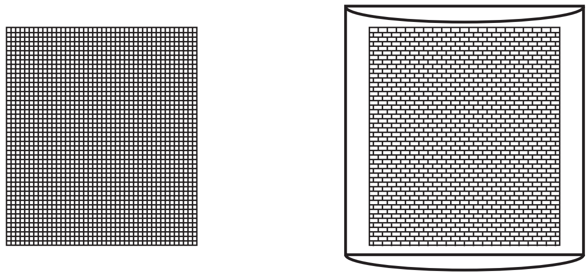

Figure 6 Meridional magnification by a plano-cylinder axis 90. This element can be considered to represent the horizontal progressive power component

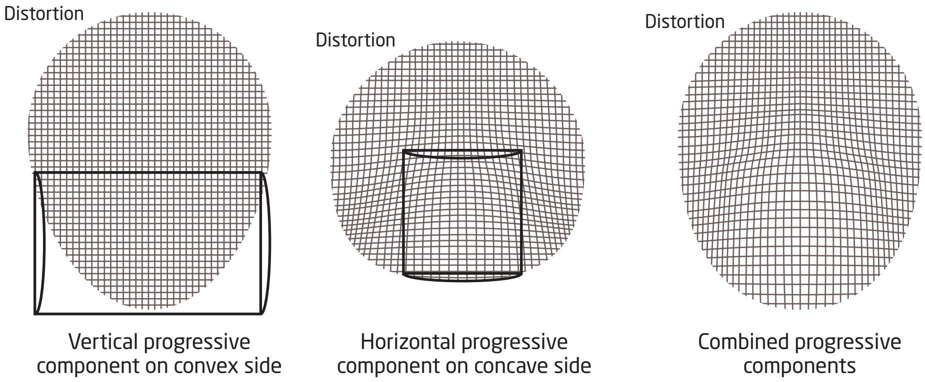

Figure 7 The vertical and horizontal progressive power components combine to produce the progression zone and near portion

contributions together.

Figure 2 (b) illustrates a progressive design of the same prescription, 0.00 Add +3.00, where the progression is worked on the concave surface of the lens. Figure 2 (c) illustrates a double-sided progressive lens made to the same prescription, where +1.50 D of addition is provided on the convex surface of the lens and +1.50 D on the concave surface.

Figure 3 illustrates the surface powers for the design depicted in Figure 2 (a) and this type of diagram is probably the easiest way to demonstrate how the addition is achieved and is employed in subsequent diagrams to illustrate the lens structure. Note that in Figure 3, for the purpose of illustration, the concave surface of the lens has been 'removed' from its actual position on the back of the lens.

Figure 4 illustrates the surface powers for the lens described as Example 1 in Table 1 and demonstrates the integrated bi-toric nature of the Hoyalux iD family of progressive lenses. It can be seen that the convex surface of the lens contributes an addition of +3.00DC x 180, which provides the vertical progressive component of the addition.

The concave surface of the lens contributes an addition of +3.00DC x 90, which provides the horizontal progressive component of the addition. Needless to say, the two cylindrical components, +3.00DC x 180/+3.00DC x 90 sum to +3.00D sphere.

In order to ensure that the vertical progressive component is situated on the front surface of the lens, the patent gives the conditions that:

$$(D_{H1} + N_{H1}) < (D_{V1} + N_{V1}) \text{ and } N_{H1} < N_{V1}$$

Inspection of the curves in Table 1 shows that this is the case since in the case of Example 1:

$$(+4.75 + +4.75) < (+4.75 + +7.75)$$
$$\text{and } +4.75 < +7.75$$

Inspection of Example 2 shows that these criteria are also met for this Hoyalux iD design given in the Table. The patent also stipulates the conditions that:

$$(N_{V1} - D_{V1}) > \text{Add}/2$$
$$\text{and } (N_{H1} - D_{H1}) < \text{Add}/2 \text{ are satisfied}$$

Again, in the case of Example 1:

$$(+7.75 - +4.75) > +1.50 \text{ and}$$
$$(+4.75 - +4.75) < +1.50$$

Inspection of Example 2 confirms that these conditions are also satisfied for this case.

Figure 5 illustrates the surface powers for Example 2 in the table. With this design, the distance portion is also seen to be bi-toric in nature.

A simple simulation of how these distributions of surface power result in a spherical addition for near is obtained by considering the magnification effects of two plano cylinders that have been combined at right angles to one another.

Figure 6 illustrates a target in the form of graph paper, which is viewed through a plano-convex cylinder with its axis vertical. Since the cylinder has power only at right angles to its axis, the squares are magnified in the horizontal meridian only and when viewed through the cylinder, appear as horizontal rectangles.

In Figure 7a, the target is shown with a plano-convex cylinder placed with its axis horizontal over the progression area to represent the vertical progression components, while in Figure 7b the plano-convex cylinder has been placed with its axis vertical over the progression area to represent the horizontal progression components.

The result is shown in Figure 7c; the magnifications combine to produce images which are the same shape as the object over most of the central field.

The next article in this series will describe the detailed structure of the lens and describe some aspects of its performance.

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