Compositing is not the only way to blend two images together. Although very appropriate for placing solid object A over solid background B, there are whole categories of other visual, atmospheric, and light phenomena that look much better with other methods of image blending. In this chapter, we will explore blending operations that are found in every compositing package, plus some found only in Adobe Photoshop. Photoshop is used extensively in digital effects production, so the equations for some of the most important blending modes unique to Photoshop are provided in a form that can be implemented in any compositing package.

Image blending operations use no mattes, so the results are based simply on what type of blending operation is chosen, plus any color-correction done to the elements before or after the blend. We will see where to use the screen operation – a mighty useful alternative way of mixing “light” elements such as flashlight beams and lens flares with a background plate. We will also examine the multiply operation, which, when properly set up, can provide yet another intriguing visual option for the modern digital compositor. For those occasions on which suitable elements are available, the maximum and minimum operations can also be used to surprising advantage.

Adobe Photoshop Users – all of the blend operations in this chapter can be done in Photoshop. Indeed, some of them were invented by Photoshop and are revealed here so that they can be replicated in typical compositing programs.

7.1 IMAGE BLENDING OPERATIONS

The following blending operations will be available in virtually all compositing software packages, with the sole exception perhaps of the screen operation. To cover that base, the exact setup to create your own screen operation is provided.
7.1.1 The Screen Operation

The screen operation is a very elegant alternative method to combine images ("Screen" in Adobe Photoshop). It is not a composite. It does not use a matte and it gives very different results than a composite. Perhaps the best way to describe its purpose is when you want to combine the light from one image with a background picture, like a double exposure. One example would be a lens flare. Other examples would be the beam for an energy weapon (ray gun), or adding a glow around a lightbulb or fire or explosion. The key criteria that it is time to use the screen operation is when the element is a light emitting element that does not itself block light from the background layer. Fog would not be a screen candidate, because it obscures the background, blocking its light from reaching the camera. Please composite your fogs.

Figure 7-1 shows an example of a lens flare element for screening. One key point about the screen layer is that it is always over a zero black background. If any of the pixels are not zero black, they will end up contaminating the background plate in the finished picture. Figure 7-2 shows the background plate, and Figure 7-3 shows the results of screening the lens flare over the background plate. Notice that the light rays are mixed with but do not actually block the background image. The dark pixels in the background plate behind the hot center of the lens flare may appear blocked, but they are just overexposed like a double exposure of a bright element with a dark element. The bright element dominates.

Figure 7-4 illustrates the “double exposure” behavior of the screen operation. It depicts two identical gradients, images A and B, screened together. The key characteristic to note here is how the maximum brightness approaches but does not exceed 1.0. As the two images get brighter, the screened results also get brighter, but at a progressively lesser rate. They become “saturated” as they approach 1.0, but cannot exceed it. When black is screened over any
image, the image is unchanged, which is why the screen object must be over a zero black background.

7.1.1.1 Adjusting the Appearance

You cannot “adjust” the screen operation to alter the appearance of the results. It is a hard-wired equation, somewhat like multiplying two images together. If you want the screened element to appear brighter, dimmer, or a different color, then simply color-grade it appropriately before the screen operation. Again, be careful that none of your color grading operations disturb the zero black pixels that surround the light element, because any black pixel values raised above zero will end up in the output image.

Some compositing programs actually have a screen node, and Adobe Photoshop has a screen operation. Those of you not blessed with a screen node will see how to use either your channel math node or discrete nodes to create a perfect screen operation. But first, the math. Following is the screen equation:

\[
1 - ((1 - \text{image A}) \times (1 - \text{image B}))
\]  

(7-1)

In plain English, this formula says “multiply the complement of image A by the complement of image B, then take the complement of the results.” In mathematics, the complement of a number is simply 1 minus the number. The number, in this case, is the floating-point value of each pixel in the image. Again, note that there is no matte channel in a screen operation. It just combines the two images, based on the equation. This equation can be entered into a channel math node to create your own screen node.
In the event that you do not own a math node or don’t want to use the one you do have, Figure 7-5 shows the flowgraph for “rolling your own” screen operation, using simple discrete nodes in your compositing software. You will undoubtedly find that the composite runs much faster using the discrete nodes rather than the math node anyway. The screen element is first color-corrected if needed; then, both images are “inverted” (some software may call this operation “negate”; in mathematics it is the “complement” operation used in Equation 7-1). They are then multiplied together and the results inverted. That’s all there is to it. You can build this into a macro and save it out as your own personal screen node. You could even share it with your colleagues (or not).

### 7.1.2 The Weighted Screen Operation

A composite blocks the background layer, and the screen operation doesn’t. There are times, however, when you would like to have the “glow” of the screen operation, but still suppress the background layer a bit. This is the time to use the weighted screen operation. The idea is to create a matte for the screen element (the light emitter) and use it to partially suppress the background layer prior to the screen operation. The matte can be generated any number of ways. Most commonly it is a luminance version of the screen object itself, or perhaps the alpha channel in the case of a CGI element. However it is done, a matte is needed for the weighted screen.

We can compare the results of a regular screen operation vs. the weighted screen operation, starting with Figure 7-6, the screen element. Comparing the two background plates in Figure 7-7 and Figure 7-9, you can see the dark region where the screen element was used as its own matte to partially suppress the background layer by scaling it towards black. Comparing the final results in Figure 7-8 and Figure 7-10, the normally screened image looks thin and hot, while the weighted screen has greater density. Although the

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**Figure 7-5** Flowgraph of discrete nodes for creating a screen operation
weighted screen is more opaque, this is not a simple difference in transparency. A semi-transparent composite would have resulted in a loss of contrast for both layers.

The only difference between the two results is that the background plate was partially scaled towards black using the screen element itself as a mask prior to the screen operation. The increased opacity results from darkening the background, so less of its detail shows through, and the darker appearance of the final result stems from the screen element being laid over a darker picture. It's a different look. And of course, as explained in the previous section, the screen element itself can be increased or decreased in brightness to adjust its appearance even further.

The flowgraph for the weighted screen operation is shown in Figure 7-11. The screen element is used to create a mask to moderate the scale RGB operation to darken the BG layer. The screen mask could be generated any number of ways, such as making a simple luminance version of the screen element. The screen element is then color-corrected if needed, then screened with the scaled background image.

Adobe Photoshop Users – you can create a weighted screen by following the flowgraph in Figure 7-11. Create a scaled background as shown in Figure 7-9 as a separate layer, then use it as the background layer for the screen operation.
7.1.3 Multiply

The multiply operation simply multiplies two images together and is another "matte-free" way of combining two images ("Multiply" in Adobe Photoshop). Like the screen operation, it simply mixes two images together mathematically without regard to which is “on top.” The multiply operation is analogous to “projecting” one image over the other, somewhat like putting a picture in a slide projector and projecting it over some object in the room. Of course, if you really did project a slide onto some object, the resulting projected image would appear quite dark. The reason is that you are not projecting it on a nice white reflective screen, but some darker, poorly reflective, and probably colored surface. The multiply operation behaves similarly.

Figure 7-12 and Figure 7-13 show an example of two images for multiplying. The ceramic tile painting in Figure 7-13 is surrounded by a 100% white border in order to leave the wooden gate unmodified in this region. With a multiply operation, any 100% white pixels in one layer will leave the other layer unmodified. This is because the white pixels are treated as 1.0, and 1.0 times any pixel value results in the original pixel value. Note that the
multiplied results are darker than either original layer, as we would expect from “projecting” a slide on a less than 100% white surface. We will deal with this issue momentarily.

While the results of the screen operation universally lighten the images, the results of the multiply operation universally darken. The reason for this can be understood by taking an example. If you multiply $0.5 \times 0.5$ you get $0.25$, a much smaller number. And so it is with all of the numbers between 0 and 1.0.

Figure 7-15 illustrates two identical gradient images, A and B, multiplied together and the resulting darker image. It is actually a diagonally mirrored version of the screen operation graph in Figure 7-4. You could even think of the screen operation as an “inverted multiply,” which results in a brighter output, where the regular multiply results in a darker output.

7.1.3.1 Adjusting the Appearance

Like the screen operation, you cannot “adjust” the multiply operation. The two images are multiplied together and that’s it. But, like the screen operation, you can preadjust the images for better results. Normally, you will want to brighten up the results, so the two plates need to be brightened before the multiply. You want to raise the black levels and/or increase the gamma rather than adding constants to the plates. Adding constants will quickly clip the bright parts of each image.

Figure 7-16 illustrates the results of preadjusting the two plates before the multiply operation. By comparison, the un-color-corrected version in Figure 7-14 is too dark and murky. Of course, you can also color-correct the resulting image too, but when working in 8 bits, it is better to get close to your visual objective with precorrections, then fine-tune the results. This avoids
excessive scaling of the RGB values after the multiply operation, which can introduce banding problems with 8-bit images, whereas 16-bit images would not suffer from banding problems.

An interesting contrast to the multiply operation is the semi-transparent composite of the exact same elements, shown in Figure 7-17. The composited results are a much more bland “averaging” of the two images, rather than the punchy and interesting blend you get with the multiply. Each of the two images retains much more of its “identity” with the multiply operation.

7.1.4 Maximum

Another “matte-less” image combining technique is the maximum operation (“Lighten” in Adobe Photoshop). The maximum node is given two input images, and it compares them on a pixel-by-pixel basis. Whichever pixel is the maximum between the two images becomes the output. Although it’s commonly used to combine mattes, here we will use it to combine two color images. Who among us has not tried to composite a live action fire or explosion element over a background, only to be vexed by dark edges? The fire element is in fact a poor source of its own matte.

The virtues of the maximum operation are that it does not need a matte and that it usually produces very nice edges. The problem with the maximum operation is that it requires very specific circumstances to be useful. Specifically, the item of interest must not only be a bright element on a dark background, but that dark background must be darker than the target image that it is to be combined with. The basic setup can be seen starting with the fireball in Figure 7-18.