KODAK Unique Infinite Lens

Technical Report

KODAK Lens

Introduction

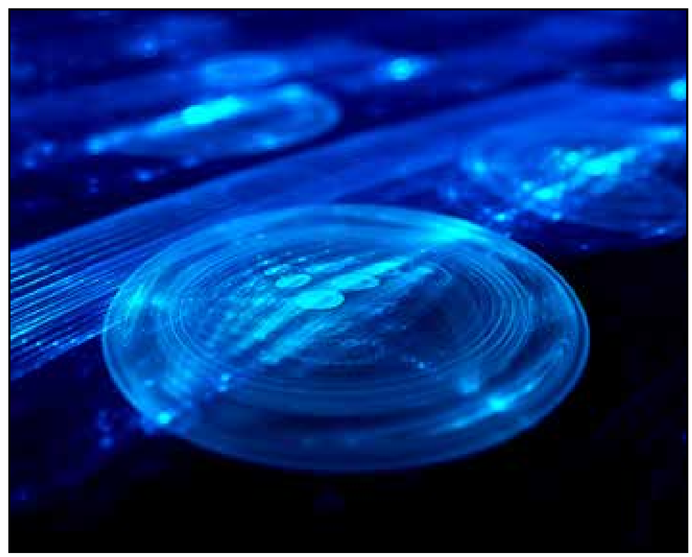
KODAK Lenses are a well-established range of unique designs and technologically-advanced lens coatings and materials. The premium range of the KODAK Unique Progressive Lens design has continually improved over the past 10 years.

Lens engineers were challenged to conduct a holistic review of the existing design and introduce new technology that would enhance the patient's wearing experience, improve the intermediate viewing zone and not compromise on any other aspect of the current design.

The result is KODAK Unique Infinite™ Lens which introduces Vision First Infinite™ and Dynamic Viewing Stabilization™ (DVS).

This Technical Report delves into the intricacies of the pioneering technologies that underpin the lens design. It further unveils an extensive analysis encompassing both theoretical assessments through surface and wavefront analysis.

KODAK Unique Infinite Lens utilizes two ground-breaking technologies to redefine progressive design. Building upon the popular KODAK Unique DRO® Lens, KODAK Unique Infinite Lens offers patients an improved performance in the visual fields without compromising on any aspect of the progressive design and enhances patient comfort through reducing an already low swim effect.



KODAK Unique Infinite Lens sets a new standard in premium-level progressive design, excelling across all aspects. Taking inspiration from the KODAK Unique DRO Lens design for essential progressive features like visual zone balance and comfort, it incorporates our proprietary raytracing technologies: i-Sync® and Dynamic Reading Optimization® (DRO). However, the similarities end there, as it embraces a fresh design platform and introduces a new technology which stabilizes mean power variation to enhance performance.

Vision First Infinite Design

KODAK Progressive Lens designs have historically been created utilizing in-house software called Vision First Design™. This software reverses the traditional approach of progressive design work by using the mean power and edge profile as a starting point.

This Vision First Design software creates a progressive lens from a series of input parameters. There are in the region of 60 parameters used as inputs to Vision First Design, each with up to 20 feasible values.
In order to create a high performing design, some values require very little modification, and some require extensive trial and error analysis. There are approximately 15 parameters which are highly sensitive but can be tuned to improve a design without changing the core characteristics. Considering just these 15 parameters, and the different values that they may have, the number of possible combinations reaches 33 quintillion.

Therefore, exploring the parameter space of Vision First Design is a highly iterative and time-consuming process. It is impossible to fully explore the design paths available by hand. However, with the use of genetic algorithms and neural networks, lens engineers can more easily identify patterns and relationships between hundreds of thousands of parameter combinations.

By combining Vision First Design with genetic algorithms and neural networks, Vision First Infinite technology is created. Vision First Infinite helps evaluate complex functions, testing a set of parameters and assigning a score. The aim of the algorithm is to find the lowest possible score, or "global minima." In the context of a progressive design, this means the lower the score, the better the design.

Vision First Infinite

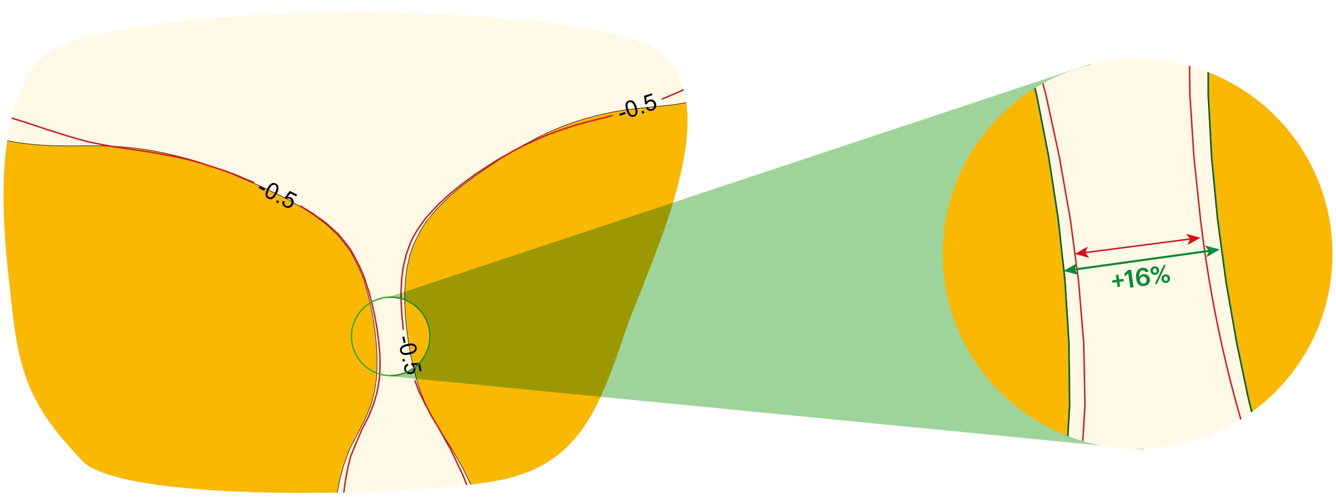
The primary aim of Vision First Infinite is to improve the performance of the design, with no compromise. In this particular instance, the design scope is building upon the known performance of KODAK Unique DRO Lens and enhancing the width of the corridor and increasing the area of the near zone.

Resulting Improvements

One method of defining the performance of a progressive lens is by measuring the size of the viewing zones. We can define the size of the distance, intermediate, and near areas according to the optical properties of cylinder and/or mean power. Ideally, we would like to see no cylinder anywhere on the lens, but this is impossible on a continuous smooth progressive surface. Therefore, if we define the good area as that which is below the 0.25 D cylinder level, and compare the KODAK Unique DRO Lens design against the KODAK Unique Infinite Lens design, we see:

» **16% improvement in the minimum intermediate width**

Normally, a single area improvement like this would lead to a reduction in the performance elsewhere, but with Vision First Infinite, there is no loss anywhere on the lens, and some gains being made everywhere.



By increasing the effective intermediate zone without compromising either the distance or near vision zones, the wearer has a more enjoyable viewing experience.

Progressive design for viewing area identification only. Not representative of any specific design.

Dynamic Viewing Stabilization

Progressive lenses exhibit a gradual power transition from the top to the bottom. This results in a progressive change in optical power, starting with distance correction at the top and gradually transitioning to near correction at the bottom. While a change in power is a requisite for a progressive lens, too much variation, or variation that is not well-enough controlled, leads to discomfort for the wearer and therefore has a negative impact on the performance of the lens.

Any single point on a lens will have two components: a spherical power and a toric power. The mean power at a given point represents its average power at that location, considering both the spherical and toric components. The engineering team behind KODAK Progressive Lenses take into careful consideration the mean power at every point on the lens design as a smooth distribution of the mean power is an integral part of KODAK Lens designs.

The mean power distribution will inevitably see rises and falls across the lens. An idealized progressive lens should, from any point on the lens, rise in mean power as the eye approaches the near reference point and fall in mean power as the eye travels towards the distance reference point. In reality, in the temporal and nasal sides of the near reference point, if left unchecked, there are additional undulations in mean power.

Using Dynamic Viewing Stabilization, we smooth these undulations in mean power. We first define two surfaces: the original input surface, and a radial-basis-function smoothed surface. The radial-basis-function smoothed surface has every point smoothed equally, but this distorts the progressive design. Therefore, we must consider mixing the original input surface and smoothed surface according to the undulations in mean power.

To do this, we determine which areas of the lens will benefit from a smoother mean power distribution, and which areas would not. We then merge the two surfaces accordingly and this results in a lens which maintains its necessary power change to function as a progressive lens but suffers much less from the negative impacts of the peripheral power variation.

Theoretical Analysis

We define the comfort of a progressive lens based on three metrics: Dynamic Viewing Index, Distortion Gradient Index, and Binocular Balance Index. Each of which depends on the distribution of mean or cylinder power.

The Dynamic Viewing Index is calculated using mean power. It is a measure of the rises and falls of mean power as the eye moves around the lens both within the main viewing zones and in the peripheral areas. The height of these undulations in mean power reduces the Dynamic Viewing Index. The greater the Dynamic Viewing Index the better.

The Distortion Gradient Index is based on the distribution of cylinder power. It uses calculations based on the rate of change of cylinder power, and peak cylinder values, to give a measure of softness to a design. The smaller the Distortion Gradient Index the better.

The Binocular Balance Index also uses the distribution of cylinder power. It considers the differences in peak cylinder power, and the overall shape of the cylinder profile, between the temporal and nasal sides of the lens. The greater the Binocular Balance Index the better.

	KODAK Unique DRO Lens	KODAK Unique Infinite Lens	
Dynamic Viewing Index	1.99	2.50	Higher Score = Higher Performance
Distortion Gradient Index	96.0	86.2	Lower Score = Higher Performance
Binocular Balance Index	0.77	0.80	Higher Score = Higher Performance

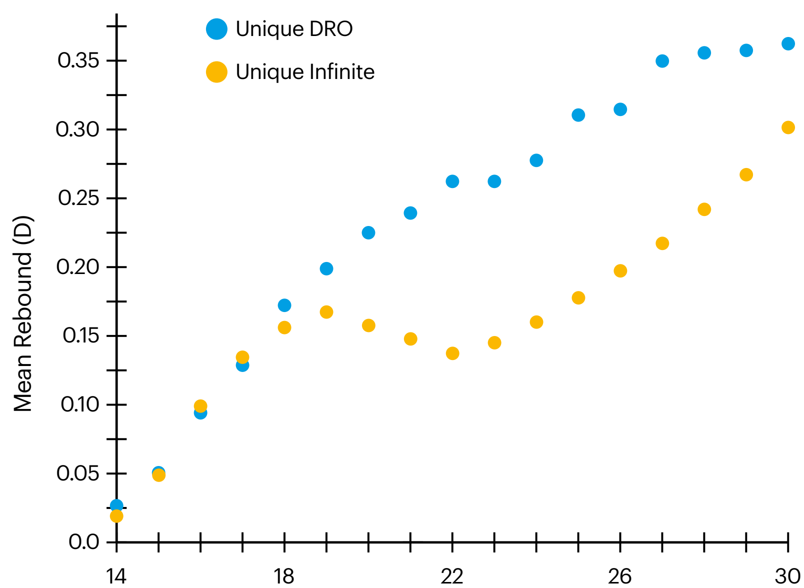
All of these additional metrics favor the KODAK Unique infinite Lens design.

Mean Rebound Measurement

A key improvement of the KODAK Unique Infinite Lens design is the increased comfort for the wearer due to the reduced swim effect of the lens. A contributing factor to this effect is the manner in which the power of the lens varies in the peripheral regions.

When the wearer looks through the peripheral portion of the lens, there will be distortion present. As a result of this, the wearer doesn't tend to look through this portion as much as the main central zones. But when on the move, the peripheral regions of the lens still have an impact on visual comfort. This is in part due to the pattern of power variation. For a progressive lens to function, there must be an increase in lens power from distance area to reading area. While this is well controlled in the main viewing areas of the lens, the peripheral regions do not experience the same uniform increase in power. There are rises and falls in this power. By concentrating on this distribution of power, and reducing the amount of rise and fall, the peripheral vision of the wearer experiences less change, and so surroundings appear more stable while on the move.

A measure of this rise and fall is the Mean Rebound, which is the variation of mean power across the peripheral zones. Using this technique, it can be seen that there is a 33.3% reduction in the Mean Rebound between KODAK Unique DRO Lens and KODAK Unique Infinite Lens.



This is a plot of the rebound measurement for KODAK Unique DRO Lens and KODAK Unique Infinite Lens.
The dots show the average value of the temporal and nasal measurements.
If we sum all the points, the Total Mean Rebound on KODAK Unique DRO Lens is 3.72.
The Total Mean Rebound on KODAK Unique Infinite Lens is 2.48. This is a 33.3% reduction.

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See the Colors of Life

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