**The last three columns in this series have discussed ETTR, a field technique which takes advantage of some of the unique characteristics of digital photography. This column moves on to another digital technique, originally developed for photo microscopy, which can be used in either macro or landscape photography to achieve DoF comparable to that achieved by view camera users.**

In landscape photography one typically combines subjects in the foreground, mid-ground and background into an eye-pleasing composition. Ideally the subjects have different color and texture (aka 'physicality') which enhances the 'three-dimensionality' the viewer sees in the image. In the field this means the photographer must extend the DoF to the max! The most obvious approach is to use smaller apertures. This does increase DoF, but is limited by lens design (minimum aperture) and by phenomenon call 'diffraction' which produces 'softness' in images shot with smaller apertures[1,2].

Traditional photographers using view cameras coped with this issue by taking advantage of the 'Scheimpflug principle'[3]. The camera is made with an adjustable lens board which can be rotated either vertically or horizontally. When the lens plate is rotated vertically and angled (slightly) downwards, it extends the DoF[4]. Landscape photographers routinely used this technique to achieve extreme DoF (think club f/64). The lenses used by view camera photographers were relatively simple; think single aperture, single focal length and **very** expensive; think no-zoom and no variable aperture! But their simplicity had the benefit of making them very sharp.

Designing and manufacturing economical SLR camera lenses which operate (zoom) over a range of focal lengths (say 24-105mm) and with a variable aperture (say f/4-f/22) means sharpness is always a compromise[5]. Modern zoom, variable aperture lenses are designed to be sharpest at the center and that sharpness drops off as you move outwards to the edge of the lens. Generally lenses are sharpest about 2-3 stops from 'wide open'; so an f/4 lens will be sharpest in the f/8-f/11 range and then sharpness drops off as the aperture is made smaller and diffraction increases. Zoom lenses will not be equally sharp throughout their focal range; in other works my Canon 100-400mm zoom will not be equally sharp at every focal length within its 100-400 mm zoom range. The 'compromise' referred to above is less of a problem with modern computer-designed and computer-manufactured lenses than was the case back when lens glass was ground by hand, nevertheless the fundamental design-compromise issue is still an 'optical reality'.

With SLR film cameras, we often used 'Hyperfocal Focusing' to increase DoF. Somewhat

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1 If you <Control><Click> on any of the links included in the footnotes, your browser should take you directly to the respective article on the web.

2 See: ***http://www.cambridgeincolour.com/tutorials/diffraction-photography.htm*** for an excellent discussion on the subject. The discussion is technical and may take more than a single read but it provides a good primer on why the smallest aperture is not always the best way to increase DoF, especially in landscape photographs.

3 See; ***http://wn.com/scheimpflug_principle***, Playlist 3, "View Camera Movements - Part 3 Scheimpflug Focusing

4 There are some DSLR lenses which incorporate this capability; called 'tilt-shift' lenses they can be tilted to increase DoF. They are, however, quite expensive.

5 See the sections on Sharpness, Distortion, Vignetting and Lateral Chromatic Aberration at: ***http://www.cambridgeincolour.com/tutorials/tilt-shift-lenses2.htm***

oversimplified, the principle is to match camera position to a known DoF (based on lens focal length and selected aperture) such that the DoF extended from the foreground subject to infinity. In practice, the technique works but usually fails to deliver the sharpness achieved with view cameras by tilting the lens plate forward.

Focus Stacking[6] is a digitally-based technique which takes advantage of the ability of image software to identify sharpness in individual images and then combine the sharpest portions of multiple images into an overall composite incorporating the sharpest portions of each of the constituents. This is a much more practical and economical alternative for modern DSLR photographers. In practice one uses a DSLR and zoom lens mounted on a tripod and make a sequence of several photographs at (typically 2 or 3) successive focus settings (and overlapping DoF), then combining the resulting images in Photoshop[7] to achieve a composite image with sharpness throughout. Ideally the aperture chosen should be one at which the lens is sharpest.

An excellent video put together by Dave Morrow[8] illustrates 'in-field' and 'in-studio' technique. However, many including me believe that his 'in-field' should be modified. I like to shoot the first image for the foreground subject using live-view and the camera's magnifier (at 10x) to make sure the foreground is absolutely 'tack sharp'. For the subsequent one or two images, **adjust only the focus ring** with the final image shot with the focus ring rotated all the way to the infinity setting.

***Figure 1*** *was shot at White Sands National Monument. The composition was created using three focus stacked images. The foreground was carefuly focused on the rabbitbrush using live-view, the background on the San Andres Moutains (infinity) and the mid-ground on the grasses and yucca in between. All of the exposures were shot with a Canon EOS 5DS R and a Canon EF24-70mm f/2.8L II USM lens, set at 60mm. Exposure was 1/40 second at f/11 with ISO 200. The images were processed in Lightroom and Photoshop.*

6 Focus Stacking was first developed for use in photo microscopy where DoF is incredibly shallow and getting a good image would be otherwise just about impossible.

7 'Helicon Focus' is an alternative software for Focus Stacking; it was first developed for photo microscopy.

8 See: ***https://www.youtube.com/watch?v=6hNhCo15Ay4***