Introduction to Focus Stacking: the Concept and the Practice

What is Focus Stacking?

Focus stacking is a digital image processing technique which combines multiple images ("frames" or "slices") taken at different focal distances in order to produce a single composite image with a greater depth of field (DOF) than any of the individual source images (*Johnson* 2008, 336; *Ray 2002*, 231–232 = "Multi-plane scanning"). Focus stacking is best used in any situation where individual images have too shallow a shallow depth of field for the intended effect or purpose. This occurs generally in macro photography and optical microscopy. Remember: this is a studio shoot and experiment, but we're normally not trying to create a problem, but rather to address a limiting situation inherent to close-up photography. We're trying to have the best of both worlds: a subject clear, fully focused in all its parts, but set apart from the background, which we want bokeh'd or out-of-focus (blurry). (http://en.wikipedia.org/wiki/Focus_stacking)

Why do focus stacking?

Historically designed for scientific photomicography, focus stacking is now widely used in general digital macro photography, since the same principles apply:

- When you cannot obtain sufficient depth-of-field for the size / magnification you want. (Remember that the longer the lens and the closer the subject, the shallower your depth of field.)
- When the DOF is restrictively narrowed by using a large apertures to get more light and to avoid background clutter.
- When sharpness is critical: the finished stacked-focus image is often sharper all over than any of the component images.

Photographic technique:

Similar consistency provisos are pertinent in focus-stacking photography as are applicable to other multi-shot techniques such as HDR series (uniform frames; more on this below) and panoramas (uniform exposures): keep the image series as consistent as possible throughout, which means uniform exposure for light, minimum movement in either subject or camera. Summed up, keep all settings the same throughout the series <u>except</u> for the distance to the slice of acceptable focus.

What is needed?

Given what was said above, this technique works best in the studio, not in the field. So for this explanation I work with a lab-type set up. This demonstrated procedure is somewhat hardware and software intensive, so try to abstract and adapt to you own needs. You will require:

1. A Camera and lens with a long-enough focal length to obtain shallow depth of field (I've never been able to get good depth of field on a point-and-shoot, but you can always try that; however, I

suggest using DSLR). In fact, the usually best lens for this is a macro lens or a lens with one or more close-up "filters" attached.

2. A steady tripod with the same kind of head you'd want to use for macro photography.

3. Don't forget the flash, but talk to Bob W. about that; he's the expert.

4. Software! This list is just a sample: the number of programs grows as this technique becomes more popular. Here are some of the ones I've seen and tried:

- **Photoshop CS4** and **CS5** (yep! And there is no change concerning focus staking between these versions); however, you'll probably want to try a dedicated program for now;
- **Helicon Focus** (http://www.heliconsoft.com/heliconfocus.html) Helicon Focus Lite, One year: $30 Unlimited: $115 | Helicon Focus Pro (incl retouching functions, 3D) $55/$200 | Helicon Focus Pro X64 (incl retouching functions, 3D) n/a/ $250; look for discounts!
- **Combine Z** (files: http://www.hadleyweb.pwp.blueyonder.co.uk/CZP/files.htm; installation: http://www.hadleyweb.pwp.blueyonder.co.uk/CZP/Installation.htm) Free, but Windows versions only;
- **Zerene Stacker** (http://zerenesystems.com/stacker/) Professional Edition $289; Personal Edition, $89; Student Edition, $39

5. Back to hardware. Optimally, a **macro focus rail**; very economic models ($33-$70) are available online, e.g. on eBay; advanced, precision controlled macro rail StackShot by Cognisys, Inc. ($ 475; http://www.cognisys-inc.com/stackshot/stackshot.php)

6. Some optimizations for working indoors (our presumed studio shoot):

- USB cords to tether camera to computer;
- Tethering software, which varies with camera make) (Canon: DSLR Assistant? PSRemote?)
- AC adaptor for camera (helps for long sessions and consistency in interrupted sessions).

My studio procedure:

Arrange the subject(s);

Tether the camera to the computer. My laptop recognizes the camera and starts Nikon Control Pro (NCP). NCP is set up to send frames from camera directly to a specific transition folder on the computer; Lightroom (LR) monitoring that folder, automatically imports shots as they arrive there and puts them into the storage folder and library for viewing and processing, thus streamlining the subsequent selection of pictures for sending collectively to the focus-stacking software: thus you can concentrate keep equipment tinkering to a minimum and concentrate more on the pictures and the processing.

Set up the camera; especially critical is using manual focus. (Those already using back-button focusing (q.v.) don't have to worry about this; just don't re-focus after you have your frame focused as you desire!.)

Shooting caveats:

- Again, keep images as exactly aligned as possible. This is where using a tripod, and focusing rail and tethering or wireless remote are very helpful

- We'll want to keep the exposure – and especially the aperture - as uniform as possible between shots, so manual exposure and manual focus are best, although I've had no problem using the semi-automatic aperture priority. Note also that some programs need to have the shots in sequence. I simply shoot from front to back.

- Keep the distance between focal "slices" as consistent as possible, otherwise some programs will complete, such as HF. Again a calibrated slide rail helps immensely.

Procedure with Photoshop:

1. Open each image as separate document (N.B.: _NOT_ as layers in the same document. You can do this from Adobe Bridge or Lightroom

2. In Photoshop, Main Menu > File > Automate... > Photomerge : choose Open Files, select the Auto option, in the dialog uncheck Blend Images Together

3. Select all layers in the newly created document

4. Main Menu (again) > Edit > Auto-Blend Layers... > Stack Images. Save, etc.

Procedure with Combine ZP:

1. Shoot your frames, preferably tethered;

2. Export/convert them. Note that CZP allows use of .tiff as well as .jpg

3. Load the frames into the program and choose either the "All Routines" batch or opt for step-by-step processing by using the specific batch routines, which include "Align and Balanced Used Frames" (quick or thorough methods); "Do Stack"; "Do Soft Stack"; "Do Weighted Average"; "Pyramid Weighted Average"; "Pyramid Do Stack"; "Pyramid Maximum Contrast". Suggestion: "All Routines" works just fine!

4. Save the output stack-focused image. (Hint: if you output to a folder monitored by Lightroom, the final result will be automatically be imported and place with the original slices)

Procedure with Helicon Focus:

1. Load shots into program (I use a LR plug-in, select the pictures and export to HF). (Note: LR exports the raw files as tiff for processing.)

2. Check the photos to use. Since I shot and imported the ones I wanted, I just check all the shots.

3. Run the process.

4. Save. Best as .psd or .tif so no loss of detail in subsequent editing.

<u>Some issues I experience:</u>

- Using a macro focusing rail moves the camera closer and farther away from the subject(s). So does focusing by using the lens. Proceeding from front to back will result in each image being a tiny bit larger than the previous. The alignment features of the software should take this into account, but I've not always found this to be the case. This size issue sometimes may result in ghosting on the "stacked" image from the unfocused parts of some shots around the focused parts of others. The CombineZP Alignment allows images to "stretch align" images. <u>More interval shots seems to help obviate this problem.</u>

- Try to focus at regular intervals; otherwise some software gets confused. Watch the knurls on your lens as you focus, or used the measurement calibration on the macro-focusing rail.

<u>Bibliography</u>

Johnson, Dave. *How to Do Everything Digital Camera* (McGraw-Hill Professional, 2008) (http://books.google.com/books?id=h15xmx3ma2cC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false)

Ray, Sidney F. *Applied photographic optics: lenses and optical systems for photography* (Focal Press, 2002) (http://books.google.com/books?id=cuzYl4hx-B8C&pg=PA231&dq=multi-plane-scanning#v=onepage&q=multi-plane-scanning&f=false)

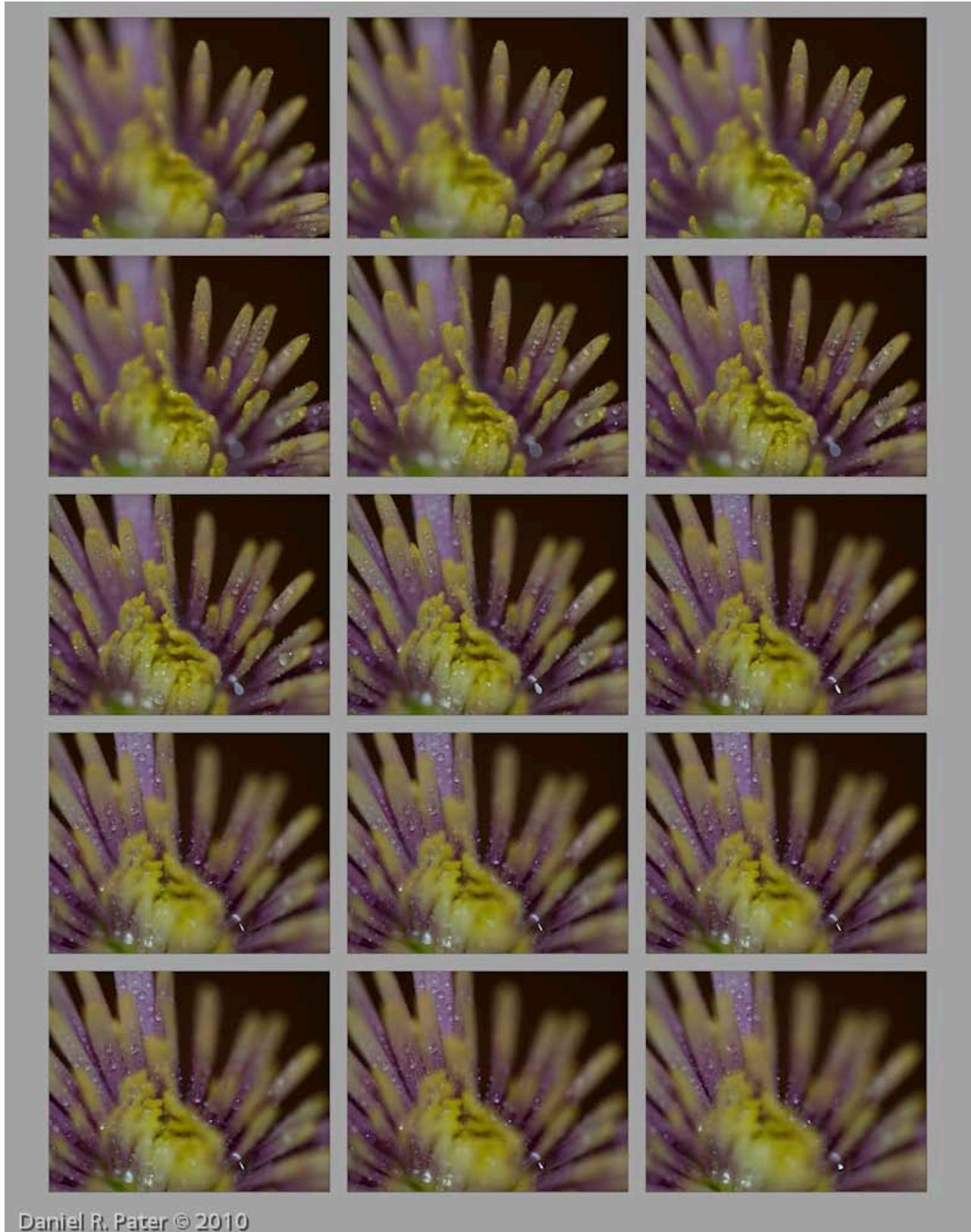This presentation is subject to revision based on questions posed and due to my OCD tendencies to edit and revise…

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Figure 1. The frames or slices, from front to back, used for figure 2 in Combine ZP.

Figure 2. Combine ZP stack, before and after processing. Note the concentric ghosting in the top shot.

Figure 3. The first and final slices, back to front, with final result in Helicon Focus, with no further processing.