Clark Optical Consulting and Prototyping, LLC

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Optical Design

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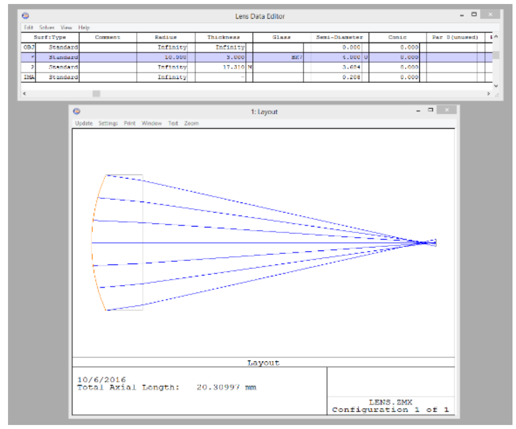
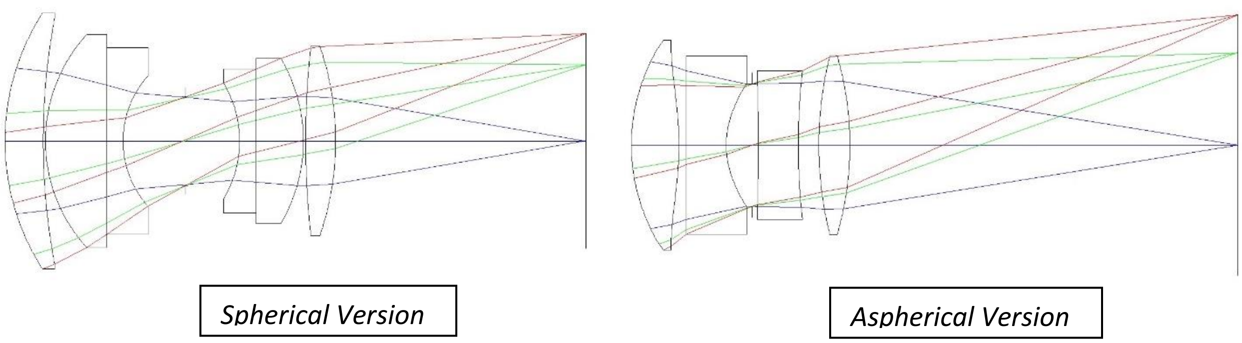
My goal when doing any optical design is to use the fewest number of elements possible in order to reliably get the job done to the required specification. This may require the use of a simple, single spherical surfaced lens, or it may require 3-5 such elements, and in some cases, the performance requirements may even require 20 or more lenses to be used. Knowing when to use more or less elements requires experience. Because I’ve worked in optical design for 20+ years, I have the knowledge and experience to know what choice to make.



Singlet—sometimes very simple optics do the job. Don’t over design

A typical optical designer is constantly looking for ways to reduce the number of lenses and make the system perform to the highest level needed. Technological advances over the past many years has made the use of aspherical lens common. Most photographic lenses available today contain aspherical surfaces. I have worked over the years to understand when and where to use aspherical lenses. Aspherical lens can have advantages over spherical surfaced lenses, for example, using aspherical lenses can often reduce the total number of optical elements needed for a given performance specification, reducing overall weight and size. Aspherical lenses may also be used to increase the optical performance over a larger field of view.



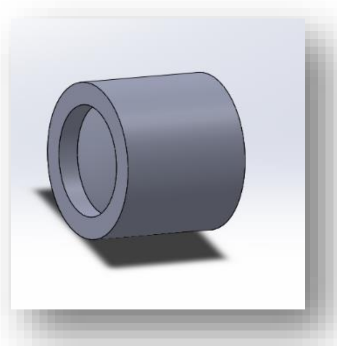
Simple camera designs can have reduced lens count when aspheres are used. In this example the first two elements of the design on the right are aspheres. Both systems have comparable optical performance.

However, aspherical lenses will not solve every problem. They tend to be expensive, though with advances in lens shaping technology the prices are coming down. They are more difficult to position accurately. They can also be more sensitive to alignment errors. But again, my knowledge and experience help me to know what choice to make.

The initial lens design is not the end of a project. Ensuring that the lenses are manufacturable and that the mechanical packaging constraints are met comes next. Optimizing any optical design to ensure that it is manufacturable takes care and experience with lens fabrication limits. It also requires knowledge of how to assemble/integrate the optics with the mechanics. Several iterations of lens design may be needed to ensure proper manufacturability and fit with the desired packaging constraints. Again, experience makes this stage in the optical design project go faster and produces with better results. We can help you!

Over the last 20 years in optical field, I have worked on many different types of optical design problems, from single element lenses used in optical fiber coupling, power collection and simple imaging to multi element wide angle rear projection TV lenses. I have found solutions to a wide range of optical design problems. I have also worked in illumination design. Though different from imaging system, illumination can be quite challenging. Obtaining a high power collection efficiency is a common requirement and getting there may require the use of special optical elements, such as light pipes, aspheric condenser lenses, lenslet arrays or even something else. Meeting the angular requirements of the light at a particular size of beam with a particular power requirement at times makes a solution seem impossible (the laws of physics simply cannot be broken.) Solid understanding and knowledge of optics fundamentals coupled with experience make even the toughest of problems solvable. That is what we do every day at Clark Optical Consulting and Prototyping, LLC.

In today's manufacturing environment plastic optics are often used to help reduce cost for higher volume products. Understanding the benefits of molded plastic optics is important. For example, molding makes aspherical surfaces the same price as spherical elements. Molding also allows mounting structures or reference structures to be created at the same time as the main optic, creating reliable and consistently mounted lenses possible. Because the bulk plastic material cost is often quite low, the cost per element of a molded plastic optics is low with sufficient volume. In order to take full advantage of these features in any optical design, understanding of the optical molding process is needed.



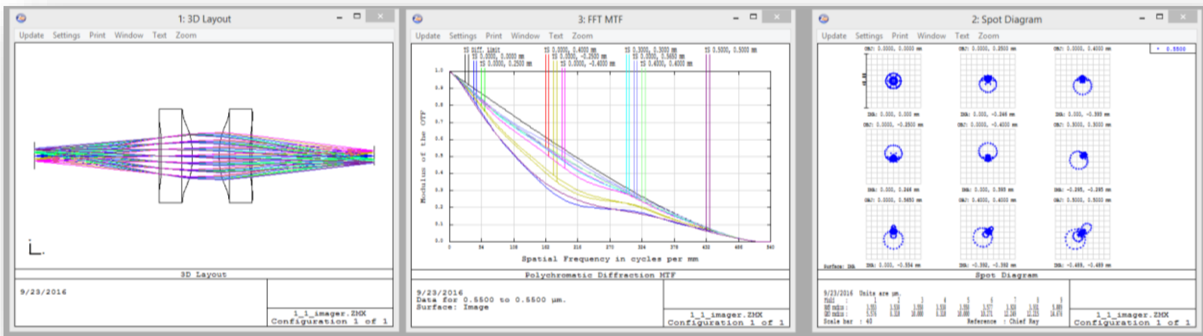
Plastic molded part with mounting flange—plastic parts can have alignment features molded right in for easy assembly and reduced part count.

The optical molding process has different design requirements than conventional glass fabrication. Edge thickness to center thickness rations are lower in a molded optic. Edge exclusions zones are larger, and there are lens surface slope limitations. They also have overall center thickness limitations, which can be much thinner than glass.

Plastics also have different environment and performance constraints than glass. Some plastics absorb more water than others, causing lens shape changes over humid operating environments. Some plastics are not transparent in the UV and most plastics have several absorption bands in the SWIR wavelength range, just to name a few.

Plastics are successfully used throughout the optics industry and may be of help with your project. During my years in industry I worked on multiple optical molding projects and have seen that plastic molded optics can be used effectively in many designs.

It is not possible to mention all the types of optical design types you might encounter but with sound optical engineering knowledge we can help your company meet your optical design needs.



1:1 imager—simple systems often have great performance.
No reason to over design