The Proper Care of OPTICS

CLEANING, HANDLING, STORAGE, AND SHIPPING,

2019 Update

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Contents

Preface

Of all the human senses, sight is the dominant one. The human brain receives most of its information in the form of visual stimulus, and optics plays an important role in delivering that information. Take, for example, a person using a digital camera to shoot a picture of the Grand Canyon. A person's eyes perceive the scene first, possibly while wearing eyeglasses, contacts, or sunglasses. Photons (light) from the sun are reflected or absorbed by the pigments in the canyon walls. The photons hit the first surface of the camera lens and are then refracted several times by the internal optical lenses. The collections of photons are focused on the surface of the imaging chip and stored, to be retrieved by a computer or printed onto paper. On the computer, the image is displayed on a screen, observed and adjusted. The image is then sent to a device to be printed or projected using internal optics. Fiber optic cables are used to send the image electronically.

We use optics every day, from the moment we wake up until we retire for the night:

- An alarm clock displays the time using lenses and LEDs;
- We view our reflection in a bathroom mirror;
- The headlights and taillights in vehicles have lenses and reflectors;
- When we drive down the road, reflectors guide us and keep us on the correct side of the road;
- Traffic lights control the flow of traffic, streetlights light the roadways, and video cameras monitor traffic;

- Digital projectors are used for meetings, computer screens display information, stage lighting in theaters use Fresnel lenses, and a microscope allows us to view microbes.

This book describes the cleaning, handling, and storage methods used by professional technicians and engineers to maintain optics. It is written for a diverse audience, from a first-time optical cleaner to a seasoned engineer who is looking for an old optical trick used many years ago. There are many ways to clean optics; some are learned from experience and/or failure. A few people will discover that these methods may differ from what they learned and question them. How to clean optics has always been a challenging and controversial subject. Searching the Internet will yield hundreds of articles and videos that claim to know the best methods.

Cleaning is one of the procedures used to keep an optical instrument at its peak performance. Dust, fingerprints, and stains can degrade even the best optical system, resulting in poor imaging. Failing to remove certain types of contamination in a timely manner can damage the optics or optical coatings. Cleaning consists of a series of simple, easy steps. To master these steps, all that is required is frequent practice.

Cleaning methods have improved since the 1960s with the start of the manufacturing of critical optics for aerospace applications and lasers. Surface quality specifications became tighter, and a so-called "commercial type finish" is no longer the norm. It is now common to have specifications for scratch and dig ranging from 40-20 to 10-5. Practically all particles must be removed to avoid interference with the image quality or the possibility of damage to critical electronics. Even partial monolayers of real contaminants can compromise coating performance and adherence. Newer materials and methods were developed to meet these new demands.

The storage of optics and optical systems is very important to maintain the optical surface cleanliness. Proper storage techniques for mounted and unmounted optics are discussed; storage for complex optical instruments (e.g., video cameras, film cameras, etc.) are not covered, although similar procedures can be used. Handling optics is

considered only as it applies to cleaning, protection, and storage. Other considerations such as shipping, assembly, and disassembly are also discussed.

I would like to thank my parents Robert and Carol Schalck and the many mentors who offered me encouragement and support throughout my career; John Young, Richard Luce, James Kent, Joe Linke, Robert Smith, Paul Zurakowski, Dr. William Humphrey, and the many engineers and technicians I had the pleasure of working with.

The author dedicates this book to his loving and supportive wife, Mary Catherine, and his wonderful son, Jonathan, his astronomy buddy.

An article in *The Atlantic* listed "optical lenses" as the fifth-most significant breakthrough since the invention of the wheel:[14]

> Refracting light through glass is one of those simple ideas that took a mysteriously long time to catch on. [...] The Romans had a glass industry, there is even a passage in Seneca about the optical effects of a glass bowl of water. [...] But it was centuries before the invention of eyeglasses dramatically raised the collective human IQ, and eventually led to the creation of the microscope and the telescope.

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