Sharpening With a Stiletto

Topic: Unsharp masking

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Author's comment: This and the following column ("Hittin' 'em Where They Ain't") represent the first known discussion of strategies to avoid the pitfalls of unsharp masking, and so are of considerable historical importance. Sharpening technique has come a long way since then, but the principles enunciated in this column, particularly the parts about favoring darkening halos over lightening and about seeking ways to use the greatest possible sharpening values without producing an artificial look, laid the foundation. Interestingly, this column states that Photoshop's USM filter is behind the times—even in 1998. As of twelve years later, it still hasn't been upgraded.

This archive, to be released over several years, collects the columns that Dan Margulis wrote under the *Makeready* title between 1993 and 2006. In some cases the columns appear as written; in others the archive contains revised versions that appeared in later books.

Makeready in principle could cover anything related to graphic arts production, but it is best known for its contributions to Photoshop technique, particularly in the field of color correction. In its final years, the column was appearing in six different magazines worldwide (two in the United States).

Dan Margulis teaches small-group master classes in color correction. Information is available at http://www.ledet.com/margulis, which also has a selection of other articles and chapters from Dan's books, and more than a hundred edited threads from Dan's Applied Color Theory list.

Sharpening With a Stiletto

How much unsharp masking should you use? As much as you can get away with. Those who are accurate can get away with more.

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By Dan Margulis

You enter the boss's office under that most tense of circumstances: you are about to ask for a raise. It is possible that negotiations will ensue, so you have to be prepared with a number. How much more money should you ask for?

The stakes are all too clear. Ask for too little, and you may get it; ask for too much, and you may get nothing.

It is also clear that the amount you can get away with asking for is not fixed, but varies sharply depending on your technique. People who, during the meeting, tell the boss what a kind, sweet individual he is and what a joy to work with, as a rule can ask for more than those who imply that, were it not for their own contribution, the boss's boss would realize what an incompetent dolt he is.

And it is also clear that it depends on the character of the boss. Should you mention that another company may make you an offer at a higher salary? Some bosses respond well to this type of thing. Others, like myself, are of the crabby variety, and are apt to suggest that, should you decide to change jobs, you not allow the door to hit you in the backside on the way out.

The fact remains, you should ask for as much as you can think you can get away with under the circumstances, but the circumstances are very much under your control, provided you exercise shrewd judgment. This is exactly analogous to unsharp masking, the topic I will be discussing in this column and my next.

How USM fools the eye

Unsharp masking is an artificial method of making images appear more in focus. It is useful in virtually all graphic scenarios, except where we are expecting someone else to rescan our work later, as when we are outputting color film from a high-resolution recorder. Whether we are preparing for a photographic print, a large-format output device, a color laser or other digital proofer, a JPEGged file for Web use, or any type of print work, accurate USM is a big deal, and the larger an image will print, also, the bigger a deal it is.

Unfortunately, accurate USM is a real art. The settings used for one purpose, such as a desktop printer, would not necessarily be applicable to, say, an ad in a newspaper.

Before discussing how USM works, let's point out that it *does* work. The only difference between the two car images below is the USM, but it's a dramatic difference, and I remind you that these are small images. The problem with most treatises on USM is that, because of space limitations, they
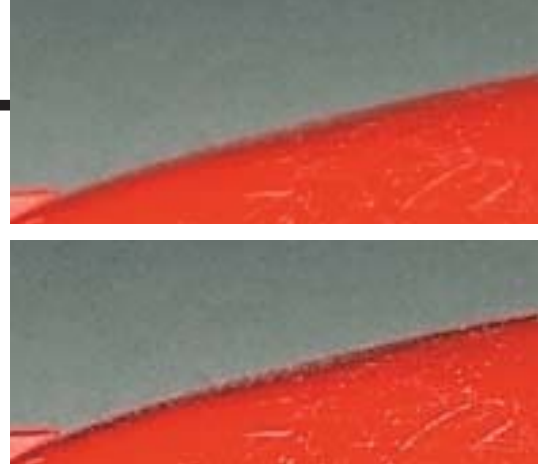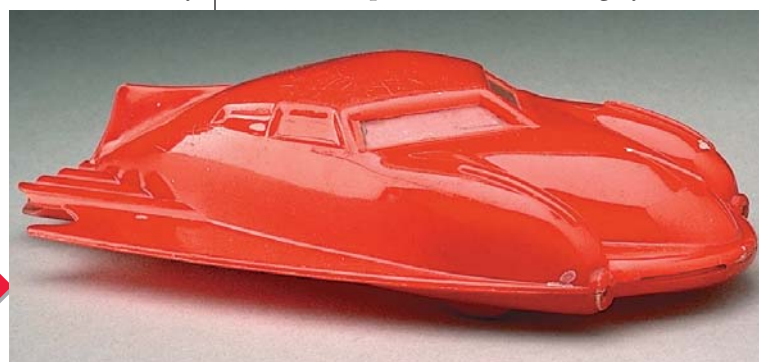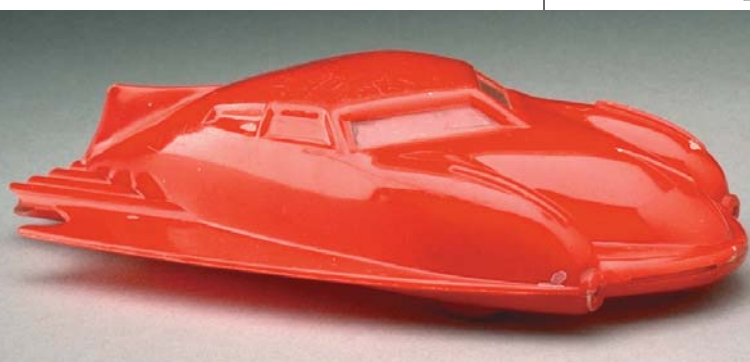
USM works through the judicious use of light and dark halos in transition areas, shown in magnified versions of the car images below.

show postage-stamp size examples, and to really appreciate the proper technique, we need to see its results at a fairly good size. (Please realize also that in this article I am sharpening throughout with a very heavy hand, in an effort to prove my points.)

At top right, the process is put under a microscope. Where car hits background, one would expect the same nice, crisp line of demarcation between red and green we might perceive in real life. Instead, in the raw scan, top, we get several pixels that are neither fish nor fowl: dark, colorless blurs caused by the real-life line of transition being narrower than the scanner can resolve, possibly even than the film of the original photograph can resolve.

The technical workings of unsharp masking are not as important as the result, which is an exaggeration of transitions, such as where the car hits the background. USM, as the second example shows, puts the suggestion, the hint, of a black border, or halo, on the exterior of the car. Furthermore, a second, lighter halo appears around the first. If done subtly enough, the viewer won't notice these halos when the job is printed at the proper size.

That this particular scam is highly

Unsharp masking in action. When properly applied, it can make images much more lifelike, but when overdone, watch out. Left, the raw scan, right, a sharpened version.

effective at hornswoggling people into believing they are seeing stronger transitions, and thus better focus, is not a big secret. Artists have been doing it for centuries. El Greco didn't use Photoshop, but as you can see below, he knew all about unsharp masking.

The four deadly USM sins

As with asking the boss for a raise, the objective is to do as much of it as possible without being so obnoxious as to be counterproductive. USM is artificial, and if we overdo it, the image will look artificial as well. Fortunately, if we pinpoint, and avoid sharpening, the things that may look artificial, we can get away with more USM overall, much to our advantage.

The four problems that may limit how much USM we can apply appear in magnified form on the opposite page. From top to bottom, they are:

1) Color shift. The idea of USM is to make the image look more focused. The idea is *not* to change color. But that is just what is happening in the

first example: note the brilliant, but featureless, reds breaking away from the more orange body of the car.

2) Unreasonably wide haloes. USM only is believable when the characteristic haloing isn't obvious to the naked eye. Here, it would be.

3) Intensification of an unwanted detail. USM makes the picture look more focused, which is fine unless the things that are being focused are not things we want to see. Here, the plastic car has some scratches in its roof. Although this is real detail and not mere noise, I cannot imagine why a client would want us to emphasize it.

4) Exaggeration of grain or noise. Random pixels in the background are being made more prominent. If we allow the image to print this way, the background will look strangely grainy.

All these problems can be finessed, provided we are willing to treat USM as a stiletto, not a shotgun. There is a lot of flexibility in how to apply it, although every program has different strengths and weaknesses. Photoshop can do everything we need, but sometimes requires kludgy two- or three-step operations. But before discussing specific Photoshop settings, let's attack the four sins in a conceptual way.

Desiring to have Christ's upper hand stand out more from the cross, El Greco (1540-1614) resorted to a double-haloing maneuver indistinguishable from today's unsharp masking practices.

Taking aim at the problems

The brilliant reds of our first example happened because applying USM to an entire file actually applies it to each channel individually, as though each were a black and white image.

(You should already be thinking: is that really the best way of doing things? Because we can certainly apply the filter to some channels and not others, or apply it in a different color-space altogether.)

Recall that USM places a dark halo at the edge of the darker of two objects, and a light one at the edge of the lighter. This explains the color-shift problem: in the magenta channel, the car is darker than the background, but in the cyan, the background is darker than the car. So, at the transition, USM darkens the magenta but lightens the cyan. This is a recipe for bright reds.

A partial solution, as hinted above, is to sharpen the weaker channel only. But for an image as soft as this one, the real answer is to eliminate channel-by-channel sharpening totally, in favor of an approach that only considers the lightness and darkness of the image as a whole, not its color.

This technique, *luminosity-based sharpening*, is better than the defaults of Photoshop and most other programs, though some, like Agfa's Color-Exact, are clever enough to *always* do it this way. The second example at right, for all its other problems, is a luminosity sharpen, and has none of the color shift of the top version.

If you wish to sharpen by luminosity, and you should, there are two ways of doing so in Photoshop without getting into Layersville. Easiest is if the document is in the LAB colorspace rather than RGB or CMYK. Guess what the *L* in LAB stands for! Sharpening the L channel only is very powerful.

If you are in RGB or CMYK, an undocumented Photoshop 4 feature allows the same thing, albeit in two steps. After applying USM, choose Filter>Fade, the main function of which, as the name suggests, is to reduce the impact of the last filter applied, namely USM. But it also allows us to

change the application method of the filter, such as to use it only to lighten or darken the original—or to act on *luminosity*. So, if we set the fade to 100% intensity, but the method to luminosity, we wipe out the color shift.

The second sharpening sin that will detour us from our goal of using as much USM as possible is the exaggerated haloing shown in the second example. Or rather, it is *one* of the halos. This points up an irritating Photoshop weakness.

USM's double haloing scheme causes a problem when, as here, one of the objects to be sharpened is relatively dark and the other is medium. The difficulty is, the car can absorb a pronounced dark halo fairly well, but the light halo at the edge of the background becomes painfully obvious.

You can try fading the filter as above using Darker mode, which will wipe out the white halo altogether, but if you are not inclined to waste time, let me tell you in advance that the image will look ridiculous if you try. No, we need to tone down the white halo, not blow it away.

The ability to control white and dark sharpening independently is an assumed feature of any drum scanner or high-end retouching workstation. But it slipped through the cracks in Photoshop, so to achieve it involves another kludge, which I will demonstrate at the end of this column.

Reduction of white-line sharpening would also help deal with the scratches in the top of the car. Even though those scratches are real detail and not noise, we certainly don't want to emphasize them, as is done in the third example.

The better way, though, is simply to avoid sharpening the darkest channel, which here is green in RGB or magenta in CMYK. That is where the scratches are best defined, because the background of the car will be dark, but the scratches light. By comparison, the lightest channel—red in RGB or cyan in CMYK—will have very little difference between car color and scratch.

Are you beginning to see a pattern

here? Even if the image can be sharpened overall, the weak channel can usually be sharpened *more*. Not sharpening the magenta would have virtually eliminated the problems in the first and third images, and gone a long way toward eliminating the grain in the fourth. Meanwhile, reducing the lightening while holding the darkening aspect of USM constant would have substantially improved *all four* of our problems.

To this point, all of our maneuvers could have been done with Photoshop's kid stuff, the filters Sharpen, Sharpen More, and Sharpen Edges. I suggest you discard these popguns in favor of the vastly greater control of the Unsharp Masking filter.

So far I have discussed general concepts only, not specific USM settings. I'll get to an extended review of that in the next column, though it has to be introduced here to deal with the problem of excessive grain shown in our fourth image. But first, another variation on the weak-color theme.

In sharpening, the key is the K

Sharpening the weak channel is so effective that it can become advantageous to work in CMYK, which often has *two* weak channels, if you count the black.

Consider the bottle image on the next page. The noise in the first sharpening attempt is worse even than in the fourth version of the car image.

One way to sidestep this problem is to sharpen a channel that *has* no noise in it, such as the black. This happens very frequently, especially if we have generated the black plate using Light GCR or its equivalent. One should always take a look at the black plate to see if it can be sharpened—even if one has already applied sharpening to the image as a whole.

And one should always look at the weak CMY color as well, if there is one. Here, the image being so greenish, the weak color is magenta. Because the background magenta is so light (and the background black nonexistent) these two plates will have much less
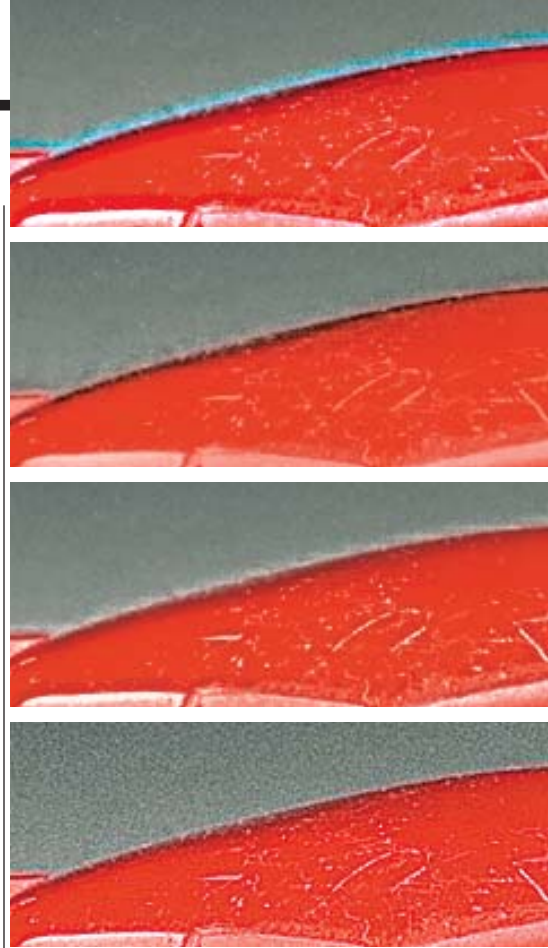
The four deadly sharpening sins, top to bottom: an overall color shift; haloes that are too pronounced; enhancement of an unwanted detail (the scratches in the roof of the car); and exaggeration of simple noise (the background). Below, an undocumented Photoshop 4 feature, the very desirable ability to sharpen by luminosity even when in CMYK.
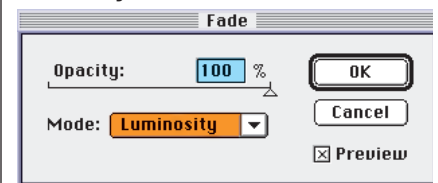
detail, and hence much less noise, than the dominant cyan and yellow.

In addition to our God-given ability to apply sharpening to specific channels and not others, an acceptable USM implementation needs to give us four things:

·Control over how strong the sharpening effect is, in other words, how dark and light the halos get.

·Control of how wide the halos are.

·Some means of suppressing noise.

·Independent control of lightening and darkening.
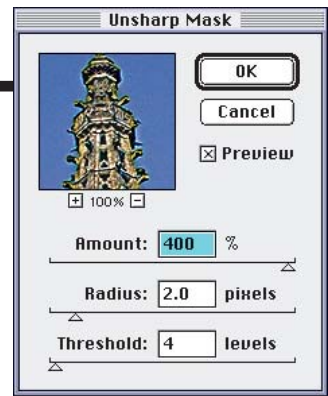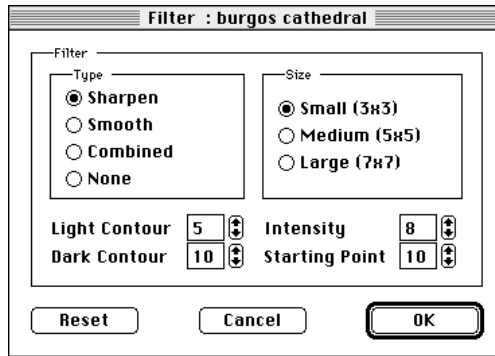
Every application has its own way

Unsharp Mask

OK

Cancel

☒ Preview

⊞ 100% ⊟

Amount: 400 %

Radius: 2.0 pixels

Threshold: 4 levels

Filter : burgos cathedral

─Filter─

─Type─
● Sharpen
○ Smooth
○ Combined
○ None

─Size─
● Small (3x3)
○ Medium (5x5)
○ Large (7x7)

Light Contour 5 ⬍   Intensity 8 ⬍
Dark Contour 10 ⬍   Starting Point 10 ⬍

Reset   Cancel   OK

The sharpening menus of Photoshop, above, and VisuaLab, left.

of doing these things. Two things that all seem to have in common are a dialog box incomprehensible to the typical user, and a failure to document how it works and for what types of images each option might be useful.

They nevertheless have to be deciphered, and they can be, if one keeps in mind the purposes described above.

Start with the obvious, the need to control the strength of the sharpen. In the examples shown here, Photoshop uses the word *Amount* and VisuaLab *Intensity.* Both clear enough, except for Photoshop's insistence on using a percent sign, which seems designed specifically to bluff people into never using a number higher than 100, when 500 is the actual maximum. Anyway, with both applications, the larger the number, the stronger the sharpen.

I doubt that most people would understand *Radius* or *Size* to refer to the width of the sharpening halos, but that's what they do. Again, the larger the number, the wider the halos. Photoshop's flexibility with this is tops

in the industry; note the paucity of choices in VisuaLab.

Stopping USM from enhancing noise as well as detail depends on allowing it to ignore small variations and concentrate on big-ticket items. The higher the value in *Threshold* or *Starting Point,* the less likely the filter is to exaggerate noise—but it isn't always possible to get this right. In the image of the red car, setting a high Threshold indeed will kill the noise in the background without harming the car, but the detail in the bottle image is no more pronounced than the speckling in the background. Certain sharpening applications can solve this, but VisuaLab and Photoshop can't: to sharpen the bottles correctly, you need to go channel by channel.

As for independent control of lightening and darkening, VisuaLab has it and Photoshop should, but doesn't. That doesn't stop a determined sharpener, as we will now see.

John of Cologne's masterpiece, the spires of the great cathedral at Burgos, present a real sharpening challenge. The blurry original (we're in CMYK here) is in desperate need of our help.

In Photoshop, the first step is to make a copy of the file, and sharpen *that.* These numbers seem frighteningly high to the uninitiated, but in an image like this, one can argue that they are justifiable—if we are careful.

Applying these settings results in the second version, which has a color shift: brilliant blues and yellows at the building edges That is fixed in the third version by using Filter>Fade>Luminosity, but the cathedral still looks like it's falling apart because of the excessive whitening.

We now return to our saved original, and put this third version on top of it, with Image>Apply Image. But we choose Darken as the method, resulting in version four: no white sharpening at all.
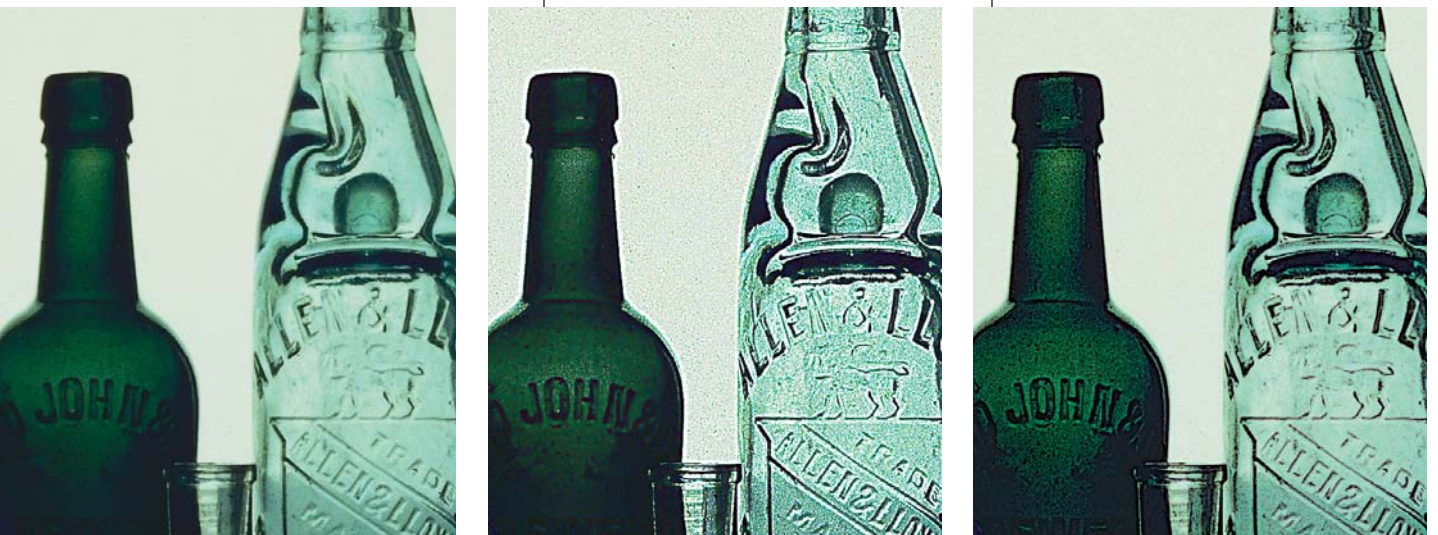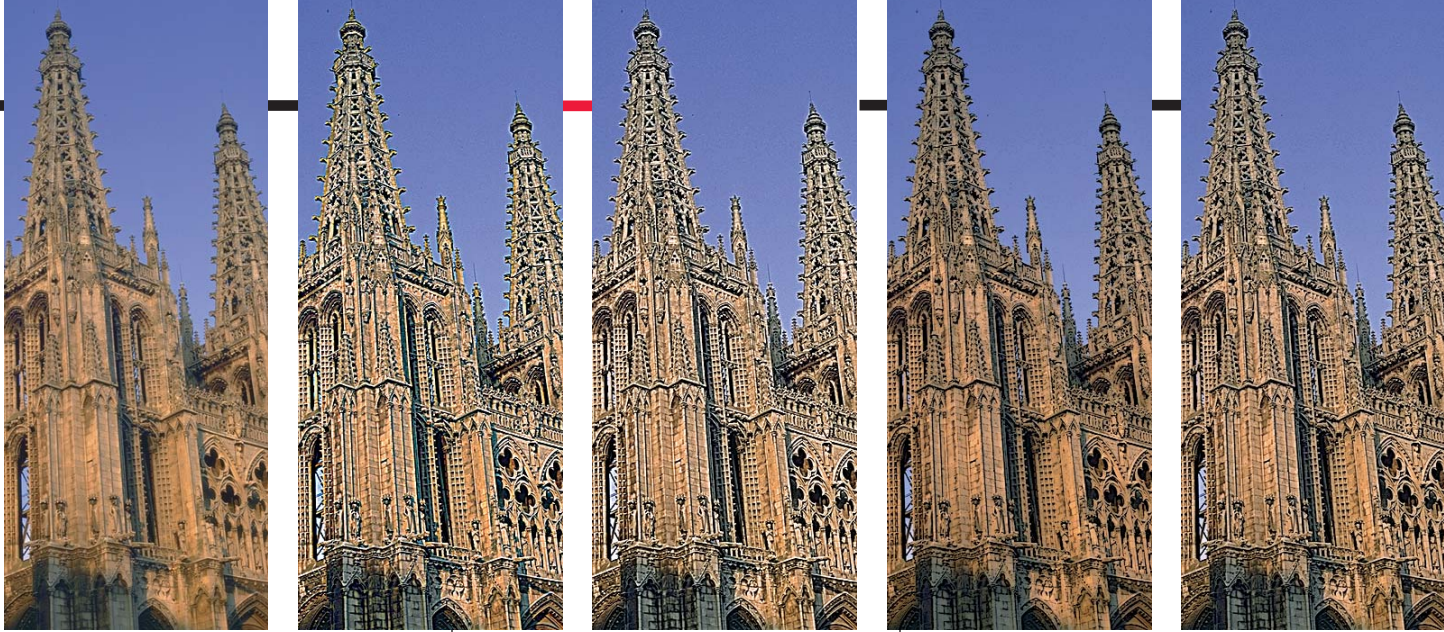
When background noise is heavy, and detail light, a high USM threshold can't always separate one from the other. In such a case, sharpen the weak colors— here, black and magenta. Top left, the original cyan plate has noise in the background, but the black has none. Bottom, left to right: the original; a careless all-channel sharpen, and a version with USM applied only to black and magenta.

Heavy sharpening is possible provided it is done stiletto- and not shotgun-style. Above, a five-step sharpen; enlarged for detail below. From left: the raw image; heavily sharpened in CMYK; the sharpening reverted to luminosity; the third version applied to the first in Darken mode; the third version applied to the fourth in Lighten mode, but at 50% opacity.
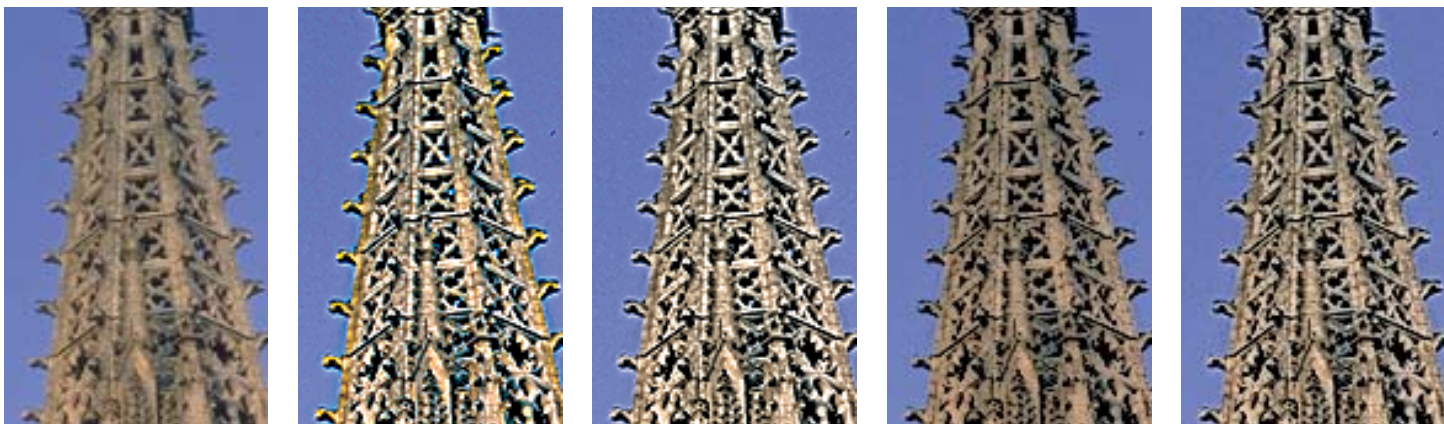
Finally, we apply version three to version four, using *Lighten* as the method, but this time we set Opacity to only 50%. This preserves the dark areas of version four, and creates some white sharpening, but only half as much as the oversharpened version three.

Some sharply focused tips
As we have finished most of the work here, it's time to apply a little USM to this column, to make its points a little crisper and more sharply focused.

•Before doing anything, look at each channel to see which have the detail you wish to sharpen, and also which have the noise that you don't.

•If you decide to sharpen the document as a whole rather than one or two channels, sharpen by luminosity.

•Think twice about about sharpening either the blue (RGB) or yellow

(CMYK) channel. These don't have much impact on overall contrast, yet have the most noise and are thus the most dangerous.

•But always think about sharpening the black, and the weak channel (if there is one), or at least sharpening them more than the others. This applies even if you've already sharpened the entire image.

•Sharpen after tone adjustment, if convenient. Applying a major adjustment to an image after USM can exaggerate the artifacts of sharpening.

Master the Threshold setting. If you are having trouble, set your USM Amount all the way up to 500% while previewing the image. This will make it obvious on screen whether your threshold is suppressing the noise. Once you have found the proper Threshold, you can adjust Amount to something more reasonable.

•Be playful, especially if the image is a large one. There are few set rules. In a large image, a little time set aside for experimentation with ever-higher USM settings can have a big payoff.

•Be conservative. If eventually you decide to sharpen a little more, it won't be the end of the world. But if after a series of corrections you discover that the image is oversharpened, you may wish to turn your stiletto on yourself—oversharpening is hard to fix.

•Be greedy. Remember the strategy of asking for a raise. There's no fixed limit. The best amount of sharpening is, the largest amount you can get away with.

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