Comfort, comfort, comfort…. one of the key objectives of lens manufacturers is to ensure the patients who wear their lenses feel the true benefits of a great fitting product that's comfortable to wear and delivers accurate vision correction – the basics of any good lens product!

Today, modern materials, manufacturing technologies and metrology progressively provide the 'tools' needed to accomplish these 'simple' needs! For years, lens manufacturers have relied on skilled artisans to accomplish individually tailored lenses. Never more than at the present time, have lens designs become more varied. The growing demand for 'custom' made lenses, push the boundaries of manufacturing to their limits.

Investing in new machine technology alone, will not deliver on that patient requirement without understanding what's important about the way in which those manufacturing tools are set-up. Furthermore, the benefits of new lens design features or process methods can never be fully realised unless these 'basics' are implemented correctly.

The 'basics' still make the difference between success and failure. It may seem obvious when reading this article, but so often, good calibration and inspection of critical aspects of lens equipment is not given the attention it deserves.

A lathing odyssey, not to be taken for granted…

Modern day lens manufacturing lathes are typically X/Y linear (Orthogonal) configuration as opposed to the former R-Theta (Rotary axis) set-up. Lens curves are created by moving both X and Y axes simultaneously, in synchronisation…..you could also think of this format as that of an X/Y Plotter.

By their nature, orthogonal machines are CNC controlled in order to ensure absolute synchronisation, accurate to sub-micron measurements. But just because a machine is 'computer' controlled, doesn't mean that by itself, every lens will be machined to the exact parameters. Set-up and Calibration are essential to make the most of this highly accurate machine control.

Orthogonal means "perpendicular to, or at right-angles to"; X and Y axes must be square to each other. A heavy tool crash or some other adverse pressure to tools or spindle nose, has the potential to dislodge even the most substantial components on a machine. Check this regularly and especially after a machine 'crash'!

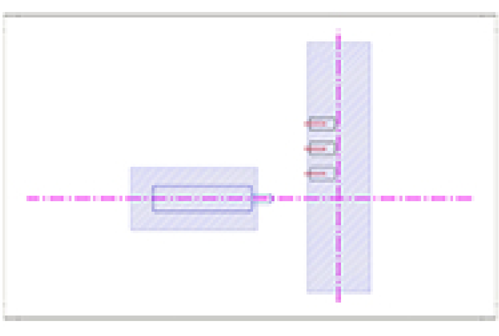
Fig 1a: Axes must be orthogonal

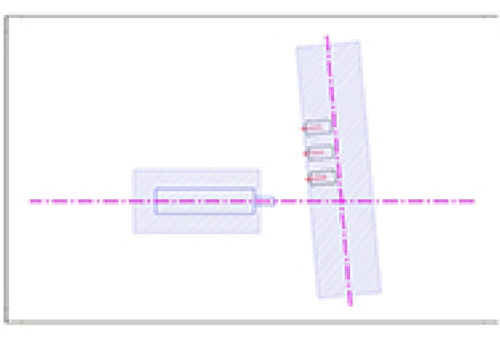
Fig 1b: Incorrect tool slide alignment

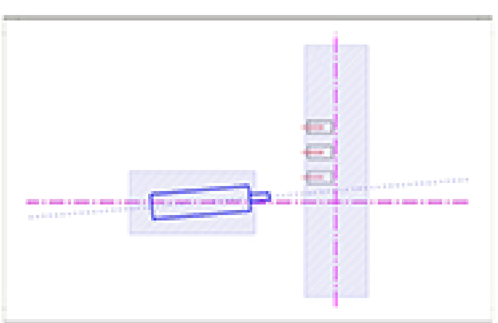
Fig 1c: Incorrect spindle alignment

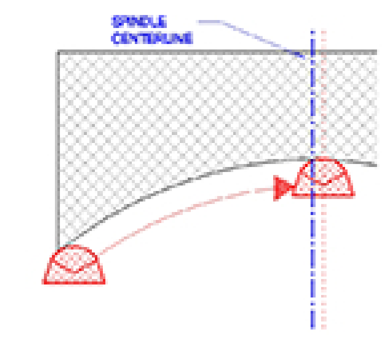

Fig 2a: Too far past centre!

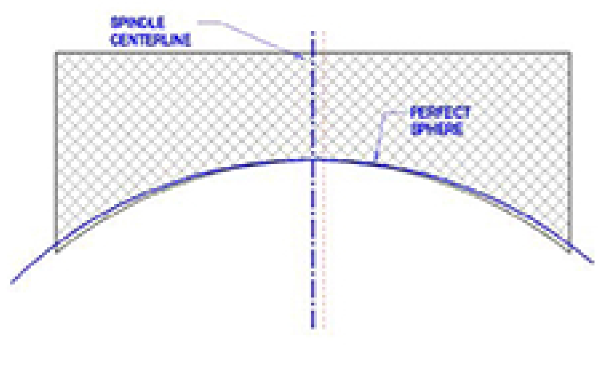

Fig 2b: It will be more than just an edge problem

Equally, if the tool doesn't travel fully to the centre, then a small raised area at the centre of the lens surface is left from the form of the tool which could be impossible to polish out or remove in any other way. That could certainly compromise visual acuity of the lens and it will *increase* the lens diameter.

Either of these lateral errors means the desired back surface geometry cannot be reached and will not match with the front surface correctly.

The way in which these orthogonal machine configurations function, means that a large area of the diamond tool radius is used when generating the lens radii, so it's imperative to use controlled waviness tools for all finishing operations at the lathing stage.

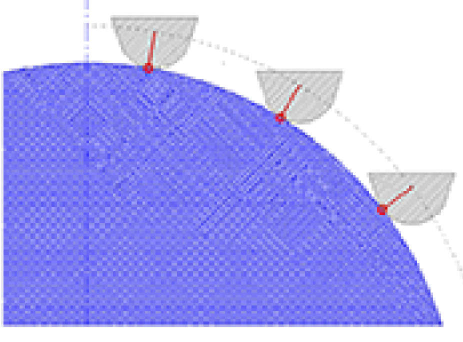
Fig 3: Controlled Waviness tools help retain accurate lens radii and shape

The roughing tool calibration can be just as important. If it isn't aligned with the spindle centre, it may result in a finish tool that doesn't 'clean up' the lens surface where the final cut depth is very small.

Even the choice you make for tool geometry can have an impact on the final lens shape and quality if not selected with care. High water content soft materials will often require tools with greater clearance angles than mid or lower water content versions. GP materials may benefit from differing tool designs if making standard or large diameter (Scleral) lens types.

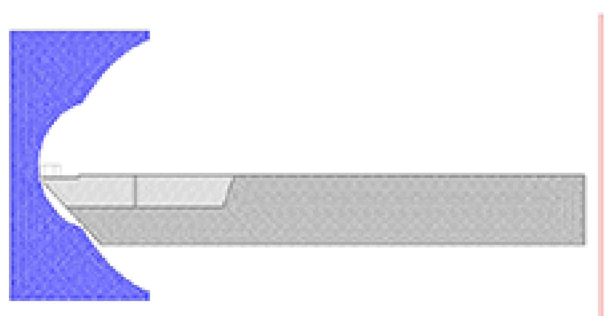
Fig 4a: Clearance angle

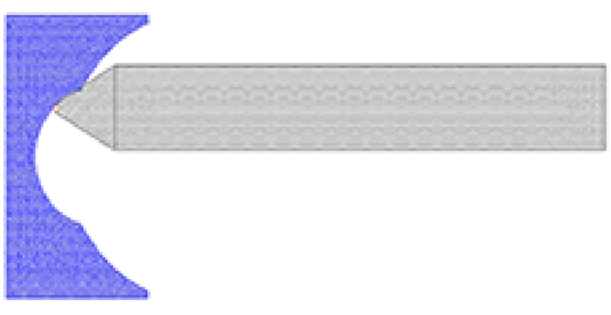
Fig 4b: Inclusive angle

Block your progress at your own peril….

Largely ignored or even dismissed as a relatively unimportant part of the lens making process is that of Blocking! Why would you spend your hard-earned money on a high precision machine, only to continue using the same old methods and accessories and expect that the lathe and blocker will take care of those errors too!

Blocking systems and methods have been recently going through a transition of their own. Maybe the speciality lens business has forced some of this, but there is still increasing pressures to make the most of our resources and investments, which in turn, has encouraged the development of both existing and new Blocking machines. These new systems offer a range of capabilities to adapt to existing lab methods and to give the innovation needed to help labs achieve more consistently accurate blocking with less process steps.

Targeting consistency….

So you've aligned your lathe and optimised your blocking process, then here are a couple of fresh ideas to improve the control you have over your final lens edges…

Many lens processes still rely heavily on manually measuring each individual back surface central thickness and using that information in the lathe to determine the final lens centre thickness. The potential for error is significant.

The use of pre-defined blank thickness (Base Curve Target Centre Thickness) is a technique designed to eliminate lens thickness errors that come from manual thickness measurements of individual base curves. Taking the largest saggital depth of your product range and setting the finished base curve central thickness, means that no matter what lens design you use, your central material thickness always ends up the same and the desired final lens thickness becomes a simple calculation for the machine. Leaving you with accurate centre thicknesses, lens after lens.

It's a comfortable feeling….

Standard edge cutting versus Bevel edge cutting – Another technique for improved lens edges and wearer comfort is the way in which the lens edge is produced. The standard method with most CNC lathes is to simply rotate a very small spherical radius that produces the edge radius for the desired edge thickness. One of the many advantages of full CNC lathe control is that of multi-zone edge curves, allowing the user to create asymmetric edge shapes to suit many differing conditions of lens comfort, fit and tear flow.

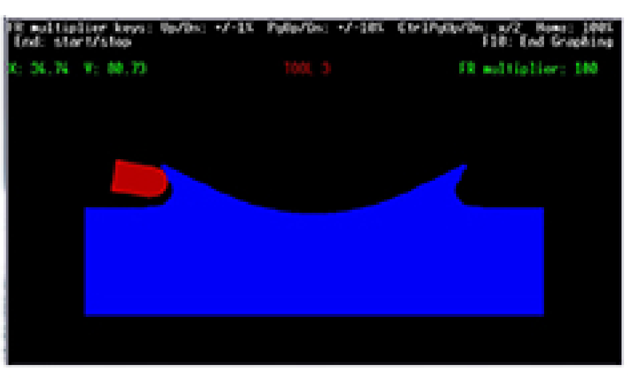
Fig 5: The lens edge is an integral part of the back surface geometry

The range of edge detail could be extensive and offers many advantages for different types of lens fit and wearer comfort. Manufacturing tolerances and a large variety of equipment means that the challenges as set-out above, for achieving good calibration and equipment set-up, can be just as varied. So, we need to explore other ways to assist in achieving the correct edge control and customer satisfaction. One such technique is to extend the edge radius machining further into the front peripheral area of the lens – otherwise referred to here, as the 'Bevel Edge'.

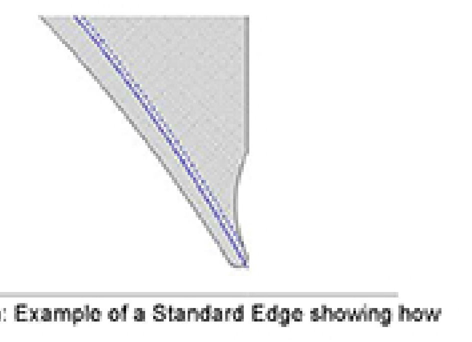
Fig 6a: Example of a Standard Edge showing how even the smallest deviation of front surface relative to the edge radius can leave an incomplete lens edge

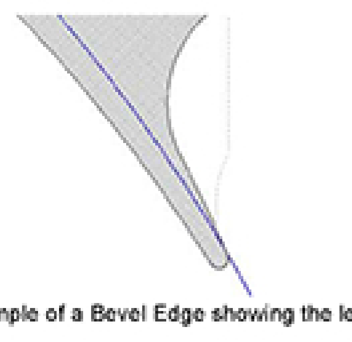
Fig 6b: Example of a Bevel Edge showing the length of bevel zone that can accommodate small deviations from blocking or poor lathe set-up

As can be seen in Fig6a above, there is little margin for error when the edge radius from the lathe, finishes at the end-point/intersection of the front peripheral curve. By extending the edge radius cut with a 'steeper' front bevel curve (Fig6b) that need be no more than 0.5mm zone width, could accommodate typical tolerance errors of blocking and/or front curve misalignments and so avoid the problems of sharp or even stepped edges.

Make the most of your resources and give yourself the edge….

Improved metrology, lens fitting techniques and CNC lathing technology has given rise to even greater speciality lenses, custom made in every detail for complete patient satisfaction. The more complex optical geometries and some new lens materials, have given rise to an increase in Polish-free lens manufacturing. Lens junctions, peripheral and edge details are fast becoming an even higher priority.

As little as 2 or 3 microns deviation between a lens edge form and the intersecting peripheral curve can be easily felt by a lens wearer. So it's imperative that you take a closer look at the investments you've made and re-check your internal QC procedures to maximise the benefits of all your investments. But don't stop looking, talk to your equipment suppliers, they have a wealth of experience from across the industry and new markets or applications, maybe they have a solution for you….one that can ***give you the edge*** in a fast changing market!

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