

# Digital Imaging Study Group: Notes on Sharpening

## Summary

Photoshop and other image editors generally have facilities that permit us to “sharpen” images. So do scanners. This paper covers sharpening only at edit time; sharpening at scan time is another subject.

In this paper, I’ve noted that we don’t actually sharpen images, but instead make adjustments that fool the eye into seeing an image as sharper. The main tool used in Photoshop for sharpening is called Unsharp Mask (USM).

I’ve concentrated on the areas that I have the most experience with, covering:

- Unsharp Mask settings
- Problems generated by “sharpening,” and their control
- Two ways of creating edge masks for suppressing the sharpening of noise

Then I’ve offered brief summaries of some other techniques I’ve run across, inviting both the reader and myself to explore them further.

- Layer-based sharpening
- Applying sharpening to individual channels
- Two-pass sharpening.

## What Is Sharpening?

So-called sharpening techniques in Photoshop and other image editors do not actually sharpen an image; they create the illusion of a sharper image. There’s a “second law of information,” like the second law of thermodynamics, that says, “information runs downhill.” If an image doesn’t have sharp edges, pixel manipulation can’t create them.

Sharpening techniques work by increasing contrast at edges in the image. An *edge* is a boundary between two areas of differing color or tonal density. Increasing contrast at edges fools the visual system into thinking the edge is sharper than it would otherwise appear.

At the same time they make an image more pleasing, sharpening techniques can also create unwanted artifacts—intrusive noise and halos—that make the sharpened image less pleasing than the unsharpened one. The art in sharpening is to create the illusion of sharpness without letting the unwanted artifacts get out of control.

## About Unsharp Mask

### *Origin of the term and how it works*

This infelicitous term originates in conventional photography, where a negative is sandwiched in the enlarger with a slightly out-of-focus duplicate negative and the print exposure time

approximately doubled. Because the unsharp copy is slightly out of focus and the exposure time increased, the light side of the edges prints lighter and the dark side darker, creating a halo around objects in the image [1].

(Sounds to me like this old-fashioned method is less likely to generate unwanted noise than the digital method, but certainly more tedious and difficult to control.)

### **Challenges**

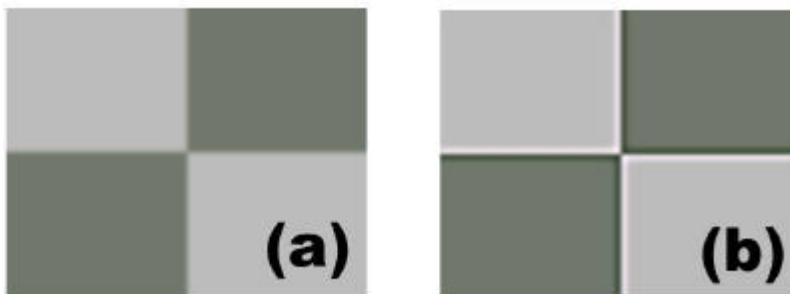
- Excessive haloing: If the degree of sharpening applied to an image is increased beyond a certain point, the halo created by the technique, instead of enhancing the image, makes it look bad. The antidote is simply: Don't over-sharpen—sometimes easier said than done.
- Unwanted texture/grain: Present sharpening techniques don't actually operate on what you and I would consider to be edges. Instead, they operate on differences in any old adjacent pixels, hence may amplify skin blemishes, grain, scratches, and other aspects of an image we wish weren't there. Fortunately, techniques are available for controlling unwanted sharpening of noise.

### **Settings**

If the Unsharp Mask operates by creating a halo, it follows that the settings of the tool control various aspects of the halo. There are three settings: Amount, Radius, and Threshold. Here's how they work:

- Amount: Controls the intensity of the halo.
- Radius: Controls the width of the halo. Images with relatively little detail generally call for a higher Radius than images with lots of fine detail.
- Threshold: Suppresses the creation of spurious halos in areas that should remain smooth.

How can you best balance the three settings? Fraser [2] recommends starting with an Amount setting in the 200-to-300-percent range and a Threshold of zero, then work the Radius setting until it seems right for the image content. Then adjust the Amount setting, probably downward, until the desired degree of sharpening is obtained. Finally, if necessary, increase the Threshold to smooth out over-sharpened textural areas.



The figure above shows, in a test image, how USM creates halos. Part (a) is a grid of light and dark gray rectangles, slightly fuzzy. The image is roughly 470 x 380 pixels. Part (b) shows the

result of applying Unsharp Mask with Amount 400 and Radius 5. You can clearly see the creation of the halo in part (b) of the figure.

## Edge Masks, Method I

### *How edge masks work*

Edge masks protect all parts of the image except the edges so that, when you sharpen the image, grain and texture in the smooth planes of the image will not be sharpened. While this device prevents accentuating grain and texture in smooth areas, it does not prevent haloming. (If it did, of course, Unsharp Masking wouldn't work!) Nevertheless, it can often be effective by permitting a higher amount of edge sharpening than would otherwise be pleasing.

Of the various ways you might create an edge mask, I've covered two here. "Method I" is from Blatner & Fraser [1], the other method from McClelland [4].

Here's an example of an image and an edge mask to go with it:



### *How to do it*

- Create a duplicate layer in which to do your sharpening
- Create the mask. Remember: the black parts of a mask protect the image from change; the white parts permit change. Therefore, we want our mask to have white edges and black non-edges.
  - Make a copy of a channel with good contrast (usually the red or green channel; just drag the channel down to the page icon at the bottom of the palette) and select that channel only (usually Ctrl-4). (Alternatively, you could start with the original image, adjusted to B/W, or with a B/W image made with the channel mixer. If you do, the following steps would be a little different. The differences are an exercise left to the reader.)
  - Filter > Stylize > Find Edges produces an image with black edges on white.
  - Invert (Ctrl-I), to get white edges on black background.
  - Filter > Blur > Gaussian Blur thickens the edges; experiment with the Radius.
  - Increase contrast of the mask (again, experiment). Tightening up the levels is an effective way to do this, but you can equally use Brightness/Contrast, if you're that kind of person.

- Convert the modified channel to a layer mask: Return to the normal RGB channel rendering (Ctrl-~); then Ctrl-click on the channel in the channel palette.
- Use Unsharp Mask and sharpen with abandon. You may be able to set the Amount as high as 500 in some cases!

## Edge Masks, Method II

### *How it works*

This method works the same as Method I, above, except you'll make the mask a bit differently. I like this method the better of the two, maybe because it's the one I learned first and have been using for some time. Experiment to find out which is best for you.

### *How to do it*

- Create a duplicate layer to sharpen (as above)
- Create the mask (here's where the differences are)
  - Make copy of a channel with good contrast.
  - Filter > Stylize > Find Edges.
  - Invert (Ctrl-I).
  - Filter > Noise > Median (try Radius = 2).
  - Filter > Other > Maximum (try Radius = 4).
  - Filter > Blur > Gaussian Blur (try the same radius as in the previous step).
  - Adjust the contrast of the mask at this point if you wish.
- Convert the modified channel to a layer mask as in Method I, and apply USM.

## Layer-based Sharpening

### *In brief*

Note that in this method, we do not use Unsharp Mask. Instead, we create a duplicate of the layer to be sharpened; change its blending mode to Soft Light or Hard Light, depending on how much sharpening we want. Superimposing the Soft/Hard Light layer on itself increases the contrast of the image. Next, we apply Filter > Other > High Pass to the layer, adjusting the Radius to achieve the desired effect. The High Pass filter limits the contrast enhancement to the image's edges only. You can adjust the effect further by reducing this layer's opacity.

Fraser [2] describes this method as the basis for sharpening “adjustment layers,” suggesting the use of multiple layers to sharpen various parts of an image to differing extents. For example, you might use one set of sharpening values for a face in an outdoor portrait, another for the background, which might contain small details. Calling these layers “adjustment layers” is a bit misleading. Adjustment layers may be changed at any time during edit; but these layers cannot, as their actual pixels have been modified in a “destructive” way. Still, the analogy may have some value to the way you think about your work on an image.

## Sharpening Channels

### *In brief*

Blatner & Fraser [1] mention another approach to sharpening, which they claim can help suppress image noise; that is, sharpen individual channels of an image separately. In their suggested approach, you may filter the blue channel, which generally contains most of the noise in an image and contributes least to its appearance, to reduce noise. Try Filter > Noise > Despeckle, or Filter > Noise > Dust and Scratches (the latter provides more control by offering variable Radius and Threshold). Then sharpen the red and green channels separately. They suggest an Amount of 200 and a Radius of 1.4 or less (use the same Radius for both or you will end up with colored halos!). It's probably best to regard these specific numeric values as starting points for experiments to find out what works well for your particular image.

## Two-pass Sharpening

### *In brief*

Fraser [2] proposes a two-pass approach to sharpening, the first pass aimed at eliminating image softness that the scanning process introduces, the second pass at adjusting the image for production on a particular output device. The first pass would be applied to the image once and for all, while the second pass would be done *ad hoc* for an image each time it is prepared for production on a specific device. Fraser advocates the use of edge masks particularly in the first step of this two-step process, so that final output sharpening will not over-sharpen textures in smooth areas.

This two-step approach seems more called-for in a professional production environment than in amateur work where only a single printer may be available for final output. On the other hand, whereas we poor amateurs may have only one printer today, we may have some new and unexpected printing device next year. Maybe we *do* need to look ahead.

## References

1. Blatner, David & Bruce Fraser. *Real World Photoshop 6*. Peachpit Press, 2001.
2. Fraser, Bruce. "Out of Gamut: A Two-Pass Approach to Sharpening in Photoshop." <http://www.creativepro.com/story/feature/12189.html>
3. Fraser, Bruce. "Out of Gamut: (Almost) Everything You Wanted to Know about Sharpening in Photoshop but Were Afraid to Ask." <http://www.creativepro.com/story/feature/11242.html>
4. McClelland, Deke. *Photoshop 6 Bible for Windows*. IDG Books, 2001.

David Warren, 5/16/2002