Restoring Sight with Laser Fit Lenses

By Melissa Fassbender, Associate Editor

The concept of the contact lens was described by Leonardo da Vinci in 1508. Lacking the technology to realize his idea, the first contact wasn't created until centuries later.

"They used to take molds of the eye, like dental molds," explains Dr. Greg Gemoules, optometrist and owner of Laserfit Vision. "A plastic impression was taken, and then the lenses were thermal formed to conform to the shape of the eye mold."

A prototypical lens dating back to the 19th century, scleral lenses were originally made in the same fashion. Engineered from a ridged lens material, the lenses are not technically "contact lenses," in that they do not make contact with the corneal surface. This unique property makes them ideal for individuals with diseased, injured, or otherwise defective eyes.

Falling into disuse because the materials were not oxygen permeable, the scleral lens lost popularity until the technology's resurgence in the 1970s with the development of rigid gas permeable (RGP) materials.

"The modality of this lens fell into the background until someone applied new RGP materials to the lens, thereby making it healthier and setting the stage for its comeback," explains Gemoules.

Digital processes have since replaced molds for a more precise fit, improved vision, and comfort, a process for which Dr. Gemoules has multiple patents pending.

The fluorescein pattern of the lens on the eye. Photo: Dr. Greg Gemoules.

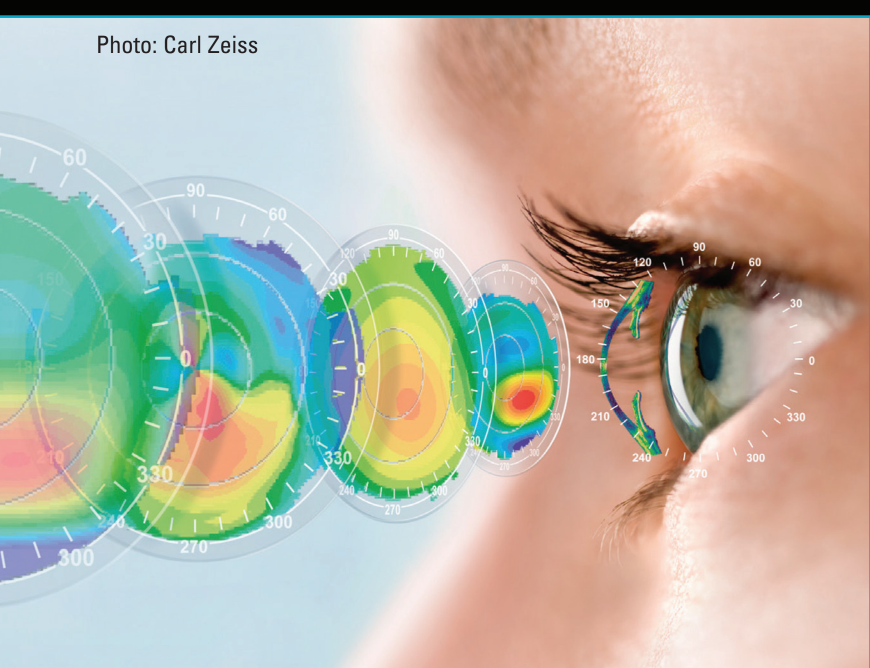


Photo: Carl Zeiss

Process

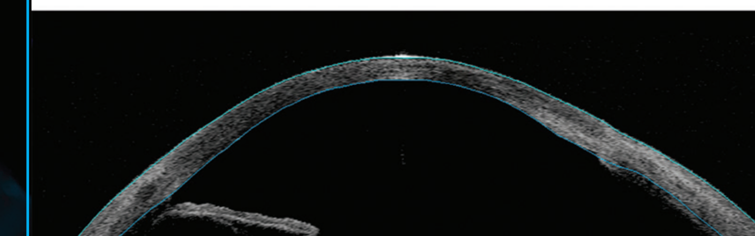
In contrast to the trial lens or empirical method that involves a kit of lenses made for the average eye (or the antiquated use of molds) Gemoules' method makes use of advanced imaging systems.

"Eyes are diverse, so we needed an image-based approach," says Gemoules. "Unfortunately, there was no imaging system specifically for scleral lenses."

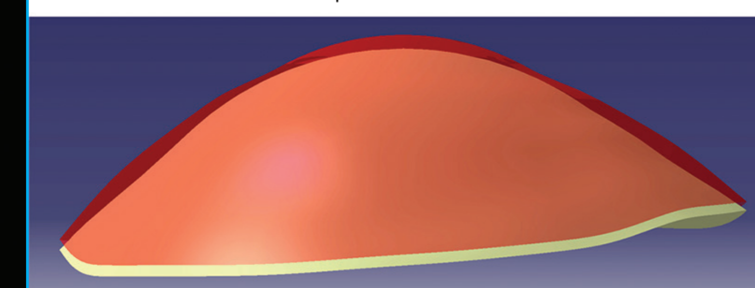
To overcome this challenge, Gemoules turned to optical coherence tomography (OCT), a non-invasive imaging test that uses light waves to take cross-section pictures. A process analogous to an ultrasound, OCT uses light instead of sound.

"OCT devices are making huge inroads into medical diagnostics, not just for eyes, but for other parts of the body," he explains. Following the development of the technology, Gemoules brought a loaner unit into his office to test its ability to scan the eye. "I thought that it might work ... and it did. That was the beginning of it."

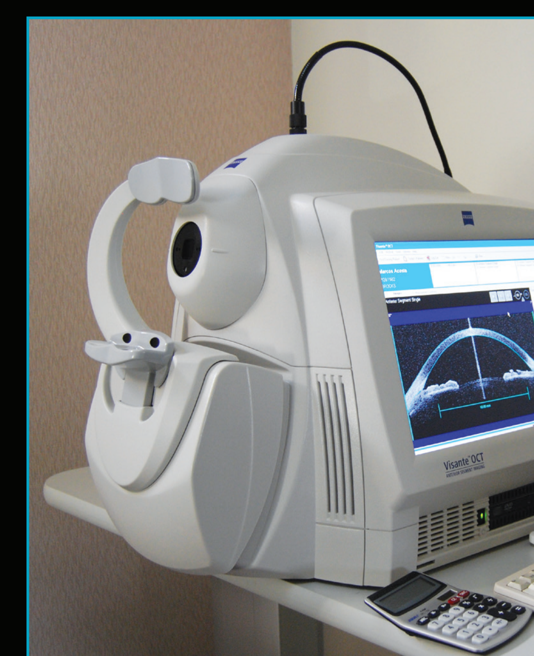
The process begins by using a topographer to create a map of the cornea. A ray-tracing wavefront aberrometer then provides a detailed analysis of the eye. After a number of OCT scans are taken, they are assembled into 3D model using CAD software (U.S. patent 7,862,176 and other patents pending).



OCT scan of anterior eye in 0 -180 meridian showing missing iris and lens



Proposed LASERFIT lens



Visante Optical Coherence Tomography Unit. Photo: Dr. Greg Gemoules.

At his practice, Gemoules uses the Visante OCT from Carl Zeiss. The device uses an interferometer with a low coherence diode laser, sending light along two optical paths: the sample path into the eye, and the reference path of the interferometer. The intersecting paths result in an accurate image of the eye.

The wavefront abberrometer, an FDA approved laser device, measures more than 44 different optical characteristics, all of which are incorporated into the lens in order to cancel out the aberration of the eye.

Scientists have been using wavefront-guided treatments in order to improve LASIK outcomes for years. Yet the idea of individualized wavefront optics in contact lenses was long ago abandoned by the scientific community as being unachievable. "This was primarily because lenses were too unstable on the eye," explains Gemoules.

However, after noticing the inherent on-eye centering and non-rotational properties of his lenses, Gemoules realized the potential for individualized corrections. Now he routinely uses this technology to obtain better visual results.

Simplifying Spreadsheets

While Gemoules was one of the first to use these advanced imaging techniques, it wasn't until recently that he began using CAD to design the lenses.

"I was using a lot of spreadsheets to do the calculations," explains Gemoules, who had to use multiple platforms to assemble his data.

With patients coming in on a Monday, and out the door with complete contacts by Friday, there was little time for error. After being introduced to Inceptra, a partner of Dassault Systemes, providing CATIA product lifecycle management (PLM) solutions, Gemoules was able to scale back on the number of spreadsheets, making iterations and adjustments much quicker.

"When you aren't working in 3D, you can't see the finished product," he explains. "Now, I can manipulate the contacts and develop a template eye that we can use to engineer the product."

Before using CATIA, Gemoules was unable to manipulate the image in 3D and the scrap rate for the lenses was as high as 30% or 40%, a rate that has been cut down to virtually zero.

Manufactured by Truform Optics, a Bedford, Texas company, the lenses are made from polymer buttons cut from extruded rods using three diamond tools used in the process: roughing, edging, and an oscillating "waviness" finishing tool for sub-nanometer precision.

Individual Customized Optics

The average reported improvement in visual acuity is between one to two lines. This means that 20/30 becomes 20/25, 20/20, or better. One patient obtained better than 20/10 vision. Because of the ultra-clear vision, patients in visually demanding occupations or sports might find the scleral lenses useful.

Gemoules is in the process of reaching out to various professional sports teams, and has been contacted by the Army, which is looking to fit soldiers coming back from Afghanistan with the specialized lenses.

As OCT technology and the scleral lens keep improving, the applications for a rigid, large diameter contact could expand to other applications including medicine delivery. PDD