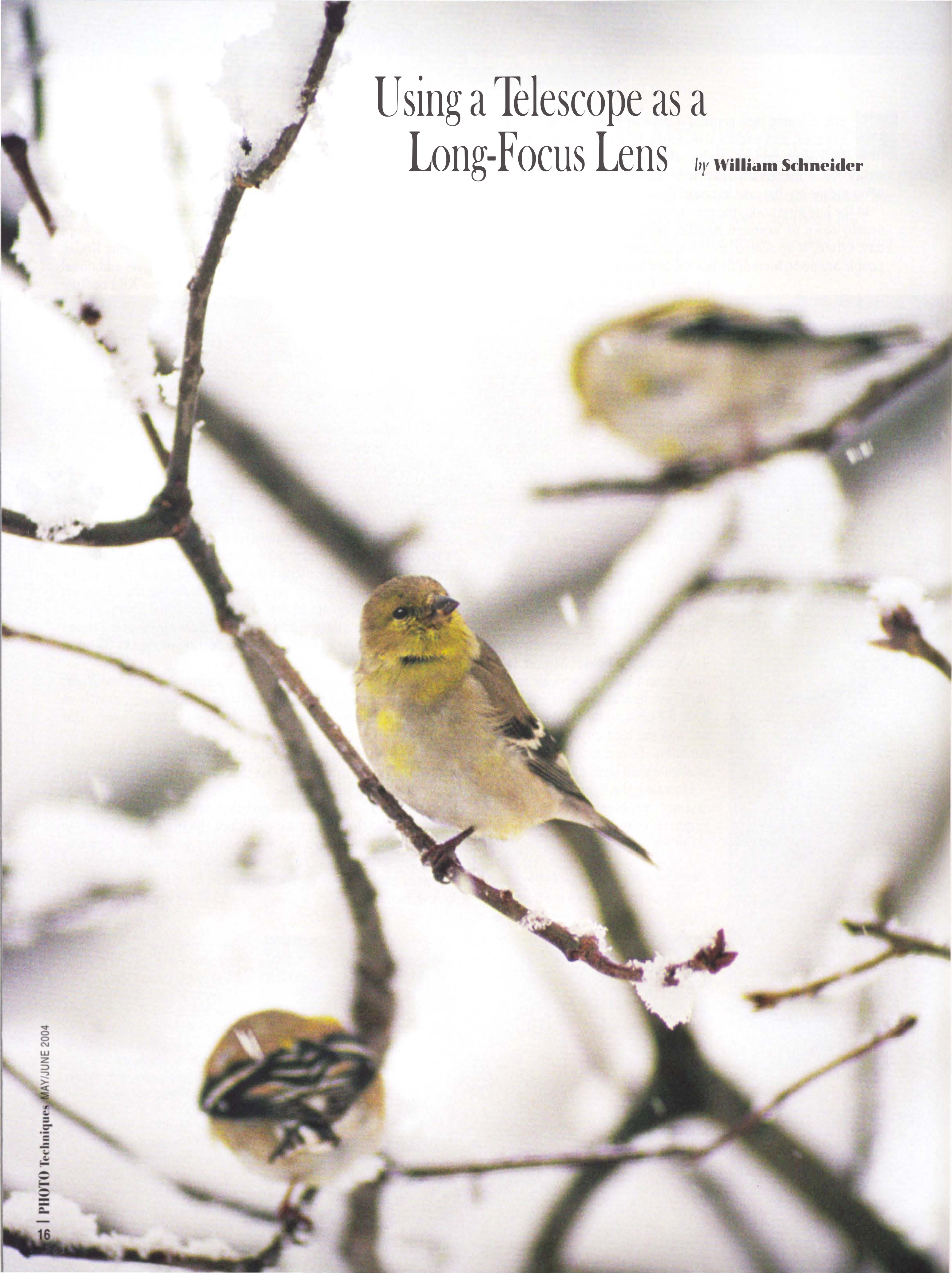
Using a Telescope as a Long-Focus Lens

by **William Schneider**



If you bought a telescope when Mars made its appearance last summer, you may have the makings of a fine telephoto lens. With the addition of a couple inexpensive adapters, you can use your telescope for daytime photographs.

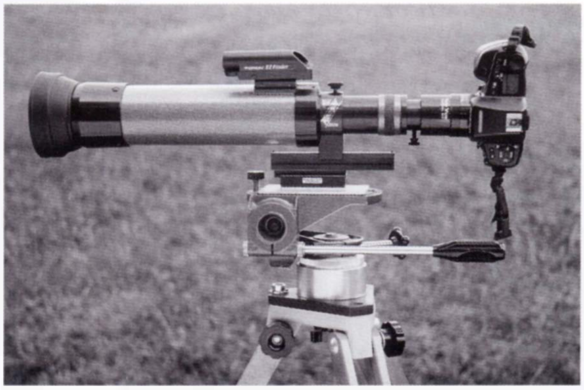


Figure 2. *With the appropriate adapters, a 35mm camera body can be fitted to a telescope for use as a long-focus lens. This photo shows the author's Tele Vue Ranger telescope mated to a Nikon N90s. A sturdy tripod is a must when using a telescope as a long-focus lens.*

Quality astronomical telescopes have more than sufficient sharpness for long-focus photography despite having only two to four lens elements. According to Tele Vue Optics, a domestic maker of mid-range to high-end refractor telescopes, general purpose photographic lenses use extra lens elements to make them acceptably compact for hand-holding. On the other hand, most refracting telescopes tend to be rather awkward and lengthy, but their length provides some optical advantages.

When I began looking around for a long focal-length lens, I found that prices were steep for 300–500mm telephoto lenses by major camera manufacturers, even for used equipment. Then I came across Tele Vue's claim that all its telescopes "can be readily used as super-quality telephoto lenses for 35mm SLR cameras." A dual-duty, medium-cost telescope that could scan the heavens at night and serve as a quality long lens during the day was an appealing option.

Refractor versus reflector

Telescopes come in two major varieties: refractors and reflectors. A refractor uses transparent glass elements that focus light from a subject onto a magnifying eyepiece, film, or an electronic photosensor. Refracting telescopes operate on the same principle as most camera lenses.

Reflectors use one or more mirrors to focus an image. The reflector designs most suitable for long-focus terrestrial photography are usually the Maksutov-Cassegrain or Schmidt-Cassegrain varieties because of their compactness. Both designs are often referred to as catadioptric telescopes or lenses. Because the words are cumbersome, they are often called "mak" or "cat" lenses. While not nearly as common as traditional camera lenses, some camera manufacturers and aftermarket vendors offer camera-ready catadioptrics as compact, low-cost, slow aperture options in their long-lens lineup. Nikon has made a 500mm $f/8$ mirror lens for years, and some third-party suppliers offer 500mm $f/8$ "cats" for as little as $100. These camera lenses are essentially small telescopes specifically designed to mount on cameras.

Deciding which to buy

On paper, refractors are capable of delivering better images than reflectors. The central obstruction in mirror designs creates contrast-reducing diffraction and causes a trademark "doughnut" appearance in out-of-focus areas.

While the laws of physics assign the advantage to refractors, design and construction quality determines actual performance in the real world. Inadequate coatings, poorly baffled tubes and other flaws can reduce picture quality with either design. In spite of its central obstruction handicap, an ultra-high-quality Maksutov-Cassegrain, such as a Questar, will deliver much clearer pictures than a cheaply made refractor.

Another consideration is size. Cassegrain designs can be very small and compact, yet still have very long focal lengths. The telescopic mirror lenses tend to have small apertures, however. The camera-specific 500mm $f/8$ versions tend to be the fastest, while most astronomy-oriented offerings have apertures of $f/12$ to $f/15$ and very long focal lengths of 1000–1900mm.

Whichever you choose, make certain that the telescope is designed to use either a 1.25-inch diameter focuser, or even better, a 2-inch diameter focuser for holding accessories such as eyepieces, mirror diagonals, and camera adapters. Avoid telescopes that feature a 0.965-inch diameter focuser. Used in low-end telescopes, a narrow 0.965-inch "pipe" will significantly vignette a picture. In addition, 0.965-inch accessories are much more difficult to locate.

After my research, I purchased a Tele Vue Ranger. It features a 70mm diameter air-spaced doublet lens made from extra-low dispersion glass to create a 480mm $f/6.8$ telescope. The price for a new Tele Vue Ranger kit is around $760, but I bought mine used for $500. This model is the entry-level telescope in the Tele Vue lineup, but is light and fairly compact. The cost included a 90° mirror diagonal and a medium-power eyepiece for astronomical or terrestrial viewing. It takes easy-to-find 1.25-inch accessories.

While the price was reasonable, it exceeds that of a 500mm $f/8$ catadioptric mirror lens. However, the appeal of being able to use it for both astronomy and photography tipped the scales in its favor.

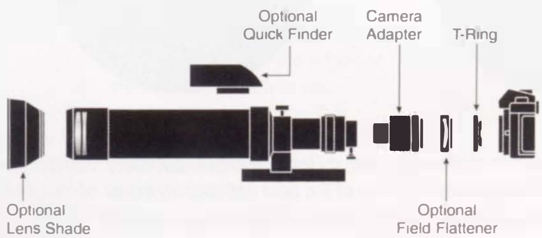


Figure 3. *This diagram shows the location of the adapters needed to use a 35mm camera with the telescope. Several parts shown are optional. The field flattener slightly improves optical performance, but is not required to produce high-quality photographs.*

Figure 1. *American Goldfinches were photographed in an early-spring snowstorm using a Tele Vue Ranger telescope as a 480mm f/6.8 telephoto lens. No field flattener was used (see text). The goldfinches, located about 10 yards away, were photographed from indoors through window glass.*

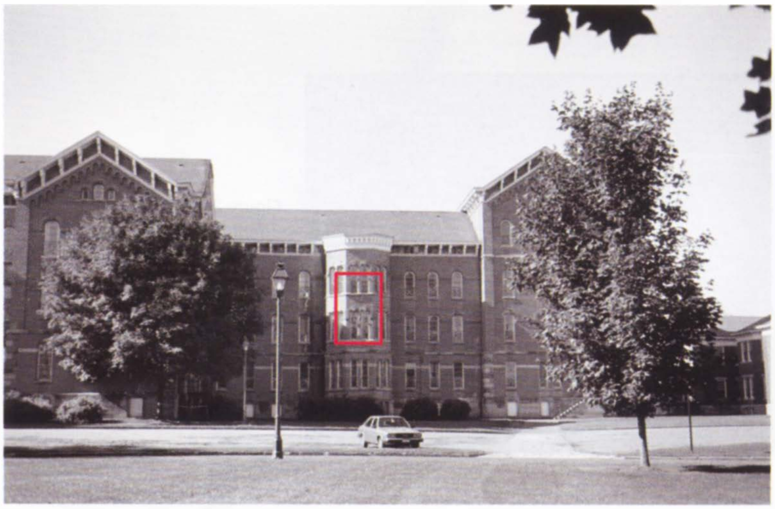


Figure 4. *The red box shows the area of the building photographed in the lens comparison. This picture, made with a 50mm lens, demonstrates how much magnification is provided by the 480–528mm lens focal-lengths compared in figure 5.*

Some suppliers of telescopes and accessories suitable for general purpose photography

Celestron
2835 Columbia St
Torrance CA 90503
(310) 328-9560
www.celestron.com

Mead Instruments Corporation
6001 Oak Canyon
Irvine CA 92618
(949) 451-1450
www.meade.com

Orion Telescopes and Binoculars
PO Box 1815
Santa Cruz CA 95061
(831) 763-7000
www.telescope.com

Questar
6204 Ingham Rd
New Hope PA 18938
(215) 862-5277
www.questar-corp.com

Stellarvue
11808 Kemper Rd
Auburn CA 95603
(530) 823-7796
www.stellarvue.com

Tele Vue Optics, Inc.
32 Elkay Dr.
Chester NY 10918
(845) 469-4551
www.televue.com

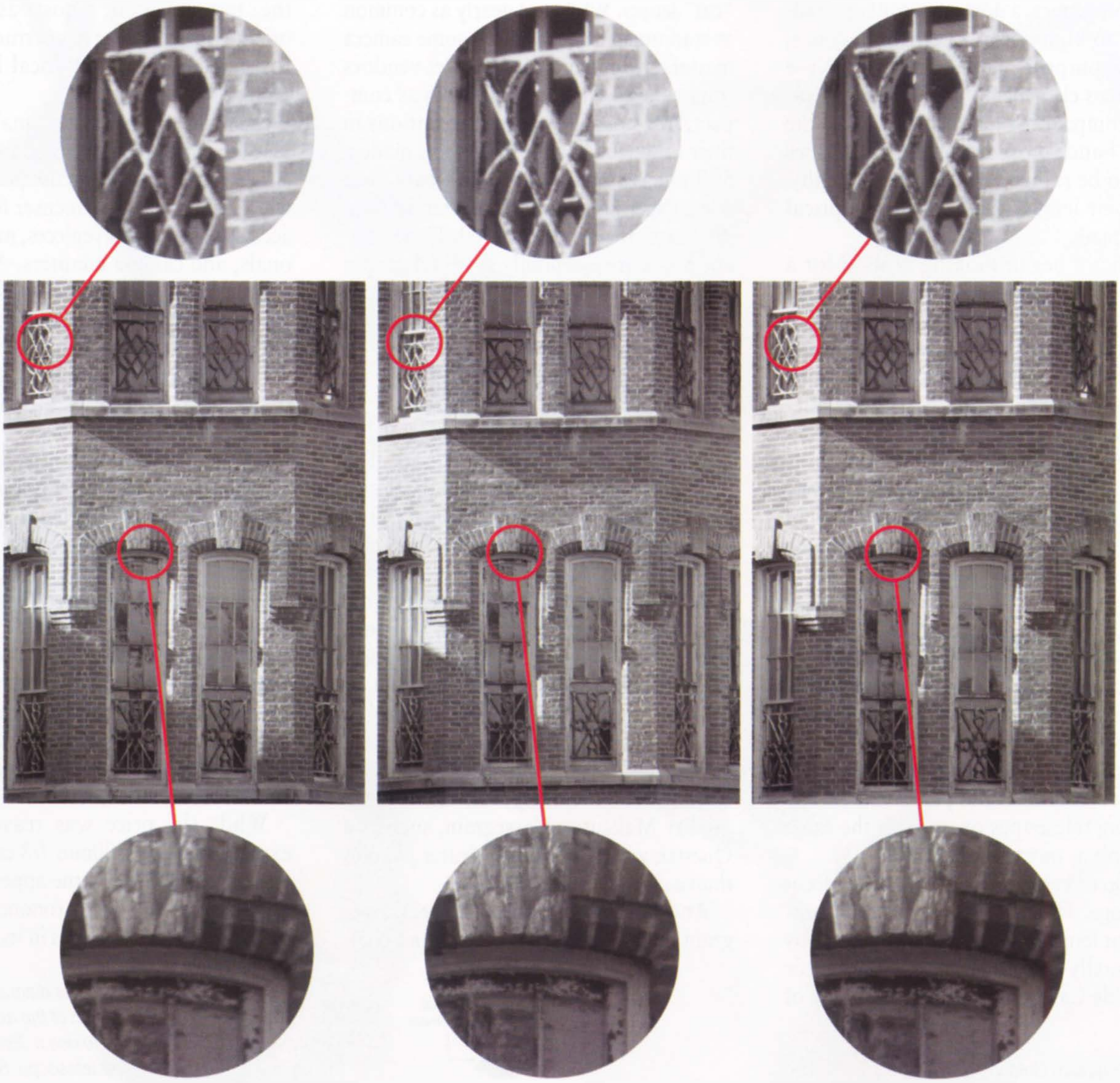


Figure 5. *From left to right are comparison test results from a Reflex Nikkor C 500mm f/8 mirror lens, a Tele Vue Ranger 480mm f/6.8 telescope, and the telescope with a field-flattener corrector lens. The use of the field flattener improves corner sharpness slightly and reduces vignetting, but causes a slight reduction in contrast. It also acts as a teleconverter making the telescope a 528mm f/7.4 lens. Both telescope configurations outperformed the Nikkor mirror lens.*

I added a camera adapter ($45) and a T-ring mount for my Nikon ($20) to make the telescope photo-ready. Later I bought Tele Vue's 1.1× field flattener (essentially a corrective teleconverter) for $85. It boosts the optics from 480mm *f*/6.8 to 528mm *f*/7.4, refines the telescope's flat-field optical performance, and reduces vignetting caused by the 1.25-inch focuser tube. Its use is optional; pictures made without it are still sharp.

The red-dot finder mounted near the top of the telescope is used when viewing the stars with a high-magnification astronomical eyepiece, but occasionally I've found it useful for quickly acquiring a terrestrial photographic subject.

How well do they work?

To test the optical performance of my telescope used as a telephoto lens, I compared it to a Reflex Nikkor C 500mm *f*/8 mirror lens, and to a 300mm *f*/2.8 AF Nikkor with a Nikon 1.6× teleconverter. The 1.6× teleconverter used with the 300mm lens provides a 480mm focal length.

I used my Nikon N90's body in aperture-preferred, averaging-meter exposure mode. Nikon's Matrix mode does not work with older lenses like the 500mm *f*/8 reflex or with a T-ring adapted telescope, but averaging-meter mode works fine. I located a brick building that had sufficient detail to test sharpness and used T-Max 100 film for the tests. For support, I used a stout Zone VI wooden tripod with a heavy-duty Gitzo 570 head that I usually reserve for my 8×10 camera. For maximum sharpness with long lenses, the importance of a stable tripod can't be overemphasized. For the tests, the camera's electronic self-timer triggered the shutter.

After processing the film, enlargements were made of the sharpest frames from each lens. Unfortunately the 300mm *f*/2.8 and 1.6× teleconverter combination proved to be inadequately sharp in the corners at almost all apertures. I presume that this older teleconverter and my 300mm *f*/2.8 AF aren't a good match. As a result, I didn't make prints from negatives for this lens.

Figure 5 compares pictures and details made with the Reflex Nikkor C 500mm lens and the Tele Vue Ranger telescope in two configurations. In one configuration, the Tele Vue field-flattener lens was installed between the T-ring and the camera adapter. When viewed at a normal distance, all three 8×10 prints appear adequately sharp. However when enlarged more, pictures made with the telescope exhibit greater sharpness than those made with the mirror lens.

The field flattener is a photographic accessory designed to reduce field curvature and vignetting caused by passing light rays down the narrow 1.25-inch diameter focuser tube. Vignetting is noticeable in some pictures I made through the telescope (see figure 6), but it has not been objectionable. The field flattener reduced vignetting in the lens comparison test, although its effects are more apparent when viewing the negatives themselves.

Like many real-life subjects, the building facade did not lie on a single plane, but even so, the photographs made with the field flattener in place are a little sharper in the corners. However, using the field flattener also lowered the contrast a touch—perhaps because a glossy-black portion of the field flattener lay in the light path. I will cover it with flat-black paint in a future experiment, hoping to increase contrast. I suspect that the field flattener was designed with critical astro-photography in mind, and that its benefits are marginal with most three-dimensional terrestrial subjects. For that reason, reduced vignetting is probably the best reason to consider the field flattener.

I was pleased with the telescope's optical performance as a long-focus lens with or without the field flattener. It compared favorably to a similarly priced long-focal length Nikon lens; photos made with it have sufficient sharpness for publication.

Figure 6. *While vignetting caused by the narrow 1.25-inch focusing tube is unnoticeable in many pictures, this photo shows the effect clearly at the edges of the frame. The picture was made without using the Tele Vue field flattener which would have reduced vignetting. Other telescopes with a wide 2-inch focusing tube are designed to reduce vignetting.*

Limitations

Test pictures of buildings are useful to determine optical potential, but what about daily use of the telescope as a telephoto lens? For starters, no one who shoots sports will want to use one because of its ungainly size and awkwardness. Camera manufacturers make fast telephoto lenses that are much easier to handle for sports photography—for a price, of course. The telescope as telephoto lens is cobbled together by slip-fitted parts secured by thumbscrews. It is extremely impractical to use hand-held because something could easily slip out of position. The assembly requires a sturdy tripod.

Also, a telescope has no aperture blades, which means there is no control of depth of field. Of course, the same argument applies to a mirror lens. Most other lenses do have aperture controls.

When used with manual-focus SLR cameras that have microprism focusing aids, parts of the viewfinder will black out when using lenses slower than about *f*/5.6. Microprism blackout combined with a dim view can make focusing difficult. In addition, most camera mirrors aren't large enough to intercept the nearly parallel rays from a long-focus telescope, and darken the top edge of the viewfinder image. The film image isn't affected, but it's annoying.

Other considerations

The first camera adapter I purchased was an inexpensive unit made by another, well-known telescope manufacturer. I found that some parts of the adapter were chrome-plated inside and outside. Pictures made with this adapter exhibited extremely low contrast because of flare. I disassembled it and spray-painted the offending parts flat black, after which it made good pictures. I later bought the Tele Vue camera adapter, which featured black-painted internal ridges for flare control. There are many manufacturers of adapters and parts, so be sure that units you consider don't have glossy finishes, or worse, chrome plating in the light path.

In spite of the disadvantages of using a telescope as a long-focus lens, you can make good pictures of suitable subjects. All it takes is about $50–60 worth of adapters. Plus, you can take the telescope out at night to view the heavens. Try that with your zoom lens.

William Schneider is an associate professor in the School of Visual Communication at Ohio University. He holds degrees in photography and mechanical engineering.