

# Doing Deep Stacks of Hairy Specimens

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*One of largest limitations of macro photography is the lack of depth of field available at high magnifications. A lens' aperture can be closed down in order to get a greater depth of field but this often leads to a loss of resolving power. So what are we to do? Should we sacrifice clarity in resolution or depth of field?*

In the recent past there has been one extremely viable solution available, especially as computers have become more powerful and digital imaging solutions more readily available. Focus stacking is not a new concept to many in the macro photographic field, so this will only cover one specific application.

If a series of photographs are taken at slightly different and overlapping focal planes on a subject, specific computer software can combine them into one final photo that has the depth of field of all of the single images combined. In theory this is very promising and in practice it can either provide beautiful results or be extremely frustrating.

The opening photo of this article is an example of a very successful focus stacked image. Comprised of over 100 images this photograph of a bee can be a very difficult situation for stacking software to handle. With all of the small overlapping detail in the hair and with a high number of images software can have issues.

When photographing simple objects in good lighting, with a minimal amount of overlapping parts separated by a relatively great distance, stacking software can be very successful. However, when photographing deep objects, especially if the objects are lit without consideration to the software and end usage, the results can be rather lackluster. Since the foreground objects are so far away from the background objects there can be situations where there is more than one area of high-frequency (indicating sharp focus) for a given area of an image. Take, for example, a photograph of the stinger of a wasp with the underside of the torso behind it. The stinger is one distinct object, and the body another. However since they are separated by a significant distance, the stinger gets so obscured when focused on the underbody that you end up with detail behind the stinger that shouldn't be visible. This will give very unsatisfactory results from stacking software, as can be seen to the immediate right.



One way to work around this problem is to actually stack the images in two sets, one for the front half and one for the back half. By removing the detail in the bottom part of the stack, you can remove some of the detail order issues and then just combine the two images manually in post. This allows the end user to control exactly what should be in the foreground and which details in the background should, in fact, not be visible. Many software solutions do have a built in retouching feature, however I have not used these. Immediately to the right you will see the image where I did this, however even though this stack was over 300 images, I really just found the background more distracting than helpful. So I chose to keep the stinger part of the stack and use that for my final image. Just because I can get everything sharp doesn't mean that it will necessarily be aesthetically pleasing and might actually end up just confusing the viewer's depth perception.



Another similar issue that arises from stacks that are very deep is colloquially called stacking mush. Stacking mush occurs when there is not enough contrast within an area of the stack for the software to determine which areas to include in the final image. This is apparent in the image to the left around the leg. The leg is so out of focus and is so large in the frame when focused on the body, that it ended up obscuring some areas behind the leg. This creates areas of low contrast which confuses the software and results in these large haloes. This is relatively unrecoverable unless one was to remove the leg without moving the body of the subject and shooting a stack without the leg obscuring the body and then combining the two later.

This image also displayed the issue mentioned above with details that should be in the background in front of foreground elements. The hairs on the leg will all have their respective photographs with sharp focus. When the focus is continually shifted back toward the body of the bee, there will then be points of sharp focus behind the leg which shouldn't and normally wouldn't be visible. This leads to the same issue as the stinger, but much more numerous since there are more hairs than there are stingers.

Harsh lighting can also lead to unsatisfactory results when photographing hairy objects since the hairs can give specular highlights, which appear to the software as high frequency, and the final image can end up with bright spots of light that travel down hairs and around any specular highlights.



When shooting these images, I used a fiber optic strobe light system by Microptics that plugs into a Dynalite pack system. This allowed me to get the specificity of light placement I required while also providing significantly more light output than a typical 'hot light' fiber optic system. Since the light output was so much greater and the strobe system is essentially setting my shutter speed by its flash duration, I could eliminate camera shake and keep my exposures at the sync speed of the camera (in my case 1/250<sup>th</sup> of a second). This may seem like a minor point however some of the images here have as many as 350 images per stack. With my lighting setup, I used a piece of white acrylic sheeting as a diffuser. This provided large, soft light source but also ate anywhere from one to two stops of light. With a typical exposure of at least a couple seconds, each stack would have taken hours too shoot and one image right in the middle may have had motion-blur from the camera or table moving, rendering those hours and images useless.

This also leads me to the other imperative piece of equipment which was a focus stand borrowed from an optical scanning setup. The bellows system I used did not have incremental fine adjustment gearing and would also have jarred the camera out of alignment. Ideally when stacking, you want to either move the whole camera/lens assembly or the subject. If your not able to easily and consistently do this, the rear standard of the bellows with the camera can be moved for fine adjustments in focus. However this also changes the magnification from shot to shot, and a lot of the final image will be cropped since it will be limited by the photo with the highest magnification. This stand allowed me to move the subject in extremely fine increments while also keeping it at the same magnification and alignment.

For most of my shots I used a Nikon D3x, Nikon bellows system, extension tubes, and an Olympus 38mm thimble lens. Using an open source tethering program called Sofortbild I was able to download the images directly to the computer while also being able to view the live view from the screen. This helped dramatically with composition, but also let me know how much I needed to alter my focus between shots by previewing my depth of field on something larger and brighter than the viewfinder.

One more camera comment that bears mentioning: clean your sensor. Unless you just tested it and found it spotless, clean your sensor. When doing focus stacks, those 5 little specks that the clone tool would normally plow through become multiplied by however many images you have in your stack. Since for some reason my cameras tend to have filthy sensors, this was a lesson I learned very early in the process and cost me a couple stacks. Sometimes it really is easier and saves more time to reshoot and in this case even if it takes you 45 minutes to get a clean sensor it is time well spent.



Focus stacking is a really powerful tool that opens up a whole new type of imagery to optical systems that have been limited by depth of field. Investing in an optical scanning system with all of its limitations was one way of getting around this in the past. Now anyone with a lens, bellows, camera and some software can do some solid sharp macro work. Hopefully some of the pointers I've given here will help get you off to a great start or help you further your images even more. So, as always, I encourage you to go find a stationary subject and see what you can do. Reading only gets you so far.

*This article was written and illustrated by Josh Marrah for Micscape which can be found at [www.microscopy-uk.org.uk/](http://www.microscopy-uk.org.uk/) and was published in the November 2011 issue. Josh is graduating with his undergraduate degree in advertising photography in 2012 from Rochester Institute of Technology with minors in Imaging Systems Management and Entrepreneurship.*

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