The Progressive Lens Maze

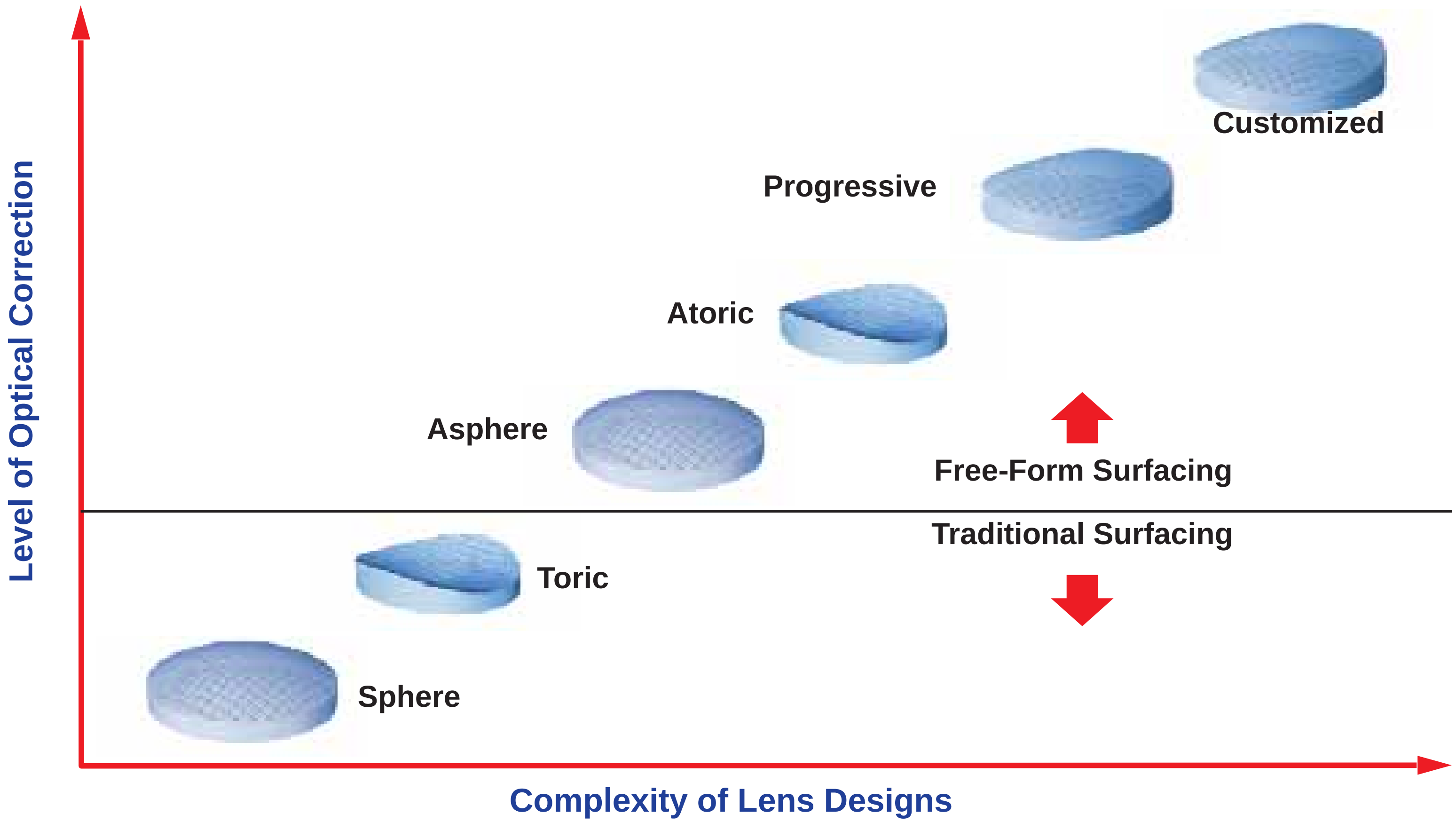
Brent McCardle

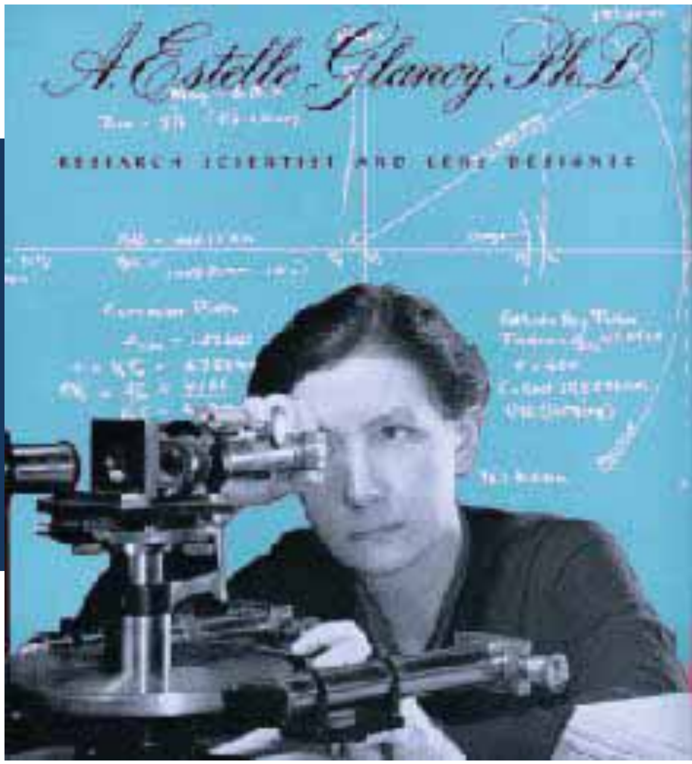
The complexity of lens surfaces has evolved with lens surfacing technology

As surfacing techniques have advanced over the years, the possible level of surface complexity has also increased

Timeline	Surfacing Technology	Surface Complexity
Pre 1950s	Hand Pans	Crude Spherical Surfaces
Late 1950s	Biaxial Generators	Crude Toric Surfaces
Late 1980s	Three-Axis Generators	Accurate Toric Surfaces
Late 1990s	Free-Form Generators	Accurate Complex Surfaces

Free Form


Level of Optical Correction
Customized
Progressive
Atoric
Asphere
Free-Form Surfacing
Traditional Surfacing
Toric
Sphere
Complexity of Lens Designs



Estelle Glancy

First Lady of Optics

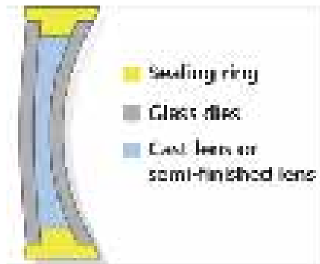
Dr. Estelle Glancy's patent on progressive lenses (1923)

Progressive Lens History

- 1959 - 1st generation Bernard Maitenaz 1959 by Essel then merged with Silor which became Essilor, Varilux 1
- 1970 - 2nd generation Gradal and Varilux 2 1970’s, moved away from spherical structure to an ellipse structure. Improved periphery with less distortion
- 1980 - 3rd generation Gerhard Fürter of Zeiss patented horizontal symmetry in 1981 which gave equal visual impressions and comfortable binocular vision, SOLA XL, Hoyalux 3, Gradal HS, AO TruVision. Investment started in CNC machinery
- 1990 - 4th generation major developments in computer aided design brought Varilux Comfort, AO PRO, AO Compact, Gradal RD
- 1995 - , patent granted to Zeiss where a progressive could be optimized for each individual Rx, GT2 and Varilux Panamic
- 2000 - 5th Generation, patent granted to Zeiss for a progressive lens with a spherical front, but all parameters could be individualized(i.e. vertex, pantoscopic tilt and face for), Individual, Hoyalux ID
- 2006 - 6th generation, more improvements in free form processing and lens design
- 2012 - 7th generation, Zeiss Individual 2, Essilor S-series, Hoya MyStyle, Shamir Autograph III

Traditional lens manufacturing
Traditional/semi-finished lenses

Manufacturer develops a lens design



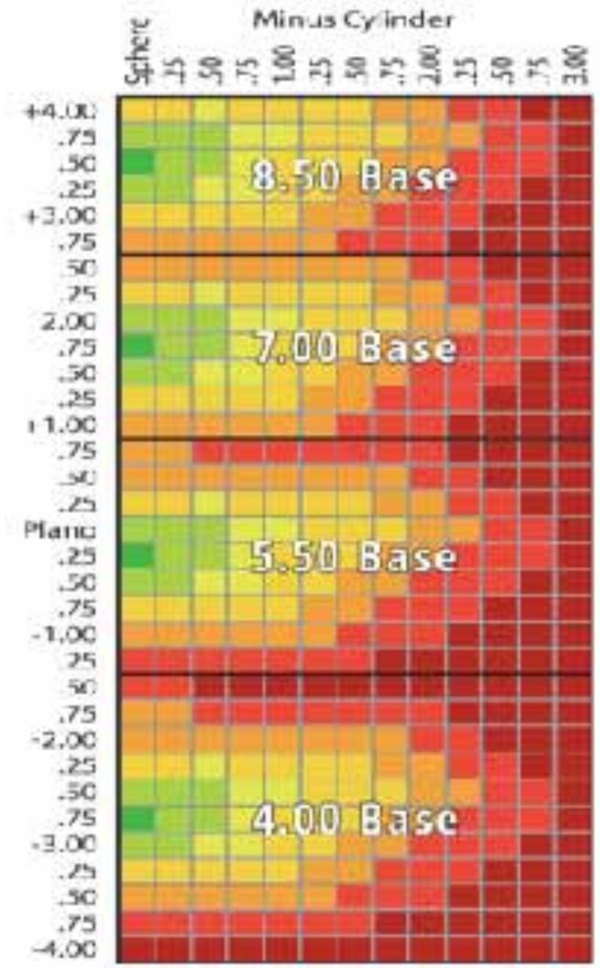
Moulds of the design are built. The liquid lens material is poured into the **mould**. The finished product is a semi-finished blank.

The prescription is ground (surfaced) onto the back of the blank. Progressive **design remains static** on the front.

With traditional surfacing, the finished product is translucent. Rough, **sandpaper-like pads** on a hard rotating disc are needed to polish the lens until it is clear.

Molded Limitations

- Many prescription combinations will deliver reduced optical performance
- Traditional lens design is based on a distance of 27mm from the eye's center of rotation to the back of the lens
- Optical performance will be degraded as the Rx moves away from the optimal base curve



Design by Prescription®

Combining variable-inset with base curve and visual field optimization**, Design by prescription®** means:

- The design of the viewing zones is modified, based on the characteristics of the patient. Thus, the lens design responds much better to the needs of the patient’s ametropia.
- Each base curve and add power combination has been optimized to ensure that the designs deliver the same versatility and balanced performance for every patient.

MYOPES: EMMETROPES: HYPEROPES:

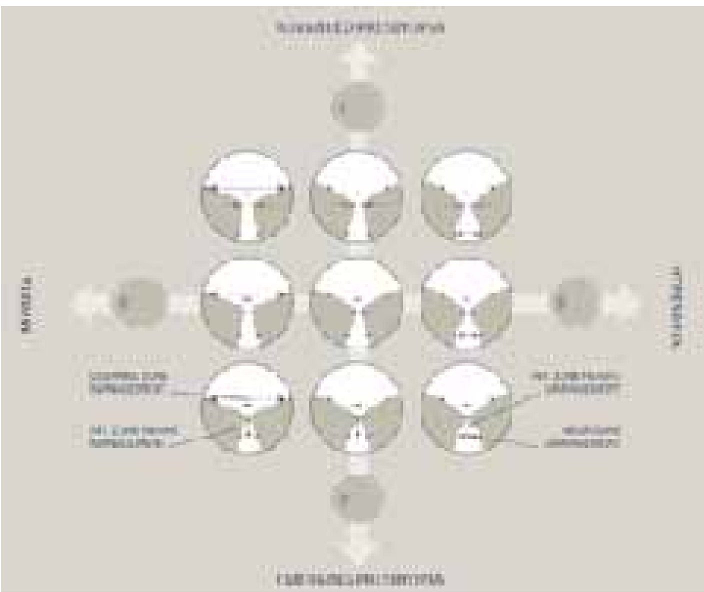
Myopes are frequently more critical concerning their distance vision when using progressive lenses. Design by prescription® lenses use flatter base curves and incorporate a wider distance zone.

Emmetropes expect minimal compromise in distance zone, and no varying distortion of objects effect in near vision.
Design by prescription® lenses offer balanced viewing zones, for a more comfortable vision at all distances.

Hyperopes rely on progressive lenses for reading (and sometimes cannot see clearly at any distance without using their lenses).
Design by prescription® lenses integrate higher base curves and a wider near zone.

Physiologically Mapped Optics®

Pushing the boundaries of Design by Prescription® one step forward, **Physiologically Mapped Optics®** introduces corridor shaping following the map of physiological needs of presbyopes of different age, add power and distance prescription



Physiologically mapped for presbyopia

Emerging presbyopes are used to unrestricted near vision and still can see objects at mid-range distances through either the distance zone or near zone of the lens. PMO incorporates a short progression length and an easily accessible reading utility for early presbyopes.

Advanced presbyopes have lost their ability to focus on both up-close and mid-range objects.
PMO presents a long intermediate zone that is also wide using a unique lens design for every addition power.

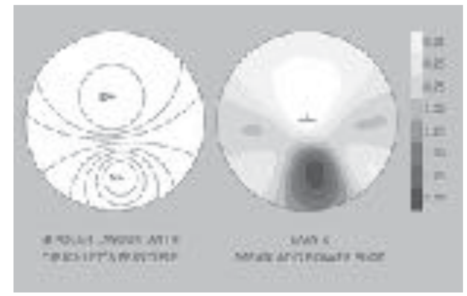
Physiologically mapped for ametropia

Myopes are more demanding for their distance vision through progressive lenses.
PMO uses flat base curves and incorporates a wide distance zone.

Hyperopes really rely on progressive lenses for reading.
PMO integrates higher base curves and a wide near zone.

Dual-polar Design Technology

Dual-polar layout used with Dirichlet's principle smoothing distributes the power and astigmatism in a very natural manner between distance and near vision zones, which serve as the two "poles." As a result, it has a smooth progressive lens optics providing the patient with a natural vision experience.



Superposition design is created by a weighted mathematical average of a "hard" and a "soft" type lens design.
The result is an excellent viewing zone utility, even in smaller frames, while maintaining a smooth and usable periphery.

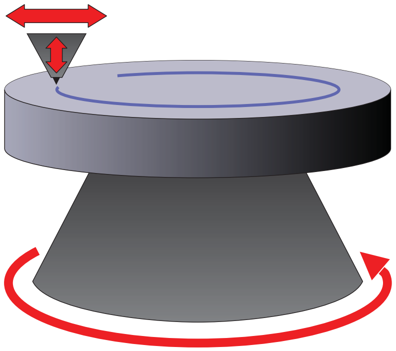
Converting Traditional to FF compensated lenses

Power	Ordered Addition			
	+1.00	**+1.50**	**+2.00**	**+2.50**
-6.00	+0.86	+1.42	+1.95	+2.47
-4.00	+0.89	+1.46	+2.00	+2.55
-2.00	+0.97	+1.46	+2.00	+2.55
0.00	+1.08	+1.68	+2.27	+2.89
+2.00	+1.21	+1.84	+2.45	+3.00
+4.00	+1.30	+1.93	+2.43	+3.06
+6.00	+1.42	+1.90	+2.32	+2.98

Free-Form

- The lens is rotated at high speed around one axis, while a diamond tool moves across the surface to score away material
- The vertical position of the diamond tool is precisely adjusted by a computer to produce the desired height at each point

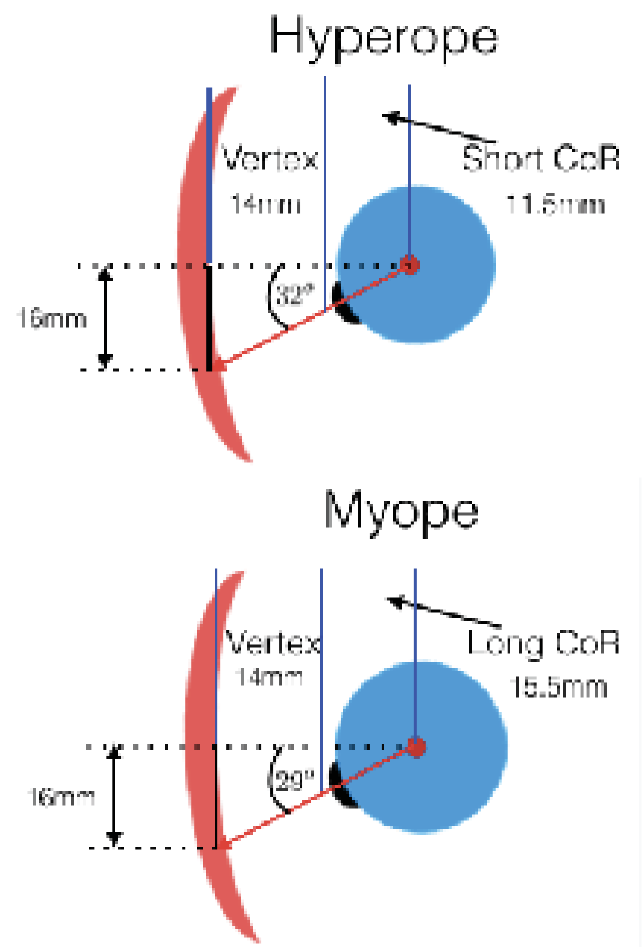
Free-Form Surfacing Using Single-Point Diamond Turning



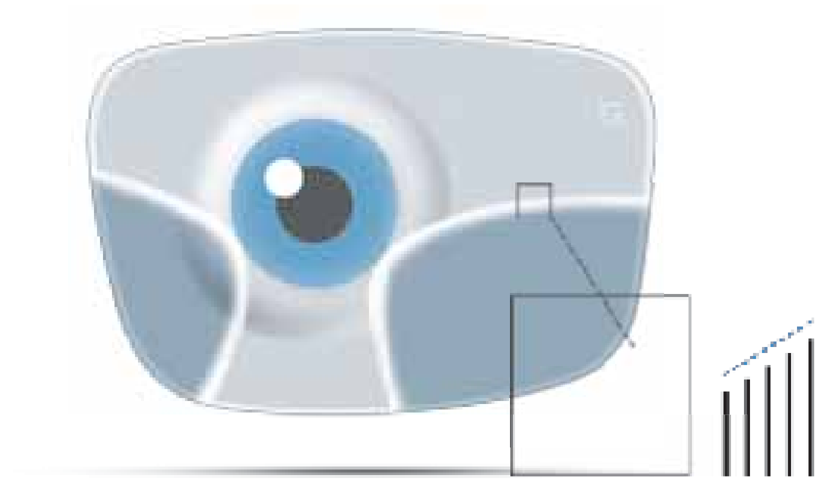
Three Axes of Movement In Single-Point Diamond Turning

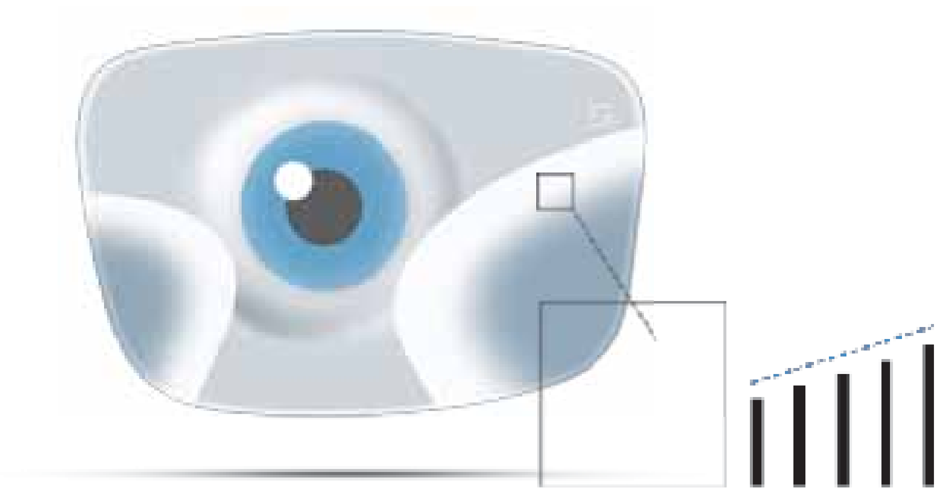
Corridor Length

- Because we know the CoR, lens manufacturers can create different corridor lengths for different prescriptions
- The hyperope has to look further down to reach the same point as a myope.(i.e. a hyperope needs a slightly different corridor length than a myope)
- Zeiss and Essilor are the only ones who use CoR. Essilor Varilux S 4D

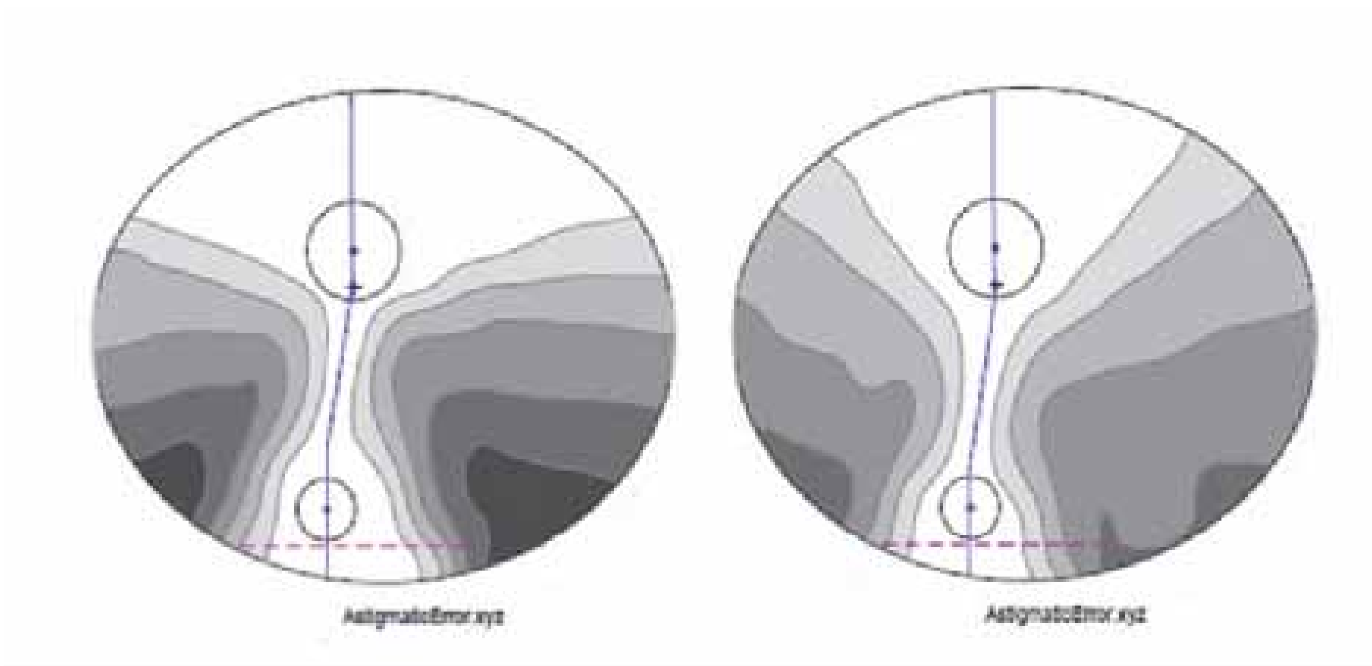


Soft Vs Hard





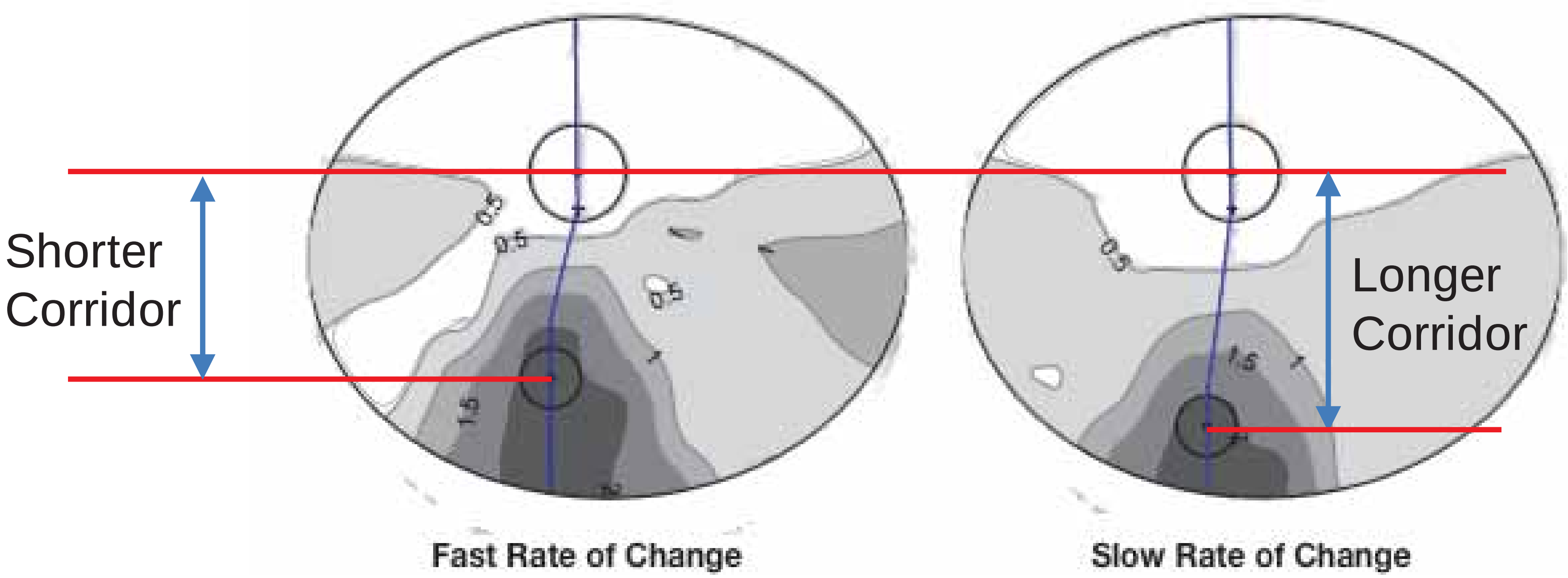
Contour Plots



Hard Design

Soft Design

Corridor Length



Variable vs Fixed Corridor

- Variable corridor varies with the fitting height, PoW, BC, CoR, Distance and Near Power

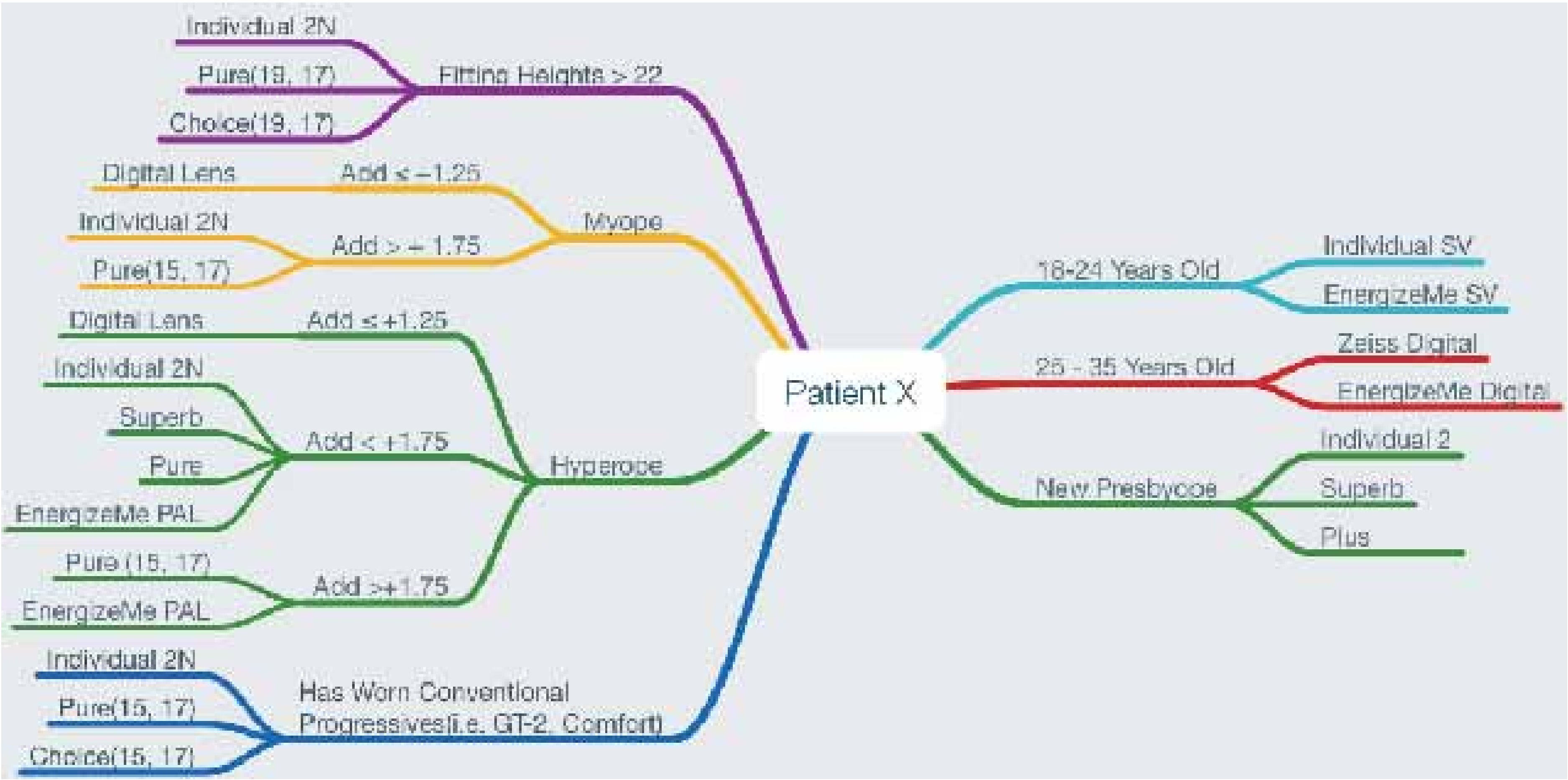
- Fixed remains the same regardless of any parameter
- Usually the length will be 4mm less than the fitting height
- i.e. Zeiss Pure 13 has a 9mm corridor

Fitting Heights Corridor's

Fitting Height Comparison	ZEISS Choice 13 Corridor Length	ZEISS Choice 13 Corridor Width	ZEISS Choice 13 Near Height	ZEISS Choice 13 Near Width	ZEISS Choice 15 Corridor Length	ZEISS Choice 15 Corridor Width	ZEISS Choice 15 Near Height	ZEISS Choice 15 Near Width	ZEISS Choice 17 Corridor Length	ZEISS Choice 17 Corridor Width	ZEISS Choice 17 Near Height	ZEISS Choice 17 Near Width	ZEISS Choice 19 Corridor Length	ZEISS Choice 19 Corridor Width	ZEISS Choice 19 Near Height	ZEISS Choice 19 Near Width	ZEISS Choice 21 Corridor Length	ZEISS Choice 21 Corridor Width	ZEISS Choice 21 Near Height	ZEISS Choice 21 Near Width
13	9.0	5.9	4.0	10.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	9.0	5.9	5.0	11.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	9.0	5.9	6.0	12.0	10.0	6.1	5.0	11.5	—	—	—	—	—	—	—	—	—	—	—	—
16	9.0	5.9	7.0	12.8	10.0	6.1	6.0	12.2	—	—	—	—	—	—	—	—	—	—	—	—
17	9.0	5.9	8.0	13.6	10.0	6.1	7.0	13.0	12.0	6.9	5.0	12.4	—	—	—	—	—	—	—	—
18	9.0	5.9	9.0	14.6	10.0	6.1	8.0	13.9	12.0	6.9	6.0	13.1	—	—	—	—	—	—	—	—
19	9.0	5.9	10.0	15.6	10.0	6.1	9.0	14.9	12.0	6.9	7.0	13.9	14.0	7.9	5.0	13.2	—	—	—	—
20	9.0	5.9	11.0	16.5	10.0	6.1	10.0	15.8	12.0	6.9	8.0	14.9	14.0	7.9	6.0	14.0	—	—	—	—
21	9.0	5.9	12.0	17.1	10.0	6.1	11.0	16.6	12.0	6.9	9.0	15.9	14.0	7.9	7.0	14.9	15.0	8.4	6.0	14.4
22	9.0	5.9	13.0	17.7	10.0	6.1	12.0	17.3	12.0	6.9	10.0	16.9	14.0	7.9	8.0	15.9	15.0	8.4	7.0	15.3
23	9.0	5.9	14.0	18.3	10.0	6.1	13.0	17.9	12.0	6.9	11.0	17.7	14.0	7.9	9.0	16.9	15.0	8.4	8.0	16.4
24	9.0	5.9	15.0	18.8	10.0	6.1	14.0	18.4	12.0	6.9	12.0	18.3	14.0	7.9	10.0	17.9	15.0	8.4	9.0	17.5
25	9.0	5.9	16.0	19.4	10.0	6.1	15.0	18.9	12.0	6.9	13.0	18.9	14.0	7.9	11.0	18.7	15.0	8.4	10.0	18.6
26	9.0	5.9	17.0	20.1	10.0	6.1	16.0	19.6	12.0	6.9	14.0	19.5	14.0	7.9	12.0	19.4	15.0	8.4	11.0	19.4


Patient X
Fitting Heights > 22
13-15mm Corridors
Myope
Hard Design Progressive
Add ≤ +1.25
Anti-Fatigue
Variable Corridor
Add < +1.75
Variable Corridor
Add ≥ +1.75
11-13mm Corridors
Hyperope
Soft Design Progressive
Add ≤ +1.25
Anti-Fatigue Lens
Add < +1.75
Variable Corridor
Add > +1.75
11-13mm Corridor
Conventional Progressive Wearer
Non-Compensated Lenses
11-13mm Corridors
If Compensated 11mm Corridor
Heavy Computer Wearer
Computer Lens
Age 18-24
Anti-Fatigue with a 0.40 Add
Age 25-45
Anti-Fatigue
Myope/Emmetrope Age 25 - 35
0.50 Add
Myope/Emmetrope Age 35 - 45
0.75 Add
Hyperope Age 25-35
0.75 Add
Hyperope Age 35-45
1.00 Add
New Presbyope
Variable Corridor

Zeiss Lenses



ZEISS	Essilor	Hoya	Shamir
Individual 2/2I/2N * **Precision Superb ***	**Varilux S 4D * §** **Varilux S Fit *** **Varilux X 4D * §** **Varilux X Fit *** **Varilux Physio W3+ Eyecode * §** **Varilux Comfort W2+ Eyecode * §**		**Autograph III Variable ***
Precision Plus †	**Varilux Physio W3+ Fit *** **Varilux Comfort W2+ Fit ***		
Precision Pure † **(13, 15, 17, 19, 21)**	**Definity 3 plus ***	**MyStyle (11, 14, 16)(Ht 14, 17) *** **LifeStyle 2 Clarity (11, 14) *** **LifeStyle 2 Harmony (11, 14) *** **Summit ecp iQ (18)** **Summit cd iQ (14)**	**Autograph III Fixed *** **Autograph II (11, 13, 15, 18) ***
EnergizeMe PAL (14, 16, 18) †			**Spectrum + (14, 16, 18) ‡** **Spectrum (14, 16,18)**
Choice (13, 15, 17, 19) ‡	**Varilux Physio W3+ ‡** **Varilux Comfort W2+ ‡** **Varilux Physio DRx ‡** **Varilux Comfort DRx ‡** **Definity ‡** **Definity 3 ‡**	**Summit ecp (18)** **Summit cd (14)**	**InTouch (15, 18)** **Element (16, 19)**
ZEISS Digital (0.50 - 1.25)	**Eyezen +1 (0.40)** **Eyezen +2 (0.60)** **Eyezen +3 (0.85)**	**Sync 5 (0.53)** **Sync 8 (0.88)**	**FirstPAL (0.50 - 1.50) ‡**

ZEISS	Unity	Kodak	Seiko
Individual 2/2I/2N * Precision Superb *	VIA Elite (12 - 18) * VIA Plus (12 -18) * VIA Mobile (12 - 18) *		Superior *
Precision Plus †			
Precision Pure † (13, 15, 17, 19, 21)		DSII (13 - 18) * Unique HD (13 - 18) *	Surmount WS (Hard Design) * Prestige II Wide (Hard) †
EnergizeMe PAL (14, 16, 18) †			Surmount (Soft Design) * Prestige II (Soft) †
Choice (13, 15, 17, 19) ‡	VIA (12, 14, 16, 18) ‡	Unique DS (13 - 18) ‡ Digital ‡ Precise PB ‡ Precise ‡	Supernal ‡ Supercede II ‡ Perfas Prominent (14, 16, 18) ‡ Perfas Premier II ‡