Focus Stacking
Finding More Depth
by Kevin Lisota
When is Focus Stacking Needed and How is it Done?

Sometimes you are trying to capture a scene in focus from immediately in front of you, to infinity. Long rows of flowers is one such scene where I like to use focus stacking. Given the large depth-of-field, most camera lenses—even at apertures like f/16, f/22 or f/32—will not be able to have an entire scene like this in focus. Even when the optimal “hyperfocal point” is set, at these small apertures, there is much more diffraction, which decreases the sharpness of the final image. Using a tilt-shift lens is one way to potentially achieve this in one shot, but most photographers do not own them, and tilt-shift lenses can be difficult to operate in the field. Focus stacking is an easier method for achieving optimal focus and sharpness. Focus stacking is the practice of taking a series of photos focused at varying parts of the scene and combining them into one image that is entirely in focus.

At f/13, only the front third of this scene (at left) is in focus. Nikon Z7, 130mm, f/13, 1/40 sec, ISO 64.

The same scene as above after focus stacking (right). Notice that the flowers in front and barn in back are all in focus. Nikon Z7, 130mm, f/13 ISO 64.
Taking Images for Focus Stacking

Your camera mustn't move when taking a series of images that you intend to focus stack. A sturdy tripod is essential to avoid difficulties in merging images that have slight differences in perspective. Using a timer or cable release to trigger your shutter also helps ensure that you do not move the camera. If you are using one of the latest Nikon cameras like the D850, Z6 or Z7, there is a special focus shift function that I'll get to in a bit. Let’s start with instructions for most cameras.

With your camera on a tripod, compose your scene. For landscape images, use an aperture in a range where the lens is in sharpest focus and avoids the diffraction present at very small apertures, so something like f/8-f/11. Wider apertures (with shallower depths of field) can make it difficult to capture a series of images without missing a “slice” of the focus area.

Since you will be blending the images, it is also important to ensure that exposure settings like ISO and shutter speed are also fixed throughout the series of photos. If outdoors, you should take the series of photos in reasonably quick succession, to avoid changes in lighting, exposure, or the sky over the series of photos. These variations will make it difficult to blend images together later.

For most DSLR and mirrorless cameras, using manual focus will be easiest. Focus on the nearest element in the scene and take a picture. Now move the focus ring of your lens a small increment towards infinity and take another photo. Repeat this process until you have reached either the furthest element in your scene or infinity focus. Be sure that you have one picture at infinity focus.

Users of the latest Nikon cameras (Nikon D850, Z6 or Z7) currently have a benefit over other camera manufacturers. A built-in mode called “focus shift shooting” allows you to automate this process. If you have one of these cameras, use auto-focus mode, compose your shot and focus on the closest part of the scene. Then enter “focus shift shooting” mode, choose the number of intervals and width of those intervals, and choose start. Because this process is automated, you can use a wider aperture like f/5.6–f/8. The camera will take a series of photos and change the focus depth at each exposure. The camera will focus the lens beyond infinity, so you will want to discard the extra photos at the end of the series that go beyond infinity before merging the images. Take one additional picture at infinity focus to be certain that you have it.

Motion in the scene can be your enemy. Flowers, leaves, or plants swaying in the wind, or other objects moving in the scene are difficult or impossible to merge in post-processing without odd artifacts or extremely tedious manual edits. Smooth motion, like that of flowing water is easier to merge. On landscape photos you will likely end up with a series of 2–6 photos, depending on the aperture used and the depth-of-field you are trying to capture. When using this technique for close-up macro photos, or when using longer focal lengths, a larger number of photos with narrower areas of focus will be necessary.
Processing Focus Stacked Images

Synchronize Edits in Lightroom. I use a combination of Lightroom and Photoshop to process my focus-stacked images. Starting in Lightroom, identify a focus-stacked sequence of photos. Edit one of those to your liking, making adjustments to color temperature, exposure, contrast, highlights, etc. This is also the point where I apply any lens correction, sharpening, noise reduction, and spot removal. Once the Lightroom edits are complete, synchronize the edits to the series of focus-stacked images. The final result should be a group of photos that are identical, other than their focus points.
Next, highlight the series of photos in Lightroom. Right-click and choose *Edit In > Open as Layers in Photoshop* to bring each photo into Photoshop as an individual layer.
Remove Focus Breathing with Auto Align. Most still camera lenses will exhibit some amount of focus breathing. Focus breathing is when the focal length of the lens changes slightly when focusing at different depths. In your series of focus-stacked images, this may be subtle, or it may be obvious. As focus changes, you will see that the images appear to zoom in or out. Sometimes it is a few pixels, but sometimes it is quite a bit more. This is entirely dependent on the lens that you used.

Photoshop can help correct this by auto-aligning the images. Select all of the layers that you brought in from Lightroom and choose Edit > Auto-Align Layers. For Projection, Auto will usually give great results, but you can also use Collage, which allows for image rotation, scale and translation. The resulting layers will be scaled slightly to align the image and remove any changes in scale, perspective, or distortion caused by focus breathing.
Blending focus-stacked images. Photoshop’s **Auto-Blend** Layers command allows you to blend multiple images with different areas of focus. Once your layers are aligned, select the same layers, and choose **Edit > Auto-Blend Layers**. Choose **Stack Images** for your **Blend Method**. Also, choose **Seamless Tones** and **Colors** and click OK. This process may take awhile. The end result is a set of layer masks applied to the various areas of focus in each layer. These are normal Photoshop layer masks, so you could alter or tweak them if the initial result isn’t to your liking.
**Fix Mistakes in the Sky when Auto-Blending.** The process that Photoshop uses to focus stack images is to compare areas of micro-contrast in each area of the photo to determine which areas are in focus and which are not. This works great for many parts of the scene, except for the sky. A clear sky or even a cloudy sky will have no discernible changes in micro-contrast when it is in focus or out of focus. Because of this, focus stacking software may mistakenly blend parts of the sky using the wrong layer. Inspect the layer masks applied to the layer that is at infinite focus to see which layer or layers are being used for the sky. The eye icon next to each layer can be toggled on/off to help you to see which layer(s) are being used in the sky.
In some cases, despite blending mistakes in the sky, the image may look perfectly acceptable as it is. In cases where blending mistakes in the sky are noticeable, this can be fixed by altering the layer mask for the sky.

First, chose the layer that is at infinity focus. Move it to the top of the layer stack, if it is not already there. Turning off the visibility of the other layers will help you to see the exact layer mask that you are working with.
Now highlight the layer mask that should include the entire sky. Choose a brush tool and make it white. Brush in all of the areas of the sky that are masked out.
You can toggle the color of the Brush tool between black (to hide) and white (to reveal) layer contents.
As you brush with a white brush, you will see that the transparent areas now begin to reveal the photo. Ensuring that this layer is at the top of the layer stack will make sure it is visible for the sky versus the lower layers of the image.
Clean Up the Edges. If your lens exhibits quite a bit of focus breathing, the edges of the merged photos are going to show transparent areas. This is because auto-aligning the images caused changes in scale, leaving transparent areas that need to be cropped from your final image. You may also find that the auto-align/auto-blend process leaves artifacts at the edges of the photograph that appear to be out of focus because of the auto-align process.

Zoom to at least 100%–200% and inspect each edge of the photo. The quickest solution is to crop out any edges that did not satisfactorily merge because of changes in scale. For some lenses with minor focus breathing, this may only be a few pixels. For lenses with heavier focus breathing, you may need to crop a little bit more.

Once you are happy with the merged image, you can flatten it to remove the layers and save your final image.
Other Focus Stacking Solutions

Photoshop is not the only software tool available for focus stacking. Software like Helicon Focus and Zerene Stacker can focus stack images, and do offer more control and tweaks for the image blending process that may provide better results. However, for many uses, the focus stacking capabilities of Photoshop are quite powerful and useful.