White paper

Shamir Autograph Intelligence™

An Intelligent Vision Revolution

Harnessing today's cutting-edge technologies, Big Data and Artificial Intelligence, Shamir now introduces its most advanced progressive lens. Shamir Autograph Intelligence™ is a continuous lens design that optimally matches the wearer's Visual Age™ and visual needs.

Progressive Lenses – Background

The most advanced optical solution for presbyopes is progressive lenses, which enable using one pair of glasses for all distances – far, intermediate and near.

Freeform technology has led to the development of dedicated tools for designing complex optical surfaces. These new capabilities allow us to produce a wide variety of progressive lenses, adapted to frames, to specific uses or professions, and based on advanced technologies that simulate natural vision. The results promise a high degree of optical precision and better suitability for the customer – both optically and cosmetically.

Over the years, progressive lenses have been adapted to meet lifestyle changes. From traditional progressive lenses, which provided a solution mostly for the far and near vision zones, to progressive lenses for digital viewing, considering today's increased use of desktop computers, laptops, tablets and smartphones.

Fashion trends also influenced the structure of progressive lenses. When smaller frames became fashionable, the world of lens development adapted and designed a progressive lens with shorter corridors to adapt to the frame shape. Additional adaptations took place to design a progressive lens suited to sports and outdoor activities using wraparound or flat frames.

## A Single Design Concept Offering Everyone the Same Solution

All these variations of progressive lenses were based on the principle of using the same design concept to provide everyone with the same solution. In other words, it was based on the idea that everyone's visual needs are more or less the same.

Every type of lens has unique characteristics that are expressed in every Rx. The art of tradeoff between width of vision zones, unwanted astigmatism, softness, and other parameters, lends itself to design variations. In the examples below, the cylinder plots illustrate two different design concepts.
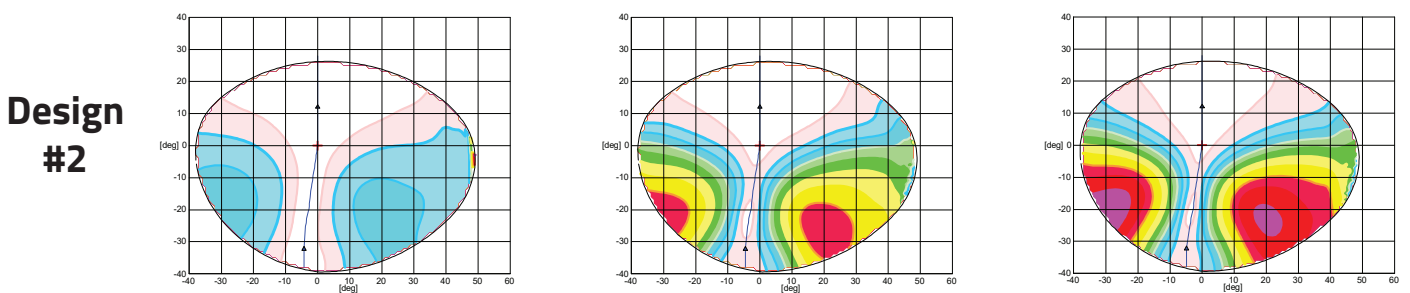
Design #1, the intermediate vision zone and softness are given highest importance.

	Low Add	Mid Add	High Add
Design #1			
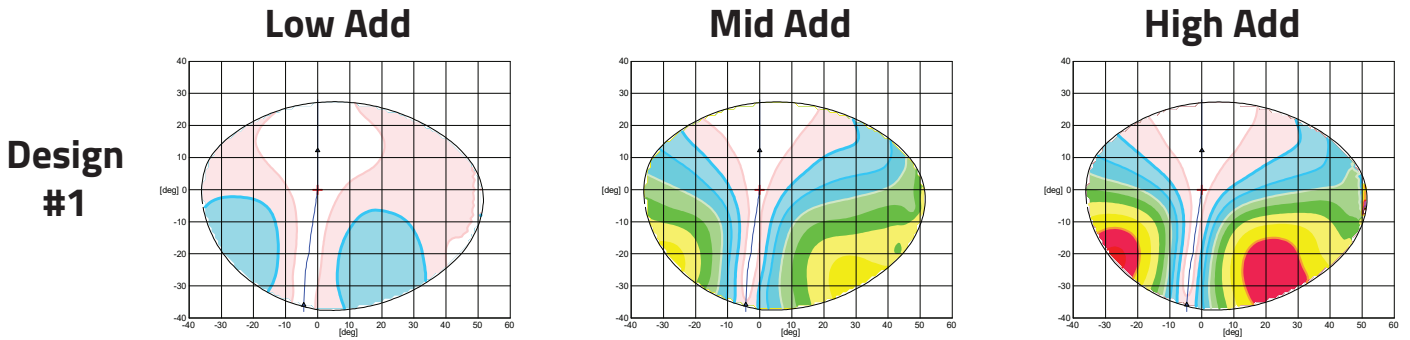
Design #2, the far and near vision zones are given highest importance.

Design #2			

Personalized Lenses

Currently, the most popular form of personalization in progressive lenses is based on the frame choice. The lens design compensates according to the position of the glasses as worn on the patient's face - panoramic angle, pantoscopic tilt & BVD.

Customized Design by Lifestyle

Another attempt at improving progressive lens suitability to patient needs, is based on lifestyle information obtained through a questionnaire. In order to draw reliable conclusions regarding visual needs, the questionnaire has to be in-depth with as few interpretations as possible. This requires a long session in addition to the current time with the ECP. Todays questionnaires are short and made to be convenient, which may result in a lens not optimally suitable for the customer. In fact, most ECPs do not use even these short questionnaires. Instead, they rely on their knowledge of the performance of various lenses in the belief that they are matching the most suitable lens to their patient. But can one really be aware of all the features of all the available lenses from every manufacturer? It is close to impossible.

So...
How can we help ECPs make the best choice of lens to meet the needs of their patients, without complicating the dispensing process?
How can we offer one product that will meet most customer needs?

To answer this question, Shamir has harnessed the capabilities of the relatively new and rapidly growing fields of Big Data and Artificial Intelligence.

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Entering the World of Big Data

Looking at a huge database allows us to learn about the real world through massive data collected from extensive sources. Big Data analytics allows us to process, analyze and learn from such large sets of data, sometimes revealing interesting and previously unnoticed patterns.

With regard to progressive lenses, Big Data analysis has allowed us to map today's user distribution by Rx, and to study behavior patterns and visual needs of presbyopes. Any correlations discovered between these parameters can assist us in building an optimal solution to meet a range of customer visual needs.

Our Massive Database - 5 Million Job Orders

A huge amount of data has been collected by Shamir over the years regarding, among other things, the manufacture of progressive Rx lenses.

The following chart illustrates the distribution of progressive lenses per sphere and addition, based on some 5 million worldwide orders of progressive lenses handled by Shamir over the last few years.

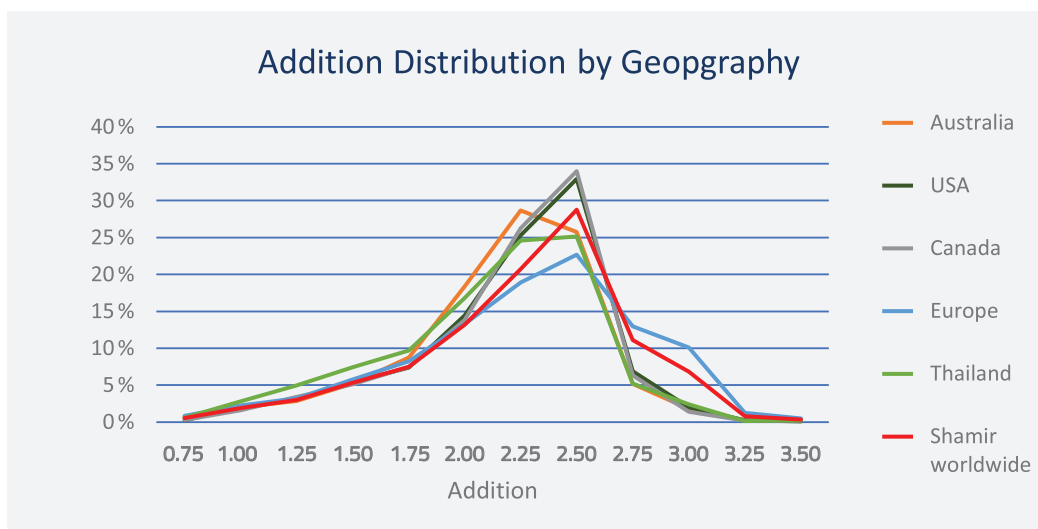|						Addition							
Sphere	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	Total Sphere
-11.00	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.05%
-10.00	0.00%	0.00%	0.00%	0.01%	0.02%	0.02%	0.02%	0.03%	0.01%	0.00%	0.00%	0.00%	0.12%
-9.00	0.00%	0.00%	0.00%	0.02%	0.02%	0.04%	0.04%	0.06%	0.02%	0.01%	0.00%	0.00%	0.22%
-8.00	0.00%	0.01%	0.02%	0.03%	0.04%	0.06%	0.08%	0.10%	0.03%	0.02%	0.00%	0.00%	0.38%
-7.00	0.00%	0.01%	0.03%	0.05%	0.07%	0.11%	0.14%	0.17%	0.05%	0.03%	0.00%	0.00%	0.66%
-6.00	0.00%	0.02%	0.05%	0.09%	0.11%	0.17%	0.24%	0.29%	0.08%	0.04%	0.00%	0.00%	1.08%
-5.00	0.00%	0.03%	0.07%	0.12%	0.16%	0.27%	0.36%	0.45%	0.13%	0.06%	0.00%	0.00%	1.65%
-4.00	0.00%	0.06%	0.10%	0.18%	0.22%	0.38%	0.56%	0.68%	0.19%	0.09%	0.00%	0.00%	2.47%
-3.00	0.02%	0.08%	0.13%	0.24%	0.29%	0.50%	0.75%	0.98%	0.29%	0.16%	0.02%	0.00%	3.45%
-2.00	0.03%	0.10%	0.16%	0.27%	0.34%	0.59%	0.94%	1.25%	0.38%	0.21%	0.02%	0.01%	4.30%
-1.00	0.04%	0.13%	0.24%	0.42%	0.56%	0.90%	1.31%	1.68%	0.54%	0.36%	0.04%	0.02%	6.25%
0.00	0.31%	0.99%	1.47%	2.43%	3.12%	4.61%	6.07%	7.92%	3.14%	2.16%	0.28%	0.14%	32.64%
1.00	0.09%	0.26%	0.42%	0.82%	1.45%	3.05%	5.08%	6.70%	2.59%	1.54%	0.18%	0.08%	22.25%
2.00	0.03%	0.10%	0.14%	0.29%	0.54%	1.27%	2.82%	4.60%	1.96%	1.17%	0.13%	0.05%	13.12%
3.00	0.02%	0.06%	0.08%	0.15%	0.24%	0.54%	1.15%	2.07%	0.99%	0.58%	0.09%	0.03%	5.99%
4.00	0.00%	0.03%	0.05%	0.10%	0.14%	0.29%	0.54%	0.87%	0.37%	0.22%	0.03%	0.01%	2.66%
5.00	0.00%	0.02%	0.03%	0.06%	0.09%	0.18%	0.29%	0.44%	0.17%	0.09%	0.01%	0.00%	1.38%
6.00	0.00%	0.00%	0.02%	0.03%	0.05%	0.11%	0.16%	0.27%	0.09%	0.05%	0.00%	0.00%	0.77%
7.00	0.00%	0.00%	0.00%	0.02%	0.02%	0.05%	0.09%	0.13%	0.05%	0.03%	0.00%	0.00%	0.38%
8.00	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.03%	0.05%	0.02%	0.01%	0.00%	0.00%	0.13%
9.00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%	0.03%
Total Addition	0.53%	1.92%	2.99%	5.34%	7.47%	13.16%	20.70%	28.78%	11.11%	6.83%	0.81%	0.34%	

Regarding Sphere Power, a natural bell distribution was obtained, which peaks at a range of Plano to +1.00 lenses. Some 90% of job orders fall within +/-5.00. Only 20% is for correction of myopes, while almost 50% are hyperopes above +1.00.

Regarding Additions, the data reveals a clear pattern. The curve peaks at add 2.50. Only 18% of lenses have additions lower than 2.00, while 19% have additions higher than 2.50. More than 60% of the manufactured lenses have additions of 2.00 to 2.50.

At higher additions, the trend for fewer orders with additions of over 2.50 is quite reasonable since theoretically, with lack of accommodation one would need 2.50[D] addition for reading at 40 cm. There are various schools of thought among ECPs in different geographic locations or optometry schools. Some ECPs recommend higher additions only for special pathologies or particularly poor vision, closer reading and so on. On the other hand, others prescribe high additions more often. As can be seen in the graph below, the highest rate of high additions occurs in Europe. From other areas, additions above 2.50 are rarely quoted.

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Addition Distribution by Geopgraphy

As for low additions, the data obtained across geographic locations consistently shows that younger presbyopes enter the world of progressive lenses very late, even though they undoubtedly would benefit significantly from their use earlier on. These same presbyopes use reading glasses to meet critical needs, but these glasses do not provide a solution for today's intermediate and digital needs. What's more, they cause ongoing visual and postural discomfort due to the further development of their presbyopia. Entering the world of progressives only when higher additions are required, may lead to adaptation difficulties or a longer adaptation period.

There are several reasons for the late adoption of progressive lenses among younger presbyopes. They may be concerned about being able to get used to a more complicated lens, or they may feel it labels them as "aging". ECPs, based on their worry that the patient will have trouble adapting, and resulting in possibly having to redo the job, may deter them to offering progressive lenses to younger presbyopes.

The Way to Define Visual Needs
Today's progressive lenses are based on the idea that "everyone is more or less the same". One design concept is used for everyone. However, the result of our Big Data analytics calls this approach into question, with **Visual Age™** being a key factor.

Visual Age™ refers to the physiological age of the eye (the required addition) and is generally correlated with the patient's chronological age.
Visual Age™ is a new concept adopted by Shamir to help ideally suit progressive lenses to patients' visual needs.
A patient may still be young, and look and feel young, but their eyes may need some extra support for close and intermediate tasks.

The question that ultimately led to the development of the new advanced progressive lens, Shamir Autograph Intelligence™, was this: **Is there a correlation between Visual Age™ and visual needs?**

To answer this question, two studies were conducted:

- An external research into the behavior and habits of presbyopes, and the full range of their
- visual needs.
- An internal study consisting of in-depth interviews to learn about visual preferences.

Prior to embarking on these studies, categories of visual needs were defined.

Visual needs

Daily activities are divided among 5 major categories based mainly on viewing distance:

- **Far vision** used mainly for outdoor activities such as driving, walking, etc.
- **Switch distances frequency** refers to eyes switching focus from one vision zone to another
- **Intermediate vision** used mainly during office work in front of a desktop computer
- **Digital reading** mainly used for handheld digital devices such as smartphones and tablets
- **Near vision** used mainly during writing or reading a book, newspaper, etc.

Daily Activities Evaluated

Reading Books and/or Newspaper

Smartphone or Tablet

Computer Use

Frequency of switching from one vision zone to another

Driving and Outdoor

Visual Needs

■ Near

■ Digital Reading

■ Intermediate

■ Switch Distances Frequency

■ Far

External Research Conducted for Shamir

Research was conducted in the United States on a large population of 1,300 presbyopes regarding their behaviors and habits. The research subjects included 62% women and 38% men, all of them above 40 years of age, from a range of socio-economic levels, and geographically dispersed throughout the USA.

Female **62%**	› 40-45 years old	(459 participants)
	› 46-50 years old	(270 participants)
	› 51-55 years old	(144 participants)
Male **38%**	› 56-60 years old	(128 participants)
	› 60+ years old	(300 participants)

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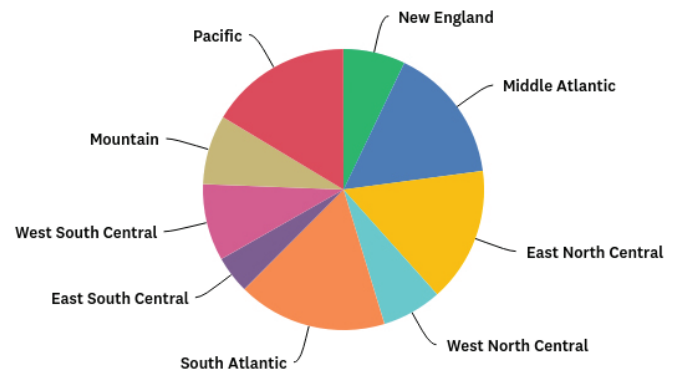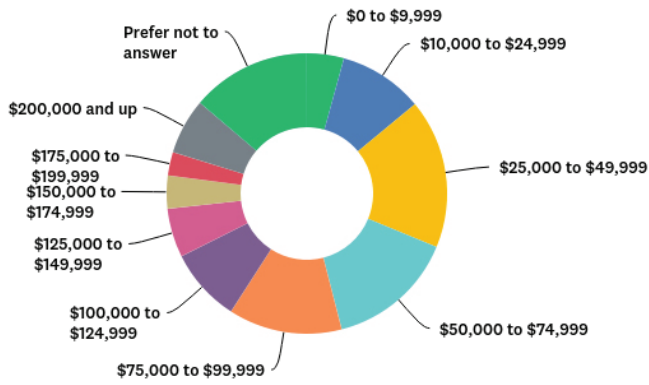
The research subjects were asked to complete a detailed questionnaire regarding their lifestyle. The questionnaires asked respondents how much time they spend on a variety of tasks, what activities they regularly engage in (that define their lifestyle), what devices they regularly use and for how long, and all questions related differentially to weekdays and weekends.

Respondents' habits were examined regarding the following tasks:

- Driving
- Amount of time using a computer during the course of the day
- Outdoor activities such as sport engaged in
- Use of smartphone or tablets – whether for phone calls or other uses such as reading, surfing the Net, games, and so on.
- Frequency of smartphone use – how many times per hour the respondent looks at their phone
- Varied use of Internet – for online shopping, reading, and so on.

In addition, the questionnaire asked about vision correction: Do you use glasses or contact lenses? If so, for what purpose – distance viewing / near viewing. When was your last eye examination?

We organized our research data into age groups, for each visual need. At a later stage, we converted the age groups to Visual Age™, based on commonly accepted charts that show the correlation between chronological age and required lens addition.

"Personal Lens" Study Conducted by Shamir's R&D Department
During 2017-18 Shamir's R&D Department conducted an internal research. Research subjects included 130 presbyopes, ages 40 to 80. They underwent a comprehensive interview conducted by Shamir's optical designers and optometrists. The aim was to ascertain definitively, each subject's visual needs based on their behavior and habits, that is, on the activities they engage in during work hours, at home, during hobbies, outdoor activities, and so on. The overall aim was to fit each person with a "personal lens" ideally suited to their needs.

The respondents were also requested to rate the importance of various visual needs to their lifestyle.
The results of this research closely corresponded with those of the external research with regard to visual needs as a function of Visual Age™.

The second phase of this study included a clinical verification comparing a washout pair of lenses (base line design) to a specially designed lens adapted to the visual preference profile of the wearer. These specially designed lenses became later the prototypes for the new "genes" to create Shamir Autograph Intelligence™ lenses.
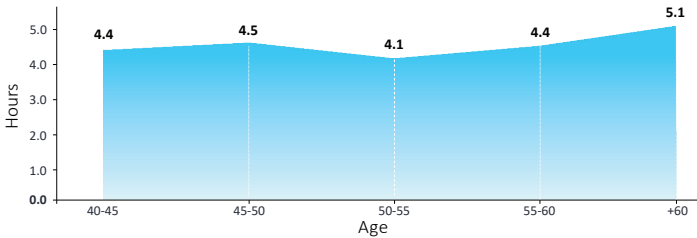
Research Results per Visual Need

Far Vision

Presbyopes of all ages tend to spend on average the same number of hours per week outdoors, with this number increasing slightly with age.

Example: Driving hours per day

Intermediate Vision and Digital Reading

The study revealed a clear trend regarding use of handheld digital devices – the younger the subject, the greater the use. Younger subjects use smartphones or tablets more than desktops. As age increases, use of digital devices decreases, with desktops more used than other handheld devices. Middle aged presbyopes demonstrate high use of both. Data on age related usage of digital devices is clearly illustrated in the graphs below.

Smartphones and tablets- hours / day
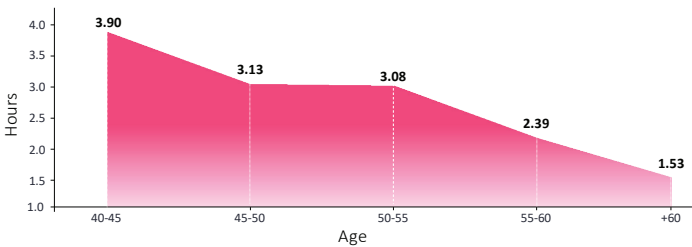
Computer- hours / day
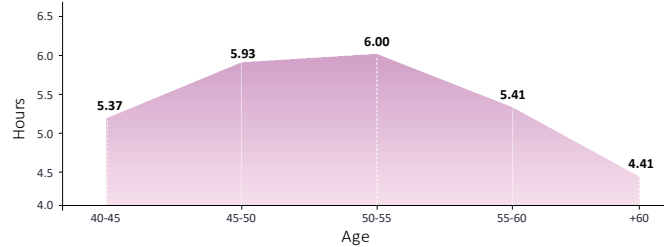
Near Vision

When asked about reading habits, use of the near viewing zone, respondents demonstrated a clear trend: use of and importance attributed to the near vision zone increases with age of presbyopes. Most reading by younger presbyopes is of digital devices, less of printed material. In contrast, presbyopes of age 60+ indicated that the near vision zone had the highest importance among their visual needs.

Reading hours a week

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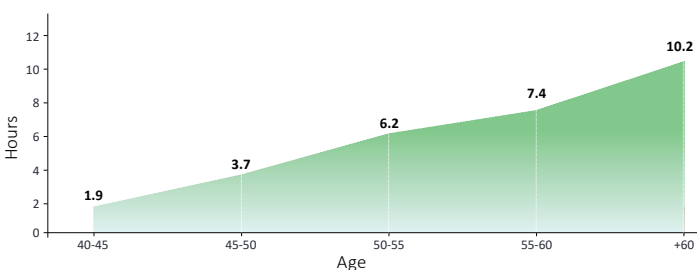
Switch distances frequency

One of the more interesting findings of the research showed that not only does the importance of visual distances vary among presbyopes by age, but also the amount of dynamic viewing – switching from one vision zone to another – changes with age. Younger presbyopes tend to display far more dynamic viewing, indicating that the need for flexibility and switching between vision zones is higher for younger age groups.

Look at smartphone more than 5 times an hour
(% of the age group)
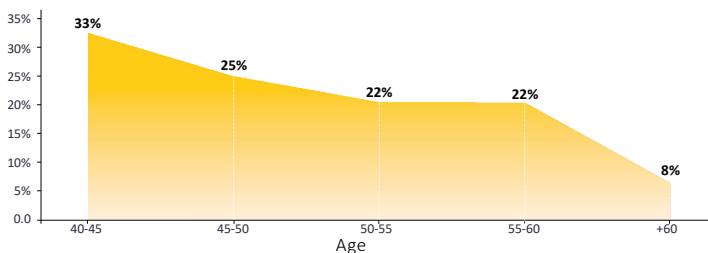
Big Data analysis of both the external and internal Shamir research reveals a consistent trend with a high correlation between the two.

At different Visual Ages, a correspondingly different importance is attributed to the various visual zones, reflecting visual needs.
In other words - Visual needs are a function of Visual Age^{TM}.

Visual Needs per Visual Age^{TM}

The following diagram summarizes the results of both researches regarding age-related preference of visual zones.
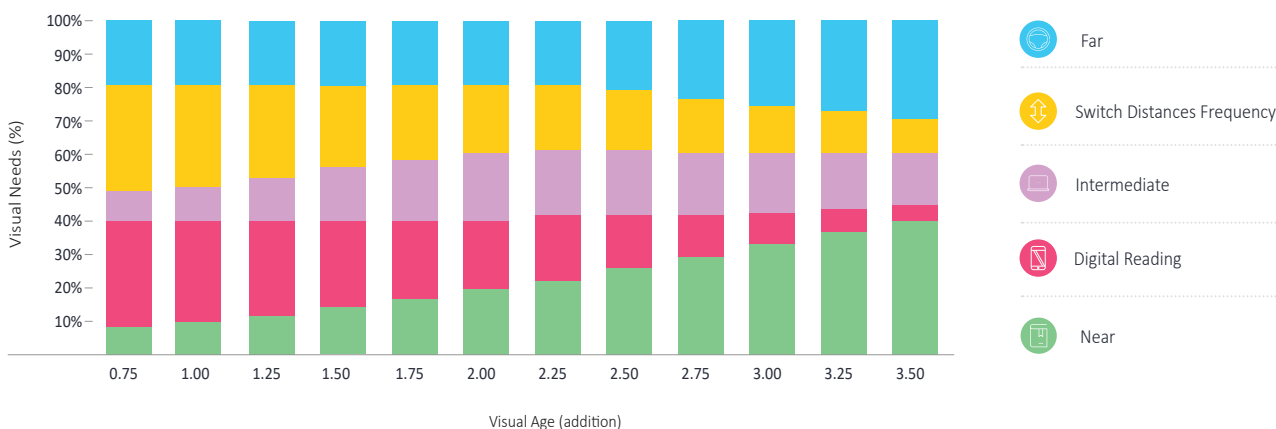
The diagram illustrates the varying profiles per Visual Age^{TM}.

- Younger presbyopes need a good solution for digital reading and support for dynamic vision. Near vision has lower priority. Reading is mainly done on handheld digital devices.
- Advanced presbyopes, by contrast, need a good solution for far and near vision, while switch distances frequency, intermediate vision and digital reading are lower priority.
- Middle age presbyopes demonstrate more balanced needs. All vision zones hold more or less equal importance.

# Extent to which visual needs are met

Current progressive lenses provide a reasonably good solution for visual needs, but they provide the same solution for everyone, while it transpires that visual needs are different at different Visual Ages. According to research findings, these differences develop gradually with age. It follows then, that any progressive design available today that takes an "everyone's the same" approach, can only meet the needs of a limited range of Visual Ages. People falling into other Visual Age[TM] groups will find the lenses less satisfying and may seek a different solution to better meet their needs. There is no Progressive product that addresses the visual needs of the total population of presbyopes.

HOW DOES SHAMIR AUTOGRAPH INTELLIGENCE[TM] MEET THE VISUAL NEEDS PER VISUAL AGE[TM]
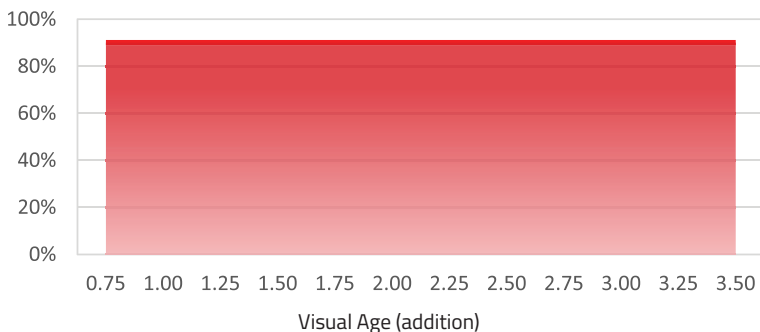
Shamir Autograph Intelligence[TM], meets the visual needs of most of the population at all Visual Ages

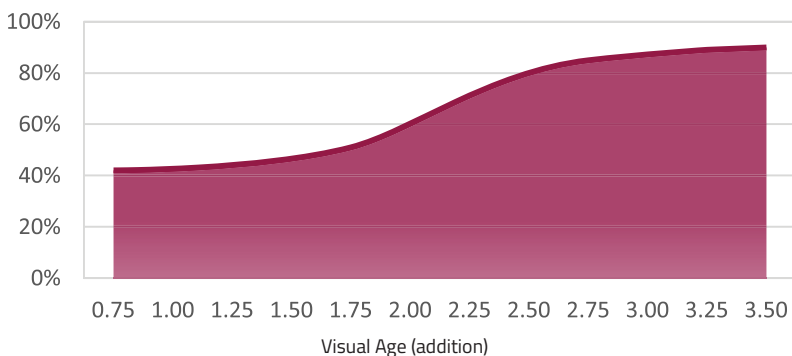HOW DOES A BALANCED LENS DESIGN MEET THE VISUAL NEEDS PER VISUAL AGE[TM]
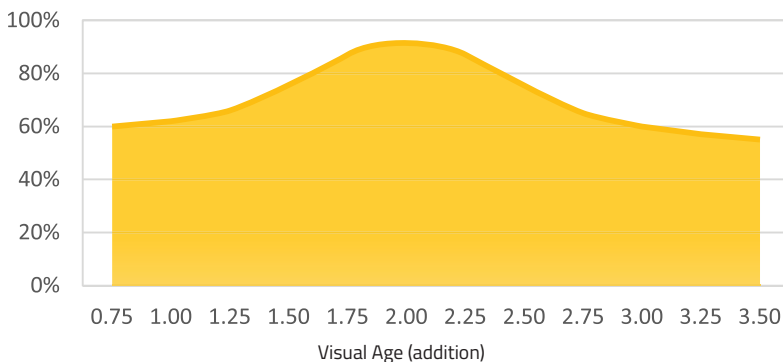
A balanced design meets the visual needs of most middle aged presbyopes

HOW DOES A DIGITAL LENS DESIGN MEET THE VISUAL NEEDS PER VISUAL AGE[TM]
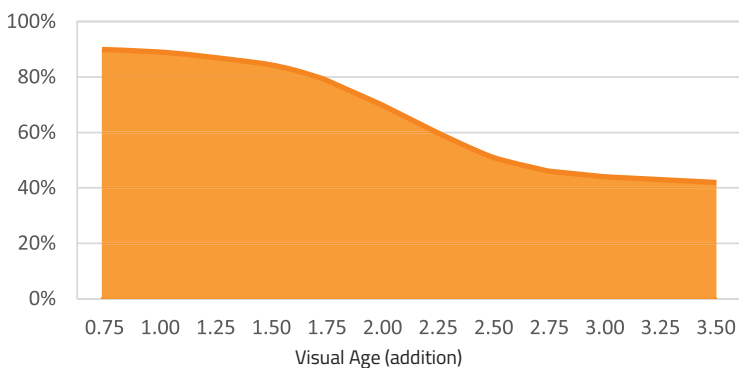
A design for digital viewing meets the visual needs of young presbyopes better

HOW DOES A NEAR AND FAR LENS DESIGN MEET THE VISUAL NEEDS PER VISUAL AGE[TM]

A design mainly for far and near viewing meets the visual needs of older presbyopes better

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HOW DOES DIFFERENT LENS DESIGNS MEET THE VISUAL NEEDS PER VISUAL AGE^{TM}

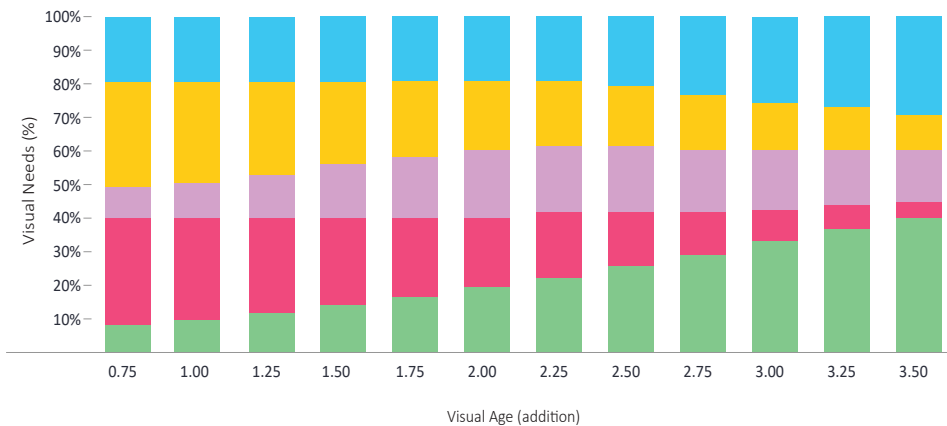Shamir Autograph Intelligence™ — Balanced — Digital — Near and Far
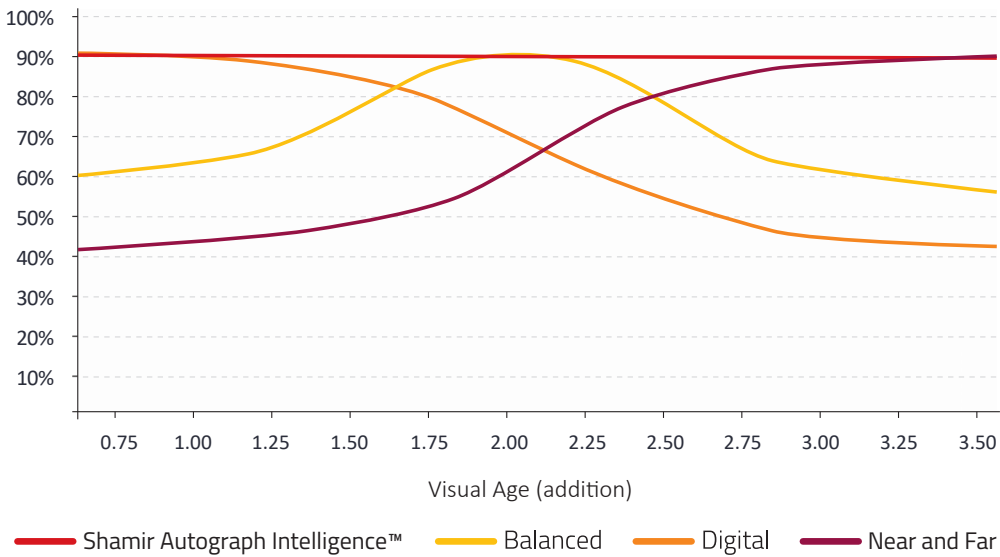
The diagrams below illustrate the differences between an "everyone's the same" design concept, that is, a balanced design giving equal attention to every vision zone, and the actual visual needs of most of the population.

EXAMPLE OF BALANCED DESIGN
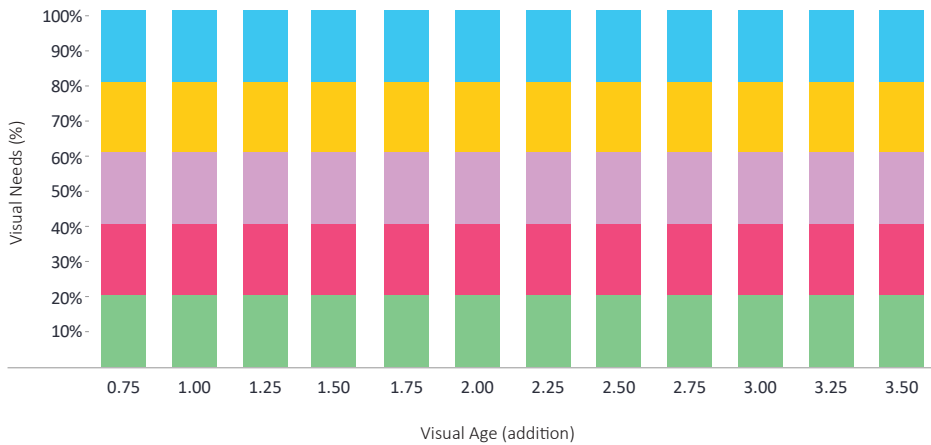
VISUAL NEEDS ACCORDING TO RESEARCH FINDINGS

The Solution:

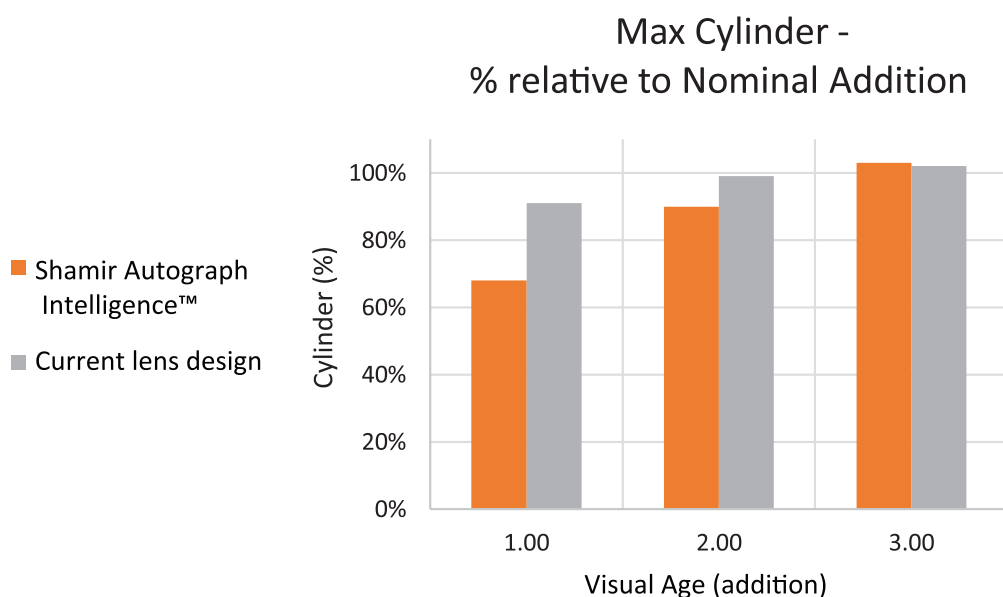### Continuous Design – Lens Design per Visual Needs

Having found a correlation between visual needs and Visual Age™, the logical conclusion was that there is a need for a progressive lens that meets the continuum of visual needs. Rather than a lens design assuming that everyone is the same, or using a questionnaire to verify what one's actual needs are, we need a lens design that takes visual diversity into account. This understanding led Shamir to develop its Continuous Design Technology. Using this new technology, Shamir's optical designers integrated multiple design genes based on 12 different prototypes, one for each Visual Age™, introducing a continuum of gradual change to form the foundation of Shamir Autograph Intelligence™. Such uniquely designed progressive lenses will enable comfortable viewing that is ideally adapted to changing visual needs, with no need to compromise.

Shamir's new design technology also promises that individuals whose habits deviate from the Visual Age™ profile will still receive a satisfyingly personalized lens thanks to the new concept of Continuous Design Technology.

To understand the different lens design concepts, we need to compare designs of different Visual Ages. In order to make the comparison, we have normalized the values of the design parameters by expressing them in percentages of the nominal addition. Below are some examples, illustrated by accompanying diagrams, comparing Shamir Autograph Intelligence™ lenses per Visual Age™, with a current lens design.

Maximum Cylinder

In the current lens design the maximum cylinder is quite constant - between 90% to 100% of the nominal addition for the entire range. In Shamir Autograph Intelligence™, the maximum cylinder ratio significantly grows with Visual Age™, with values between 68% to 102%, demonstrating a great advantage for younger Visual Ages. At the same time it directly contributes to ease of vision zone switching, which occurs at a higher frequency among younger presbyopes.

Max Cylinder -
% relative to Nominal Addition

■ Shamir Autograph
   Intelligence™

■ Current lens design

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Digital Reading Width

With Continuous Design, the digital reading width of Shamir Autograph Intelligence™ lenses changes per Visual Age™, whereas it remains a fixed value in the current lens design. The relative width of this zone per Visual Age™ 1.00 is 60% higher than for a Visual Age™ of 3.00. This fully meets the visual needs for those characterized by frequent digital reading.
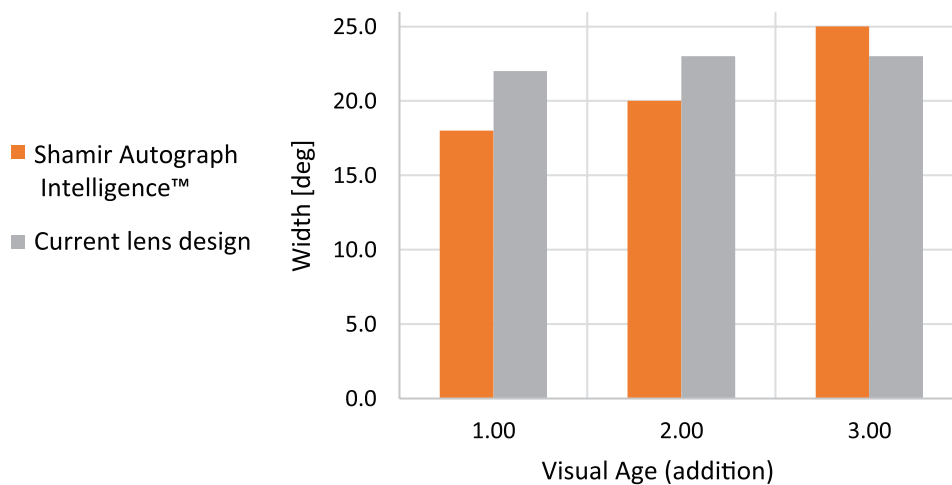
Digital Cylinder Width of 25% Total Addition
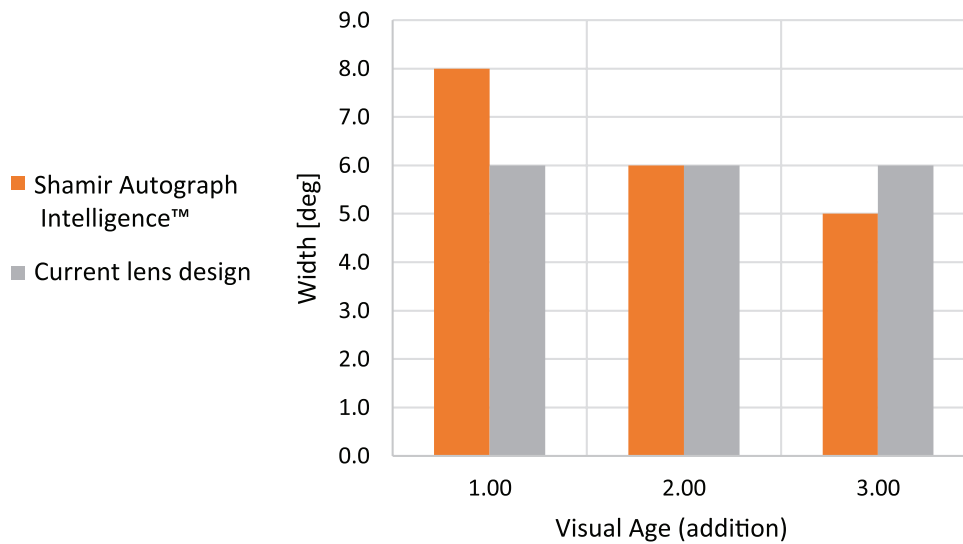
Addition Width

In the reading area, the addition width (75% of addition) changes significantly with Visual Age™ from 17° to 25° in accordance with demonstrated near vision needs. The reading zone width in a current lens design remains 22° to 23°.

### Addition Width at 75% of Total Addition

IntelliCorridor™ Technology in Shamir Autograph Intelligence™

IntelliCorridor Technology is the ability to fit the corridor profile to every design concept. Until now the same corridor concept of a product was applied to all Visual Ages.

This proven technology is now utilized in Shamir Autograph Intelligence, providing a unique addition progression to suit every Visual Age™ based on its particular visual needs and HEIM (Head Eye Integrative Movement) findings.

Unique Corridor Profile per Visual Age -
% of Addition
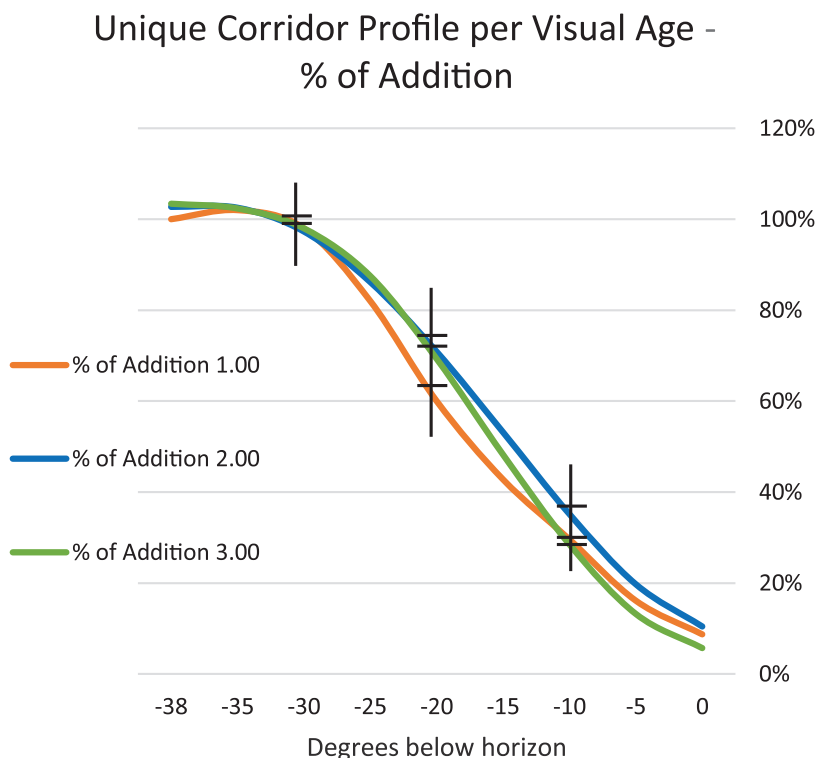
Eye-Point Technology AI™

Until now, Eye-Point Technology III used simulations of the human eye and real-world images to improve visual acuity and width of vision for every prescription. Using a new software, Head Eye Integrative Movement (HEIM), developed by Shamir engineers, we tracked exactly through which areas in the lens patients actually look, along both the vertical and horizontal meridians in the different vision zones. This technology now enables us to design a lens that takes into account actual viewing angles computed for every distance.

Previously, our designs were based on simulated eye movement. Now we actually know where the eye looks. Whereas in the past we simulated, now we see.

Shamir Visual AI Engine™

Visual AI Engine implements the continuous design concept along the entire matrix of optimization parameters such as: sphere, add, face-form angle, pantoscopic tilt, fitting height, base curve and index. Mimicking human intelligence, the engine runs a multi-dimensional optimization process, based on the various design genes. The complex design required for Shamir Autograph Intelligence™ would have been too demanding to achieve without the new technology of the Visual AI Engine. The end result is a product ahead of its time, designed with extreme accuracy for each Visual Age™.

In conclusion:

Shamir Autograph Intelligence™ is a new progressive lens whose vision zones are designed according to the visual needs of the patient's Visual Age™, as demonstrated in our studies. Shamir Autograph Intelligence™ takes visual diversity into account and provides the right solution for patients at every Visual Age, with no need for questionnaires or applications.
Shamir has taken on the responsibility for meeting patients' needs, thereby releasing the ECP and the patient from the need for any additional verification regarding lifestyle.

The new lens design concept allows us to provide an optimal visual solution for every Visual Age™ without compromise. The first progressive lens to seriously take this into account, Shamir Autograph Intelligence™ provides a better visual solution to a broader population of presbyopes, in one product.
What's more, given future lifestyle changes and increasing longevity, visual needs per Visual Age™ may vary and change. Shamir's new technology and design concept opens the door for continuous evolution of this lens design concept.

SHAMIR