PROBLEMS IN COLOR PHOTOGRAPHY

The following paragraphs describe some of the basic practical problems which to a greater or lesser degree are peculiar to color photography.

COLOR QUALITY OF ILLUMINATION

Though virtually negligible in black and white photography, the color quality of the light source is an all-important consideration in color photography. Essentially, the problem in color work arises from the fact that a color film does not always "see" colors as human beings see them. For example, if the cover of a book appears green in daylight, that is, in illumination which is a combination of sunlight and skylight, we think of it as having the same color in tungsten light. Although the difference in the quality of the illumination actually effects the quality of the light reaching the eye, our vision automatically compensates for the change. A color film, having no such automatic compensation, *reproduces color approximately as the eye sees it only when the illumination is the same as that for which the film is balanced.*

Contemporary photography accepts artistic license in the use of light sources which do not necessarily match the film's color sensitivity.

Thus the book will be reproduced as green by daylight type film exposed in daylight, or by artificial light film exposed in tungsten light. If daylight type film were to be exposed without a compensating filter in tungsten light, it would reproduce the book as yellowish-green. Similarly, artificial light film exposed without a filter in daylight would reproduce the book as bluish-green. These variations in color rendering are illustrated on page 46.

Since, as suggested above, we tend to perceive colors as they appear in daylight, the objective of color films balanced for exposure in artificial light is to make the picture appear as if the light source were of daylight quality. This is also the objective of filters recommended for use when a color film must be exposed under lighting conditions other than the one for which it is balanced.

It must be emphasized that, *except for special applications, light sources which are appreciably different in spectral energy distribution cannot be mixed for any one exposure.* In viewing an original scene lighted by two different light sources, the eye adapts to an intermediate color quality, thus tending to minimize the visual effects of the color differences between the two sources. The film, however, has no power of adaption and will show the full color difference in parts of the subject illuminated by a light source differing in quality from that for which the film is balanced.

Color Temperature. For visual purposes, the color quality of a light source is evaluated in terms of the color of a perfect radiator, or "black body", heated to a certain temperature. This temperature is expressed in degrees Kelvin (K), obtained by adding 273 to the temperature in degrees Celsius. When the light source matches the black body in color, it is said to have a *color temperature* equal to the actual temperature of the black body in the Kelvin scale.

The color of light is bluer with higher color temperatures and yellower with lower ones. *Note that color temperature refers only to the visual appearance of a light source and does not necessarily describe its photographic effect.* For example, one type of "white" fluorescent lamp is rated at 3500K, but the spectral distribution of the light it emits produces photographic results quite different from those produced by a tungsten lamp operated at the same color temperature. *Color-temperature values for various daylight conditions also tend to be misleading when they are applied to color photography.* Tungsten lamps, however, have spectral qualities closely resembling those of black-body radiators, and in this case, color temperature is a reliable indication of photographic effect.

SUBJECT CONTRAST

At first glance, subject contrast might be considered as a property of the physical subject matter before the camera lens. Suppose, for example, that we are photographing a model wearing a white shirt and dark pants. If the shirt reflects eight times as much light as the pants, and these are the lightest and darkest objects in which detail must be reproduced, we might assume that the subject contrast ratio is 8 to 1. Actually, 8 to 1 is the reflectance ratio. From the point of view of the film, subject contrast involves an additional and very important factor, the *lighting contrast*.

Lighting contrast can be defined as the ratio between the highest and lowest amounts of illumination falling on the principal subject. Continuing with our example, let us assume that we are going to make a close-up with the simplest type of lighting, involving the use of only two lamps. One might be placed at the same distance from the subject as the camera, but on a line forming an angle of about 45° with the camera axis. This light would be the *key light*, and would cast shadows which, seen from the camera position, would delineate the contours of the subject's face. But the shadows cast by this single light would be very dark and would obscure some of the important detail of the face. To soften them, we might place another light close to the camera. This would be a *fill light*, because it would partially fill in with light the shadows caused by the key light.

Daylight type film exposed in daylight.

Daylight type film exposed with 3200K lamps.

Tungsten type film exposed with 3200 K lamps.

Tungsten type film exposed in daylight.

These photos show the results of matching or mismatching film stocks and light sources. Any combination may be acceptable depending on the color quality desired. The background in all four pictures is 18% gray; the woman is holding a blue notebook (Pantone color 2925U).

Great differences of light and dark in any scene cannot be reproduced successfully unless the lighting is adjusted to offset the extreme differences in brightness. Otherwise, dark areas will be much too dark and off-color, while light areas will be "burnt out", lacking color and detail.

Color negative films allow more leeway in the matter of lighting contrast than the reversal films, because you can make some adjustments for color balance during printing and/or in electronic transfer.

In this discussion, we have been speaking principally in terms of indoor work, which allows control of lighting contrast by variations in the placement of the lights. In outdoor work, the sun can be considered as the key light and the sky as the fill light. On a clear day, the ratio of sunlight to skylight is frequently too high for satisfactory detail in both shadows and highlights, especially with near by side or back lighted subjects. In such cases, the lighting contrast can be reduced by supplementing the natural skylight illumination of the shadow areas, either with a suitably balanced light source (which approximately matches daylight in color quality), or with reflectors to direct sunlight into the shadows. On a hazy day, the natural lighting is softer, and supplementary lighting is seldom necessary.

EXPOSURE ACCURACY

Compared to black and white or color negative materials, reversal color films have much less exposure latitude. In other words, there is a much smaller difference between the greatest and least amounts of exposure which will produce satisfactory results. Lens settings must therefore be determined with a correspondingly greater degree of accuracy.

In the determination of camera settings, an exposure meter can be of real assistance, especially under unusual lighting conditions and with complex studio lighting arrangements. Furthermore, photographers must be fully aware of the characteristics and limitations of the meter if they are to obtain consistently reliable exposure indications. For the most critical work, an actual photographic exposure test is recommended.

Daylight lighting conditions such as clear sun, hazy sun, etc., are constant enough so that it is practical to give fixed exposure recommendations in the form of tables, guides, and built in camera computers. These recommendations give excellent results under the specified conditions.

COLOR PERCEPTION

Color pictures occasionally show colors which appear faulty to an observer inexperienced in color photography, but which were actually present, unnoticed, in the original scene. In judging results, the photographer is frequently unable to compare the picture directly with the subject and uses a memory of the image instead.

If the photographer has not learned to observe color, that is to recognize subtle mixtures and reflections, colors which were not noticed in the original subject may appear when the photograph is viewed. These unnoticed colors are due largely to the effects of the lighting conditions and the surroundings.

An example is a snow scene, photographed in bright sunlight under a clear blue sky. Although it might be thought that shadows on white should be colorless, snow often contains bluish shadows. Actually, the shadows are bluish, and they appear so largely because the light that does reach them comes from the blue sky.

Claude Monet, *The Magpie* 1869, Musee d'Orsay, Paris, France. Giraudon/Art Resource, NY

A COMMENTARY ON THE MONET PAINTING

By Woody Omens

No one in the history of painting so keenly observed the nature of light and color like Monet. His eye, actually his retinal, sensitivity to color was superhuman. He saw fragile color most of us miss. Where most of us would see white snow everywhere, he saw it as warm one place and cool another. When it came to painting, he was not misled by the phenomenon *approximate color constancy* (see page 59). Monet's intuitive understanding of this phenomenon, in part, contributed to his unique color vision.

He never tired of seeing how the environment produced infinite coloration effects. He observed snow to be a substance upon which light *falls* and from which light is *reflected*. Light from the sun and the sky fell on the snow (*illuminance*) only to return to his eyes as a warm yellow gold tint in the sunny portions of snow, and cooler bluish in the shadow portions (*luminance*). The expanse of open blue sky above produced the fill light which caused the shadows to appear bluish. In this painting, he worked from actual observation of color, not from his memory of color. He painted the shadows on white snow as they actually were.

This painting is a masterful example of Monet's powers of observation long before refined color photography was available to demonstrate the accuracy of his color vision. Monet's eye was natural, instinctive, and expressive.

Exercise: Each day, observe these and other effects as light plays upon surfaces. Also study the color of human skin. How do various light and dark skin tones reflect environmental light differently? Think like Monet. Beware of the *approximate color constancy* phenomenon and other factors in the chapter on Perception.

Here are two books on Monet:
Monet by Robert Gordon and Andrew Forge. Harry N. Abrams, Inc., New York, NY., 1989
Monet by Christoh Heinrich. Barnes and Noble, New York, NY., 1996

A second example is a color photograph exposed early in the morning or late in the afternoon. The color of sunlight during these hours is quite orange, and as a result the picture comes out orange. The warmth of color and shadow effects obtained early or late in the day may be desirable.

Still a third example is a portrait of a model posed near a strongly colored reflecting surface. The face and arms may look perfectly natural at the time the picture is taken, but the colored light reflected on them may produce an unnatural effect in the finished picture. It is interesting to note that if colored surroundings are actually included in the shot, the resulting picture will seem more natural because the reason for the unexpected color in the subject is evident.

There are two reasons why such color effects are more difficult to recognize in viewing the original scene than in viewing a reproduction of the scene in the form of a color photograph. First, we commonly think of the color of a real subject as characteristic under all circumstances, and therefore do not expect any change. Second, in viewing the original scene, the eye tends to reduce disturbing illumination color by adapting to it in a way quite beyond the powers of the film. These factors will be considered at greater length under the heading *Perception* (page 51); here it is sufficient to point out that the photographer can learn to detect unwanted color effects in the original scene and take steps to prevent their appearance in the color picture. Photographers can attain a better appreciation of color and will improve their ability to remember colors and to control the results.

The foregoing should not be interpreted as indicating that Kodak color films will provide a perfect reproduction of the colors of the light which is reflected from a subject into the camera lens. If we make critical measurements on the very best color photographs, we find considerable differences between their colors and those of the original subjects. Actually, there is no available process of color photography which can be said to give entirely accurate and repeatable reproduction of color. Kodak color films, properly used, give satisfactory color rendering for their intended purposes, but in the present state of technical knowledge it is not possible to design materials suitable for making precise color records, or for matching or measuring colors. Further, since the reproduction of a physical subject by means of a color transparency or print involves psychological factors in the response of the observer, it can never be "perfect" in any simple sense.

Color photography allows full scope to originality and individual taste. An observant eye can find endless ideas for effective color schemes in paintings, printed and woven fabrics, interior decoration, and in the purely accidental combinations that occur in everyday life. The effectiveness of a given color scheme depends not only upon the colors themselves, but also upon their comparative areas and their distribution in the scene area. The textures of the colored surfaces are also important, because they lead to different color rendering under different lighting arrangements. Ease in composing with color is to a great extent the result of experience and observation.

COLOR BLINDNESS

A final consideration in our discussion of problems in color photography is the matter of color blindness. Few people realize how large a proportion of the population has defective color vision. Statistics on the subject vary because of differences in testing equipment and technique, however, it is safe to say that approximately 8 percent of men and 0.4 percent of women have some degree of anomalous color vision. Of those displaying defective color vision, approximately 2 percent of men and 0.03 percent of women are afflicted in such a way that it is dangerous for them to engage in occupations requiring the proper recognition of colored signal lights. Such cases can be identified with the test charts that oculists and qualified optometrists have.

Anomalous color vision usually dates from birth, but may also be acquired as the result of certain types of injury, disease, or poisoning. There are many types and degrees, some individuals see one part of the spectrum as gray; others see another part as gray. Usually, people who have defective color vision merely experience difficulty in distinguishing and naming colors. In many cases, the deviation from normal color vision is so slight that it is never recognized.

There is no reason why the majority of people with anomalous color vision cannot engage in and enjoy color photography. In serious cases, however, duplicating and color printing processes should be undertaken with caution, because the individual control allowed by such processes may lead to results which are not acceptable to those having normal color vision.