wind? Clearly the tree branch idea needed improvement.

I wanted a "subject" that stressed my lens/film/developer combination beyond my typical needs for sharpness, was inexpensive, and that could be repeated easily if I got a new lens or used a new film or developer.

My solution, pictured in Figure 1 (opposite), was to mount a piece of window screen in a frame, cut a slit in it, and place it in front of a reflector lamp with a piece of wax paper as a diffuser behind the screen. I found that a 15-watt bulb was sufficient illumination (it produced an EV of about 12). The slit was necessary because the regular pattern of the screen was not sufficient to evaluate differences in sharpness. The wires around the slit were cut and moved so that I had lots of very fine wires against a relatively bright background.

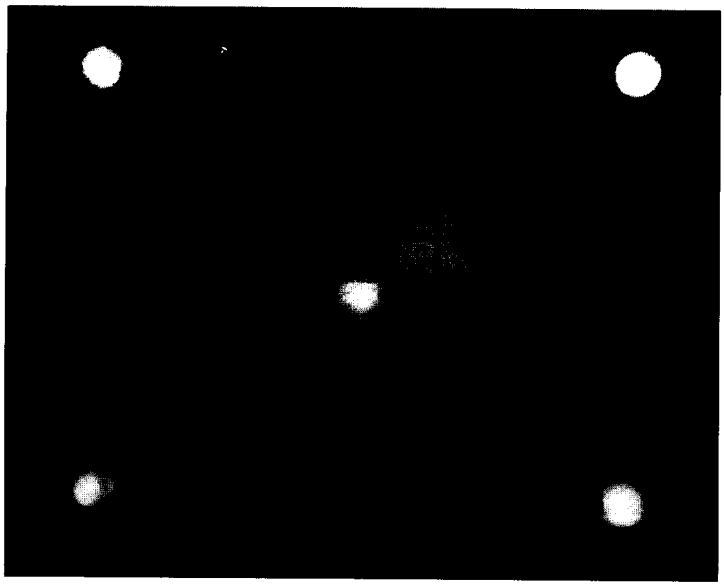

Figure 2. Sample image where each of the five bright areas is a screen similar to the one shown in Figure 1.

Starting with a 150mm lens, I placed my 4x5 camera as far from my "subject" as possible while still being able to see the fine wires on the ground glass with a 7x loupe. For this lens, the lens-to-subject distance was 131 inches. Distances for my other lenses were calculated in proportion to their focal lengths, thus keeping the size of the image essentially the same for all lenses. A sample full-frame image is shown in Figure 2 (above).

For each lens, I made a series of exposures ranging from f/11 or f/16 down through the smallest aperture (usually f/64), adjusting the shutter speed to keep the exposure the same. In order to keep from mixing up my negatives in the darkroom, I printed a set of labels on clear plastic film to identify the lens and camera settings, and I taped these just above the center of each image. I placed the brightest part of my "subject" on Zone V, and gave N+1 development.

MAKING TEST PRINTS

Keeping my "stress test" criteria in mind, I made a series of prints with the enlarger set to project a full-frame image of about 22x26 inches (my typical largest print size is 16x20). Preliminary trials indicated that the corners of my images were equally as sharp as the center, and suffered from diffraction in about the same way, so the results presented here use just the center of each negative.

I printed the central part of each image that contained the slit and exposed wires only. To save paper, I arranged these images in a matrix with images from each lens in a column, and images from a particular f/stop in each row. I printed with greater than normal contrast (approximately equivalent to grade 4), and each image had the same enlarger exposure.

My enlarger f/stop was f/11, 2 stops down from wide open.

RESULTS

As expected, a careful examination of the fine detail of the screen and its wires shows a decrease in sharpness as the f/stop is increased beyond a certain point. While in most cases individual wires can still be seen, their outlines against the bright background become fuzzy, which leads to a general *perception* of lack of sharpness in the photograph. For most of my lenses, f/32 seems to be the turning point, and apertures smaller than f/32 are definitely less sharp than f/16 or f/22.

So my general conclusion is this: if you really need to close down beyond f/32 in order to get sufficient depth of field, by all means do it, but be aware that diffraction may limit the size of the print. On the other hand, whenever possible, use those camera movements and stay around f/16 or f/22!

One surprising result—which is the opposite of my original thinking—is that diffraction is not worse for my shorter lenses. In fact, while most of my lenses behave about the same, my worst lens is the longest! For the 400mm lens, f/22 seems to begin to show degradation, and all images with the 400mm lens look less sharp than for the larger f/stops of my other lenses. This may be due to the "telephoto" design of the 400mm lens, which allows it to be used with less than 400mm bellows extension. This design probably incorporates more lens elements, which means more air/glass interfaces, which causes additional dispersion and results in less clarity.

CONCLUSIONS

So, if you are always striving for maximum clarity in your work, I encourage you do some testing of your own. I have always found that the best lessons are the ones you learn for yourself! ▲

Paul Wainwright holds a PhD in physics from Yale, and has been making b&w images for 40 years. In 2001 he retired from Bell Labs to pursue large format, fine-art image making full time. His interests include landscapes and architecture detail, and applying his research background to make the more technical aspects of photography simple to understand. Wainwright lives and works in Atkinson, New Hampshire, and teaches advanced workshops at the New Hampshire Institute of Art. He can be reached at paul@wainwright.mv.com.