VARILUX® X SERIES™ LENSES

EXTENDED RANGES OF VISION

WHITE PAPER

SÉBASTIEN FRICKER
DR. MARTHA HERNANDEZ-CASTANEDA
MÉLANIE HESLOUIS
VALÉRIE JOLIVET
CHARLES LEBRUN
DR. DAMIEN PAILLÉ
BENJAMIN ROUSSEAU
The Varilux® S™ Series lens was the first premium progressive lens to provide a wide field of view without having to compromise on the edges of the lenses, where the so-called swim effect impairs vision.

It was based on state-of-the-art optics and advanced knowledge of wearer physiology, with two sophisticated technologies at its core: Nanoptix® and Synchroneyes®. The former re-engineers the lens structure to dramatically reduce the swim effect, and the latter takes into account the difference between the two eyes to enlarge the binocular field of vision.

Despite these significant advances, lifestyle changes mean that even highly advanced lenses like Varilux® S™ Series lenses fall short of wearer expectations. Indeed, presbyopia presents both those who suffer from it and eyecare practitioners with special challenges today. This is particularly true for near vision. Finding a lens that allows the wearer to switch from distance vision to near or even intermediate vision with as seamless as possible a transition is not always easy.

Essilor’s new Varilux® X series™ lens builds on its Varilux® S™ Series lens to meet the challenges modern life poses for wearers of progressive lenses and ensure a level never before reached by a premium progressive lens offer. What’s more, its Xtend™ technology delivers additional benefits for today’s demands for near vision.

KEYWORDS: arm’s length vision, near vision, multiple near distances, seamless transitions, acuity model, volume of acuity, peripheral vision, premium progressive lens, Varilux® X series™, Xtend™ technology, Nanoptix®, Synchroneyes®
Sébastien Fricker graduated as a Physics Engineer from Ecole Polytechnique (Palaiseau, France) in 2000 and obtained a masters in electrical engineering from the University of Michigan (Ann Arbor, USA) in 2002. He worked for 10 years in Research and Development in the optical metrology industry. Sébastien joined Essilor Research and Development in 2012, where he works on ophthalmic lens design methods and lens performance modeling.

Dr. Damien Pailé is a member of Essilor International’s optical research and development team, based in Paris, France. Damien holds a degree in optometry and practiced as an optician before completing and defending a doctoral thesis in 2005 in cognitive sciences at the University of Paris VIII, in collaboration with the College de France and Renault. He then pursued post-doctoral studies at the Laboratory for Perception and Motion Control in Virtual Environments (a joint Renault-CNRS laboratory), before joining Essilor International’s research and development team in 2007. He currently works in the Vision Sciences department.

Sébastien Fricker
M.Sc., R&D Study Manager, Essilor Center of Innovation & Technology Europe

Charles Lebrun joined the Essilor R&D Consumer Experience team based in Créteil after a master’s degree in optometry and vision sciences. During his graduate program, he worked in the fields of clinical research in French and Indian Hospitals, as well as a volunteer participant and manager of humanitarian missions in West Africa. He has been working within the Consumer Experience team on wearer tests and instruments.

Charles Lebrun
M.Sc., R&D Study Manager, Essilor Center of Innovation & Technology Europe

Mélanie Heslouis
M.Sc., Optical Engineer, Essilor Center of Innovation & Technology Europe

Mélanie Heslouis joined Essilor in 2007 after receiving her physics/optics engineering degree from Centrale Marseille. She went on to join Essilor’s Optics Department, working on new product development. Her work has focused on the conception and design of progressive lenses since 2011.

Dr. Martha Hernandez-Castaneda is a member of Essilor International’s optical research and development team, based in Paris, France. Martha graduated from the University Colombia La Salle College of Optometry. She holds a degree in optometry OD and completed her training with a doctoral thesis in 1992 in binocular vision at Ecole des Hautes Etudes de Paris, in collaboration with the Foundation Rothschild. Before joining Essilor, she worked in low vision and binocular vision, participating in surgeries on strabismus and motility troubles. Her others specialties are Virtual Simulation and practice clinical in refraction. She is member of Essilor since 1991. She currently works in the Vision Sciences department. She has been a member the Federation of Colombian optometrists (FEDOPTO) since 2005.

Dr. Martha Hernandez-Castaneda
Optometrist OD, PhD, Senior Vision Scientist, Essilor Center of Innovation & Technology Europe

Benjamin Rousseau graduated as a Physics Engineer from Ecole Supérieure d’Optique (IOGS Palaiseau, France) in 2002 and obtained his masters in optics and photonics. Benjamin joined Essilor Research and Development in 2002, where he worked on ophthalmic lens design, simulation and personalization. He is now in charge of global programs dedicated to delivering the next generation of progressive lenses and products, including the Varilux® X series™ program.

Benjamin Rousseau
M.Sc., Consumer Innovation Manager, Essilor Center of Innovation & Technology Europe

Valérie Jolivet
M.Sc., R&D Study Manager, Essilor Center of Innovation & Technology Europe

Valérie Jolivet is a member of Essilor International’s optical research and development team, based in Paris, France. Valérie holds a Master of Science degree in statistics. She worked for 5 years in the pharmaceutical industry as a bio-statistician before joining Essilor International in 1995. After working as Quality Engineer, she has worked in the Consumer Experience department since 2008.

Valérie Jolivet
M.Sc., R&D Study Manager, Essilor Center of Innovation & Technology Europe

Dr. Martha Hernandez-Castaneda
Optometrist OD, PhD, Senior Vision Scientist, Essilor Center of Innovation & Technology Europe

Dr. Damien Pailé
B.Sc. Optom; M.Sc, PhD, Senior Vision Scientist, Essilor Center of Innovation & Technology Europe

Valérie Jolivet
M.Sc., R&D Study Manager, Essilor Center of Innovation & Technology Europe

Benjamin Rousseau
M.Sc., Consumer Innovation Manager, Essilor Center of Innovation & Technology Europe

Charles Lebrun
M.Sc., R&D Study Manager, Essilor Center of Innovation & Technology Europe
1. MULTIPLE NEARS

For the past two-and-half decades, static situations and reading in seated positions have been the references used by professionals and manufacturers for addressing near vision in progressive lenses (Meister, 2006; Cochen, Albou-Ganem & Renard, 2012; Maitenaz & Chauveau, 1999; Miege & Pedrono, 1993; Meslin, 2006).

Varilux Comfort® lenses were optimized according to this, with power corresponding to 85 to 100% of the prescribed addition. These values are roughly those needed for reading an A4 sheet of paper at a distance of 40 cm (FIGURE 1).

As this conception of near vision is clearly outdated, Essilor R&D has updated it for the digital age by taking into account the many different near tasks and activities that can be performed at an arm’s length today. In addition to static tasks, wearers today need to be able to multitask. These different tasks can be considered to correspond to “multiple nears”.

Varilux® X series™ lenses are designed with these multiple nears in mind, covering visual needs within a range of between 40 and 70 cm from the wearer, roughly equivalent to an arm’s length (FIGURE 2). By doing this, Essilor has optimized global vision.

2. THE VISUAL NEEDS FOR THE MULTIPLE NEARS

When it comes to near vision, reading is perhaps the most important activity and most demanding in terms of visual performance. It is a central part of our lives in today’s society. Not only does it take place in a wide array of environments, with many different types of text and dynamic tasks, but it requires precise vision and involves accurate eye movements.

Among other things, it involves perceptual aspects such as letter and word recognition, which are obviously crucial for wearers of progressive lenses.

The reader acquires textual information on several levels: letters, words and sentences are processed (Perrin, 2015). Visual acuity, as measured by the eye care practitioner (Snellen acuity), is the most important measurement for the reader.

Once the reader recognizes the letter, higher processes involving orthographic and phonological information come into play (Grainger & Ferrand, 1994; Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). Together, they allow the reader to comprehend the elements read.
3. VISUAL ACUITY

The eye’s ability to perceive and resolve fine details of an object or text is known as visual acuity, and it depends on the clarity of the image projected on the retina. Sharpness of resolution, or Minimum Angle of Resolution (MAR), is commonly used to express it. MAR represents the minimum angle of separation that enables the eye to distinguish between two distinct objects.

A MAR of 1 arcminute (equal to 1/60 of one degree), which corresponds to 0 LogMAR (i.e. Logarithm of the MAR), is usually considered normal (expressed in feet it equals 20/20 and in meters 6/6). With respect to text and reading, this means the eye is able to make out a letter of which any detail subtends 1 arcminute, assuming the entire letter is five times the size of the detail (FIGURE 3).

When reading at a distance of 40 cm, visual acuity of 0.1 LogMAR is sufficient, and at a distance between 50 and 70 cm 0.15 LogMAR is enough.

4. ADDITION PRESCRIPTION

Ametropia must be corrected with the maximum convex for the best acuity. Any undercorrection of hypermetropia or overcorrection of myopia must be avoided so as not to require a higher addition for near vision.

Indeed, the addition prescription is of the utmost importance for visual quality in near vision.

As an individual goes about daily life, their eyes must adapt to the varying distances separating them from objects in their line of sight. This is known as accommodation and allows the eyes to keep objects in sharp focus. Crystallin shape modification is the reason for this phenomenon (Millodot, Goumillout & Pouget, 1997).

Addition is the amount of power in diopters (D) that is needed to compensate for a loss of accommodation in near vision. With respect to the latter, this loss typically happens around 40 years of age and results from a hardening of the lens of the eye and its subsequent inability to change shape.

FIGURE 3. MAR FOR VIEWING A LETTER
5. ACUITY MODEL

Essilor has developed a new calculator that is able to manage higher complexity in lenses. It takes into account an acuity model to predict the loss – measured in LogMAR – in sharpness of vision when the wearer is looking at a given object through a particular lens. Essilor has perfected its new calculator to take into account the model to generate acuity targets and evaluate the performance of lenses.

The loss in acuity when a wearer looks through a lens at a given point depends on the following parameters:

- The power of the lens
- The astigmatism of the lens
- The proximity of the object
- The accommodation of the wearer

In addition to this, the sphere and cylinder of the lens have a direct impact on the visual acuity performance obtained with the lens (FIGURE 4).

The acuity a wearer attains from the use of both eyes is in most cases higher than the best acuity of each eye. This is known as binocular summation and represents a roughly 10% improvement at high contrast.

6. SYNCHRONEYES® & NANOPTIX®

Not only does the acuity model allow Essilor to optimize lenses, it also enhances its Synchroneyes® and Nanoptix® technologies. The former uses the prescription for both eyes to calculate the addition for the lenses as a pair, ensuring they take into account the eyes working together as a whole visual system. This improves retinal image matching, which means the wearer has better spatial perception and more expansive vision across the entire lens.

The latter technology literally re-engineers the lens surface to allow light to pass through each optical element, preventing the unwanted deviation of light that results in the so-called swim effect at the edges of the lenses. This translates into better peripheral vision for the wearer.
1. NEW ALV ZONE ON THE LENS

For an individual with a 2.5D addition and no residual accommodation, a distance of 70 cm represents a proximity of 1/0.7, which equals 1.43D. This means about 60% of the total prescribed addition is used for what is generally considered to be in the intermediate vision.

The zone of the lens that corresponds to between 60 and 85% of the addition - and is often included in what is referred to as arm’s length vision - is neither intermediate nor near. This new arm’s length vision (ALV) zone complements the typical near vision zone (FIGURE 5). As such, it is more and more important in today’s digital world, with devices often held at arm’s length.

2. THE XTEND™ TECHNOLOGY

For a wearer of progressive lenses, visual acuity in the multiple nears is clearly paramount. Simply put, the proper acuity for the different distances will allow the wearer to seamlessly transition from one near to another.

To achieve this, Essilor has developed its Xtend™ technology to greatly enhance the Varilux® X series™ lens’ performance with the multiple nears – and in particular with arm’s length vision. It generates uniquely optimized acuity buffers that temper each addition variation to boost depth of field and enhance the local surface shape to widen the acuity volume.

The buffers, which are on a scale of the Nanoptix® elements, represent an improvement of the Nanoptix® structure. Thanks to Xtend™ technology, the surface of the lens is optimized like never before.

By targeting the wearer’s acuity value, Xtend™ technology maintains the highest level of sharpness for each distance and as a result maximizes the overall visual acuity volume.
III. THE PERFORMANCE OF THE VARILUX® X SERIES™ LENS

1. OPTICAL PERFORMANCE OF THE LENS

One way of testing the Varilux® X series™ lens’ performance is to calculate the volume of acuity a wearer needs in relation to the acuity threshold to be able to perform a visual task with a sufficient level of acuity.

As can be seen in the figures below, the Xtend™ technology improves the Varilux® X series™ lens’ performance markedly when the wearer is looking at a particular object.

FIGURES 7 & 8 clearly illustrate the improvement in volume both in depth and in breadth for the wearer when it comes to arm’s length vision.

Specifically, Xtend™ technology maintains the loss in near vision visual acuity above the 0.15 LogMAR threshold, resulting in a longer range of vision and a larger area of sharp sight (FIGURE 9).

NB: The performance of the Varilux® S™ Series lens (left) is compared to that of the Varilux® X series™ lens (right) for a wearer with a -3.00 Add 2.00 lens. The purple zone represents near vision up to 50cm, with an addition above 85%. The blue zone represents intermediate vision. The beige zone for the Varilux® X series™ lens represents an addition from 60 to 85%.

NB: Figures 7 and 8 do not give intrinsic characteristics of the Varilux® X series™ lens. Both illustrate the differences in performance for the same average wearer, characterized by an accommodation model.
2. LENS PERFORMANCE & WEARER TESTS

Essilor carried out two studies on the Varilux® X series™ lens, one international and one French. The former looked at the overall performance of the lens. As can be seen from Figure 10, an overwhelming percentage of wearers enjoyed high-quality vision, whatever the distance, intermediate or near. For overall and dynamic vision wearers gave a rating on a 10-point scale from “not clear at all” to “very clear”.

With respect to distance, intermediate and near vision wearers gave a rating using the same scale, plus a 10-point scale ranging from “very narrow” to “very wide”; for each distance, the average of the ratings from both scales was calculated to obtain a global visual quality criterion. In both cases 7 to 10 on the scales represented good visual quality.

### FIGURE 9. ACUITY LOSS AS A FUNCTION OF HORIZONTAL FIELD OF VIEW FOR THREE DISTANCES

<table>
<thead>
<tr>
<th>Distance</th>
<th>475 mm</th>
<th>590 mm</th>
<th>700 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 Logmar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.15 Logmar</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing acuity loss as a function of horizontal field of view for three distances](image)

**Varilux® X**

**Varilux® S**

**NB**: The Varilux® S™ Series lens is compared to the Varilux® X series™ lens over three distances for a -3.00D Addition 2.00 lens.

### FIGURE 10. PERCENTAGE OF WEARERS WITH GOOD VISUAL QUALITY WITH THE VARILUX® X DESIGN LENS

![Graph showing percentage of wearers with good visual quality](image)

<table>
<thead>
<tr>
<th>Vision Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Vision</td>
<td>88%</td>
</tr>
<tr>
<td>Distance Vision</td>
<td>91%</td>
</tr>
<tr>
<td>Intermediate Vision</td>
<td>83%</td>
</tr>
<tr>
<td>Dynamic Vision (wearer moving)</td>
<td>89%</td>
</tr>
<tr>
<td>Dynamic Vision (surroundings moving)</td>
<td>88%</td>
</tr>
<tr>
<td>Near Vision</td>
<td>79%</td>
</tr>
</tbody>
</table>

International multicenter study (n=66)
Wearers also rated their ease of adapting to the lens on a 10-point scale from “very difficult” to “very easy”, with 7 to 10 considered the “easy” range. A full 82% of wearers experienced an easy adaptation. The French study (FIGURE 11) looked at the Varilux® X series™ lens’ key benefits, measuring how satisfied wearers were when carrying out activities at an arm’s length. Again, they gave a score on a 10-point scale ranging from “not satisfied at all” to “very satisfied, with once again the 7 to 10 range being the overly positive one. The exception was “multitasking”, where wearers rated “satisfaction with focus”.

Wearers were also asked to rate their head movements needed to see clearly activities carried out at arm’s length, choosing from “not at all”, “a little”, “just right”, “too much” and “far too much”. The percentage of wearers who needed minimal or no head movements to see clearly was 97% for horizontal vision and 93% for vertical vision.

Both studies then compared the Varilux® X series™ lens to the Varilux® S™ Series lens. The international study found 65% of wearers had an overall preference for the Varilux® X series™ lens over the Varilux® S™ Series lens. In terms of visual quality, using the same scales and criteria, the former had markedly better performance (FIGURE 12). The ease of adapting to the lens was also higher for the Varilux® X series™ lens (82% vs. 76%).

As for their preference for the Varilux® X series™ lens when it came to multitasking at an arm’s length distance, the French study found no less than 86% of wearers preferred the Varilux® X series™ lens over the Varilux® S™ Series lens. A similar preference was found when wearers were asked about which lens they preferred with respect to head movements needed for tasks performed at an arm’s length distance: 74% chose the Varilux® X series™ lens over the Varilux® S™ Series lens.
The Varilux® X series™ lens clearly delivers on its promise to provide clearer and crisper vision. Not only has Essilor enhanced its Synchroneyes® technology to boost the wearer’s binocular vision across the entire lens and improve spatial perception, it has improved its Nanoptix® technology, which translates into improved peripheral vision for wearers.

Perhaps more importantly though, Essilor has engineered the Varilux® X series™ lens with the increasing amounts of time people are spending carrying out different tasks at an arm’s length distance in mind. It has developed its Xtend™ technology to ensure a smooth progression between the different distances, in particular the multiple nears. The result is a high level of clarity for all distances, whether it is near vision when reading a book, arm’s length vision when browsing a screen or distance vision when driving a vehicle.

When calculated, compared with the Varilux S™ series or evaluated by wearers, the Varilux® X series™ lens attains an extremely high level of performance, delivering satisfaction to the wearer.

KEY TAKEAWAYS:

◆ Essilor has optimized global vision by designing the Varilux® X series™ lenses with multiple near distances in mind, covering distances equivalent to an arm’s length (between 40 and 70 cm from the wearer).

◆ By developing a new calculator, Essilor is now able to manage higher complexity in lenses and generate acuity targets to optimize the performance of lenses.

◆ Drawing on its Synchroneyes® and Nanoptix® technologies, Essilor has developed new Xtend™ technology to greatly enhance the Varilux® X series™ lenses’ performance with the multiple nears.

◆ The Xtend™ technology increases acuity volume both in depth and in breadth for the wearer when it comes to arm’s length vision (vs. the Varilux® S™ series lens).

◆ Essilor studies evaluating the overall performance of the Varilux® X series™ lens revealed that an overwhelming percentage of wearers enjoyed high-quality vision, whatever the distance.

◆ In addition, studies revealed that 95% of wearers were satisfied with the lens when multitasking at an arm’s length. Wearers also found that they did not need to move their head horizontally (97%) or vertically (93%) to see clearly with the Varilux® X series™ lens.
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