Development of eyeglass lenses since 2000

Freeform makes it all more flexible, more customized and more fashionable

Joachim Kuss, Director of Group Communications, Carl Zeiss Vision International GmbH
February 2015

The past years have seen a significant change not only in refraction techniques, production methods and optical designs, but also in the lens performance demanded by eyeglass wearers. Today, the flexibility, individuality and adaptability of eyeglass lenses are greater than ever before. Technology and personal needs, visual comfort and preferences, fashion trends and digitization are all driving product development.

Let us take a brief look back at the milestones of the past decade using ZEISS progressive lenses as an example. Innovations have been the order of the day over the past decade. Today, the vision care industry is facing a development threshold. The question is: what will drive progress in the future?

Exploring the potentials of freeform technology

Freeform technology has been in use for the precise, flexible and customized machining of optical surfaces in eyeglass production since 2000. New parameters have been incorporated, and wearer tolerance has been considerably improved. A key role is played not only by the possibilities offered by leading-edge technology, but also by the dictates of fashion. In Gradal Short I the progression zone was shortened by 20 percent over Gradal Individual, and by 40 percent compared to traditional progressive lenses. This was the optimal solution for the small frames with fitting heights of only 16 millimeters that were in fashion at the time.

Precise data for precise lens calculation

For adaptation to the wearer's personal profile and eyes, however, the revolution in refraction technology is more important. For process reasons, measuring increments of 0.25 diopters are used in subjective refraction. At what value the refraction process actually starts is

heavily dependent on the experience of the eye care professional, and on how his or her patient is feeling on the day. This problem is solved by combining subjective refraction and the objective measuring method. The i.Profiler, in particular, provides a large number of parameters for the measured eye. This wavefront technology measures up to 1,500 measuring points per eye. Adapting the lens to higher-order aberrations and performing the measurement with different pupil widths to simulate twilight and night vision lead to considerably more complex, but optically optimized lenses that offer enhanced wearer tolerance and substantially improved individualization. The introduction of horizontal symmetry in 1983 and individualized progressive lenses in 2000 marked major new milestones in eyeglass lens development.

Material diversity and quality

Carl Zeiss and Ernst Abbe were unable to truly perfect their revolutionary optical instruments until Otto Schott developed his new types of optical glass displaying properties that could be deliberately manipulated. This pioneering achievement also shaped the eyeglass industry. A separate chapter could be devoted to the key role played by new plastics that offered improved material properties. The resounding success of photochromic lenses and the implementation of plastic materials with a refractive index of 1.74 are excellent examples of this.

In the past, glass was generally seen as an attractively priced alternative and was valued only by a minority of wearers due to its superior optical properties and durability. Since all glass progressive lenses can now also be produced using freeform technology, demanding wearers in particular are finding the combination of the material's benefits with the possibilities of individualization particularly attractive.

Perfect lens for fashion, lifestyle and work

Objective refraction and new progressive lens designs made it possible to perfect the adaptation of eyeglass lenses to the human eye and visual faculty. Improving the interaction of frame-lens-eye was the next step in the process. Strictly speaking, this is an old problem that was initially solved with Perivist frames from ZEISS in 1933 which enabled a anti-slip fit of the eyeglasses and adaptation of the frame to the human anatomy.

2006 was the year in which ZEISS offered flexible progression lengths for the very first time. It was now possible to vary the corridor length in freely selectable increments of tenths of a millimeter. Until then, the progression length had been a compromise based on the selection between a few options and the frame size, but now the progressive lens could be adapted continuously and precisely to all standard frame sizes.

The next few years saw a wide diversity of options for selecting progressive eyeglasses that matched the wearer's lifestyle and occupation. Special designs for computer and office work such as ZEISS OfficeLens addressed the new challenges posed to the human eye. Since 2012, it has been possible to measure the wearer's preferred viewing distances for work performed on a computer screen, in the office and at intermediate ranges with centimeter accuracy and incorporate these in the lens design.

This development is interesting not only from the ophthalmic or design perspectives. Health aspects are becoming increasingly important. Relaxed, fatigue-free vision is now an absolute must in our modern world. The more health-conscious consumers become – particularly in the established markets, the sharper development work must focus on the health-relevant requirements that must be met by leading-edge precision lenses. The added value now offered by a progressive lens is therefore also determined by factors that were not taken into consideration in traditional optical designs.

Coatings for durability and style

A high-tech coating is a must-have for a modern eyeglass lens. Here, once again, state-of-the-art technologies are needed. In the case of coatings, enhanced functionality means: scratch resistance, clarity and easy cleaning. These are now standard requirements that must be satisfied by modern coatings which consist of up to ten wafer-thin layers of vacuum-deposited metal oxides.

First used for binoculars in 1935 and then for eyeglass lenses from 1959 onwards, the technique for applying antireflective coatings has remained practically unchanged to this very day. However, the features ensuring, above all, added visual comfort and product durability are new. Hard lacquer coatings that are 50 times thinner than a human hair and to which several, nanometer-thin ceramic layers are applied, pose one of the greatest challenges to modern industry. Mastering the material diversity and, above all, ensuring constant quality for

freeform lenses – each lens has a different thickness, surface, size and shape – are major feats of technological engineering.

The role played by fashion diversity and increasing health awareness as development drivers is just as important for coatings as for lenses. Mirror coatings and reflection colors are primarily intended to meet cosmetic needs.

Vision in the digital world

Coatings designed to eliminate components of blue light which are suspected of causing damage to the eye are one example of the response to health-relevant requirements. Computer screens, smartphones and eReaders are now all an integral and indispensable part of our daily lives. For our eyes, however, they mean: stress, health risks and unaccustomed vision conditions. Adapting to different reading distances, having difficulty with small fonts, the need to switch quickly and frequently between one vision range and another, the impact of unnatural light compositions on our sleep-wake rhythm and hormone levels – like other manufacturers, ZEISS is also addressing these changes with new lens designs for the digital world.

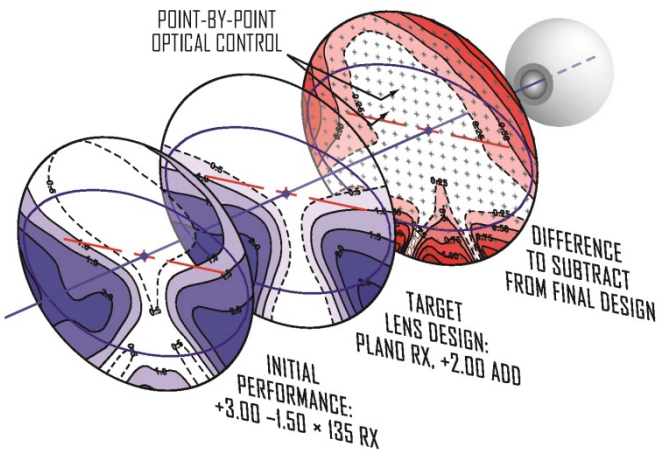
Unlike some technologies in the past, the adaptation of progressive lenses to the special and obvious challenges posed by the intensive use of digital devices is not an option that the wearer selects or not. From around the age of 35 onward, the human eye is no longer able to compensate for this stress at all, or only with great effort. Features for the digital world will become just as standard as coatings or individualized progression corridors.

More options or new clarity?

All leading manufacturers use freeform technology and have devised their own design philosophies in the past 20 to 25 years. The production technology may be the same, and the number of materials limited, but the designs and options available for branded lenses differ greatly.

In its designs ZEISS focuses on clear, dynamic and thin optics. Digital Inside Technology takes the different reading distances needed for digital devices and print media into account in the lens design. This means all ZEISS progressive lenses offer better vision for our eyes in the digital world. The proven design principles for linear transitions in all directions, large,

clear corridors and precise progressions form the foundation of all progressive lenses because they ensure high wearer tolerance in all conditions of use.



A look at consumer needs, the competition and standard market offerings leads to the question: what trends will set the pace in the future? Progressive lenses for left-handed wearers, drivers, smartphone users, frequent readers, people with colorblindness, office-workers, golf-players - the possibilities are practically endless. The sheer wealth of advertised technologies is a further indicator that the possibilities of freeform technology and digital lens design are far from exhausted. But will even more technologies, even more options and even more features actually help the eye care professional and consumer? Or is it becoming increasingly difficult to gain an overview of the progressive lens portfolio? And is it therefore becoming more and more difficult for eye care professionals to advise their patients and provide clear recommendations – just as it is becoming almost impossible for consumers to make an informed decision about the best choice of lens for their needs? Should everything that is possible be actually implemented in the progressive lens design simply because it is technically feasible?

ZEISS has decided to structure the entire progressive lens portfolio in line with actual demand and requirements. Technologies and innovative features are integrated into the lens design if they offer clear benefits to the wearer, support eye care professionals in their consultations and sales activities, and if there is market potential for them.

Whatever the innovation policies of the individual manufacturer, there are basic trends that will remain intact and dominate in the future: individualization, digitization, the adaptation of lens designs to fashion and health aspects and the need to offer tailored progressive lenses

for individual lifestyles and occupations. At ZEISS, too, these progress drivers will define optical designs and functional coatings during lens development in the years ahead.