Motion Blur

The primary motivation for strobes is that they minimize the *motion blur* of our images. By motion blur, we mean the blur induced in our image by the motion of the subject during the exposure. Here we only consider motion at right angles to the camera's line of sight.

Consider a subject moving across our field of view with a fixed velocity v. Let the exposure time for the image be Δt. The exposure time might be set by the time the camera shutter is open, by the duration of a the flash of a strobe, or by the exposure time of an electronic imager (such as our high-speed video cameras, or a digital camera).

During the exposure, the subject moves a distance

$$\Delta x_{REAL} = v\Delta t \, . \qquad \text{Eq. 1}$$

The image of the subject is reduced in size by a factor of m_{FILM}, the magnification factor between real life and the image on the film (or electronic imager). Then the distance the image moves across the film (imager) is also reduced by the same factor of m_{FILM}, or

$$\Delta x_{FILM} = m_{FILM} v\Delta t \, . \qquad \text{Eq. 2}$$

Clearly, if Δx_{PRINT} is less than the size of a silver grain in the developed negative (or less than the size of one pixel in a digital imager) we can ignore the motion blur.

It is possible for the image to have greater blur on the film/imager and yet still be effectively without blur. Instead of considering the recording medium (film or imager), consider the size of the final printed image we wish to produce. For an image of that size we can select the maximum blur we can live with (a subjective criterion). Then, the blur on the print is given by

$$\Delta x_{PRINT} = m_{ENLARGER}\Delta x_{FILM} < \textit{Maximum we allow for the print}, \qquad \text{Eq. 3}$$

where $m_{ENLARGER}$ is the magnification in going from the negative to the print. As long as Δx_{PRINT} is small enough, the image is acceptable.

Alternative Approach

A simple rule-of-thumb approach is to take the width of the plane you are imaging (also called the field-of-view, or *FOV*) and divide it by 200 times the velocity (v) of the subject in that plane. The result is the maximum exposure time you should use, i.e,

$$\Delta t = \frac{FOV}{200v} \qquad \text{Eq.4}$$

Mixed Lighting

If we have both strobe lighting and continuous lighting, can we take a clear, crisp, photo? Yes, and there are two ways to do this.

Method 1 (not preferred)

Make the shutter speed comparable to flash duration:

PROBLEM At short exposures, many shutters do not expose the entire negative simultaneously!

For example, a curtain shutter consists of two fabric curtains. One is pulled back, revealing the film, when you press the shutter release, the second follows the first after the desired exposure time. For a short exposure, the first curtain is only partway across the film when the second starts. This means that at any instant in time, only a narrow slit of the film is exposed. If you tried to take a strobe photo, you would only have part of the image captured when the strobe is illuminated.

Method 2 (preferred)
Arrange shutter speed & aperture so that the continuous light image is underexposed by 3 stops (or more). Then pick the BCPS and strobe-to-subject distance, *D*, so that the strobe image is well exposed. In general, the process is:

1) Pick shortest exposure (fastest shutter speed) that works for Flash photo
2) Find the aperture needed for a good exposure from the ambient.
3) Close by 3 stops (i.e., $A_{strobe} = A_{continuous} * 2.8$)
4) Set the BCPS and or the strobe-subject-distance so that the strobe photo is well exposed.

EXAMPLE:
My camera can take a flash photo for exposures lasting 1/30 sec or longer. My strobe has a BCPS of 51, and I am using ASA 400 film. My light meter tells me that with the ambient lighting, I need to us *A = f/2.8* at a *1/30 second shutter speed*.

1) Set at 1/30 sec.
2) Light meter says I need f/2.8 at 1/30 with ambient light.
3) Close three stops (f/2.8 -> f/4 -> f/5.6 -> f/8) to f/8.
4) If BCPS = 51, ASA 400 then DA = 32 and I pick D =4.

Set the strobe 4 feet from the subject, use f/8 and 1/30 sec.