The Incident System

Sensitometry Primer Part V

By Phil Davis

In the last installment of this series I described a procedure for analyzing film characteristic curves and extracting Zone System information from them for use in the field. If you applied the recommended analysis procedures to your own film curves and were careful to draw the construction lines accurately, you should now have working charts that relate subject range (SBR)—as indicated by N-numbers in Zone System terminology—to both effective film speed (EFS) and development time. This information is personalized because it reflects not only the characteristics of your chosen materials, but also the influences of your equipment, your darkroom environment, and your individual working habits.

These working charts should provide you with reliable exposure and development recommendations for subjects of any reasonable range, but they apply only to Zone System procedures—that is, to the use of a *luminance* meter (ideally a spotmeter) and the mental assignment of "zone grays" to selected subject areas. Other methods can achieve somewhat similar results but they require different metering techniques and different calibration data. To explain these differences it may be helpful to examine briefly how meters operate and what they can tell us.

To state the obvious, luminance meters measure luminance, which is another way of saying that they respond to both the intensity of the ambient light (*illuminance*) and the color and value of the subject's surfaces (*reflectance*). We see things that way, too; in any given condition of illumination we expect white objects to appear lighter than black ones, and we know that casting a shadow on some object will make it look darker than it appeared in the light.

Ordinarily we accept the appearance of things at face value, without worrying about why they look the way they do. The Zone System, too, deals with appearances and helps us relate our perception of the subject tones to their measured luminance values. This is a well-proven way to work, but there are times when it's convenient to separate illuminance from reflectance and consider them individually.

For example, it's occasionally useful to begin exposure calculation by reading a "gray card" in the subject space, rather than metering the subject itself. The spotmeter is an ideal instrument for taking gray card readings, but if you think about it for a moment you can see that luminance measurements of a standard gray card (whose reflectance value is constant) can really be thought of as measurements of *illuminance*. In other words, the gray card allows the spotmeter (or other luminance meter) to make incident readings.

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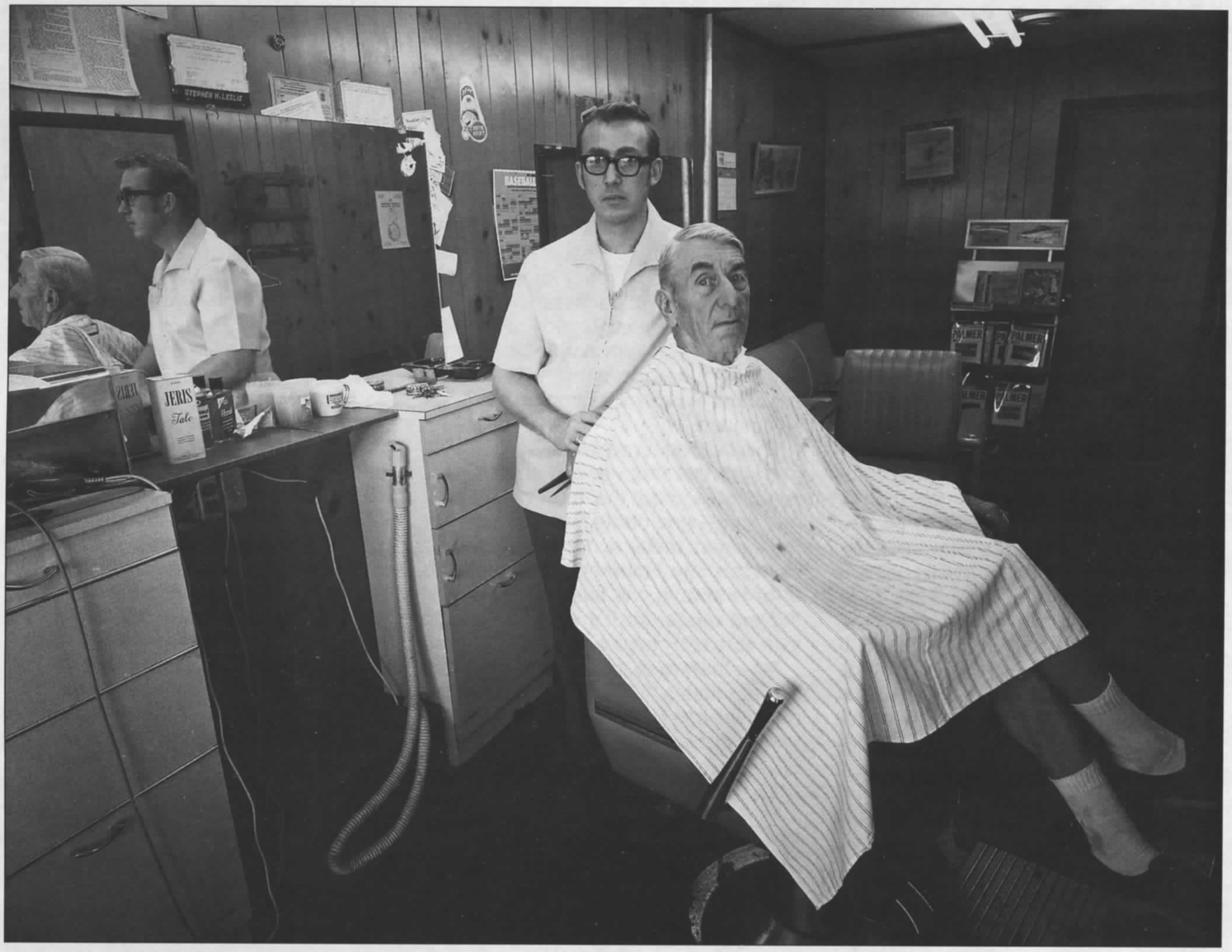
Of course an incident meter generally does it more efficiently. The translucent plastic dome that covers the incident meter's sensitive cell serves as a built-in gray card; but because of its hemispherical form it simulates a three-dimensional subject more realistically than a flat card can, and in some cases may provide more accurate exposure information. In general, though, incident readings and gray card readings are quite similar. Both are based on the assumption that there is a standard middle gray that is a satisfactory substitute for the normal subject. That's a widely held belief that sounds sensible enough; but unfortunately, in almost every instance, the familiar standard gray card is the wrong shade of gray.

If the gray card is not the *right* gray, what should it be? That depends on what you want to use it for. If you simply need a reference tone for comparative measurements of illumination, for example, then any gray—including black or white—is probably as good as any other. On the other hand, if you want a gray that's equivalent to the mid-tone of any and all subjects, you're probably out of luck because it's apparent that as subject range varies, so must the middle gray of that range.

The standard gray card is fine for the graphic arts industry, for example, because the typical copy subject is a black-and-white drawing or diagram in black ink on white paper, pinned flat to the copy board and illuminated as uniformly as possible. It's easy to demonstrate that the reflectance range of black ink or paint on white paper—even under these ideal conditions—is rarely more than 1.32, which is equivalent to a log range of 1.5, or 5 stops. For example, in making reflection density measurements on several pages of a magazine, I was unable to find a black-ink-to-white-paper range greater than 1.52. This is not to say that no greater reflectance range is possible but it is true, in general, that outside of the controlled environment of the copy studio the measured *reflectance* range of any subject will almost never exceed 5 stops by any significant amount.

Obviously, the center of this 5-stop range (representing the *averaged* values of the extremes—not a simple *average* reading of the total area) lies 2½ stops from either end. In log terms, as you know, 2½ stops is equivalent to 0.75 which, in turn, is equivalent to a reflectance of approximately 18 percent. In other words, the standard 18 percent gray card *does* represent middle gray *if* your subject is two-dimensional and illuminated absolutely evenly.

"But," I hear you saying, "real world subjects aren't flat, and they aren't often evenly illuminated!" Of course that's true, but notice that the only thing that's influenced by these "real" conditions is the *illuminance.* The subject's inherent *reflectance* characteristics (its surface color and value) are unaffected. In other words, the 5-stop basic reflectance range of the subject will almost certainly be *increased* by any unevenness in the illumination so that typical subjects are



STEVE'S BARBERSHOP *was made with an 8 × 10 Sinar P camera with a 6 7/16-inch Bausch & Lomb Protar lens exposed for 5 seconds at f/16. Exposure was calculated using the Incident System.*

likely to exhibit total ranges of anywhere from about 6 stops to perhaps 10 stops, or more.

Now you can see why the real middle gray of the subject is almost never 18 percent. In fact, the middle of the normal 7-stop subject range is actually 3½ stops from either end, for a log value of 1.05 which is equivalent to about 9 percent refectance—a full stop darker than the standard gray card.

This isn't a very serious matter unless you persist in thinking of the 18 percent gray card as a universally useful substitute for the subject (which it usually isn't) or the equivalent of Zone V (which it may be, but frequently isn't). As suggested above, its main value in ordinary photographic applications is to serve as a reference. It's convenient to have a *standard* gray that can be used for comparative measurements but, except for the fact that the 18 percent gray has rather specific application for flat copy work, any other gray that we could all agree on would probably be equally satisfactory.

For better or worse, though, the 18 percent standard exists in at least two forms: the reflectance of the ubiquitous gray card is one; the other is the transmittance of the translucent plastic dome of the incident meter.

There's a bit of a problem here. The incident meter's cell is never exposed to the real world. It *sees* only the inside surface of its little plastic cover and doesn't even *know* that the real subject exists. It responds only to illuminance and, because the dome's transmittance is only about 18 percent, the cell's response is always about 2½ stops lower than the average intensity of the outside light—a condition which the *cell* interprets to mean that the total range *out there* is always 5 stops. Unfortunately, the meter's *calculating dial* doesn't agree—it assumes that every subject has the normal 7-stop range. In other words, the cell's concept of *middle gray* is a full stop above the *middle gray* that the dial recognizes.

Most photographers who have used incident meters extensively have learned to deal with this problem more or less intuitively. We discover from bitter experience that a single incident reading, taken in full sunlight and used without modification, will almost inevitably lead to significant underexposure of the shadow areas of the subject. Eventually we learn to *cheat* the meter position away from the direct light a little. In effect, this tells the meter cell that the light is less intense than it really is and tricks it into providing a more sensible exposure recommendation.

This is probably why some photographers seem to feel that the incident meter is an inappropriate tool for serious work with conventional black-and-white films. They're not entirely wrong, either. The incident meter is generally acknowledged to be useful for measurements of *illuminance* range, but that's not enough information to form the basis of a really useful exposure/development system. What's needed is a method for estimating subject *luminance* range.

Superficially this would seem to be an impossible assignment for an instrument that ignores the subject entirely, but it's really a fairly simple matter. For example, when you take an incident reading in the most brightly illuminated area of your subject, the meter will, as usual, indicate a value that's 2½ stops below *white.* Similarly, when you take an incident reading in a deep shadow area of the subject, the meter will think that it's dealing with its ideal 5-stop range in very poor light and will again provide a reading that's centered in that range. In the first instance that 5-stop range provides 2½ stops leeway *above* the indicated reading to take care of highlight detail. In the second instance it provides 2½ stops leeway *below* the indicated reading to accommodate the deep shadows. The total subject range (SBR), therefore, can be estimated to be 2½ stops + 2½ stops + the difference between the two readings. In this case, if the high reading is 15, and the low reading is 12, the usable subject range must extend from 17½ to 9½, for a total of 8 stops. Notice that to record both ends of this range satisfactorily we must base the camera settings *on the low meter reading* and to retain the highlights we must reduce the development time—precisely the same technique that's used with the Zone System.

This procedure is surprisingly accurate in practice—once you've learned where to place the meter. But (here's the problem again) the meter's calculating dial thinks that there's 3½ stops leeway above and below the indicated readings. In other words, the meter will try to provide for 3½ stops of usable image tone below the shadow reading, which is a full stop more than necessary. The extra stop that conceptually overlaps the high end of the scale can simply be ignored because it has no effect whatever on either the exposure setting or the range calculation.

This calibration problem results partly from the fact that the cell and the dial can't agree about the length of the normal range, and partly from the fact that the incident meter is not intended to be used this way. Fortunately, the exposure error is always one stop, regardless of subject range, so it's easy enough to take care of by adjusting the film speed.

Now that we've established a method for estimating SBR with the incident meter we can return to the film's characteristic curve family (Figure 1) to extract working data for the Incident System. You've already done all the hard work. You know the SBR value, the developing time, and the EFS value of each curve. All that's left is to compile these data in chart form, as you did for the Zone System information. This time, though, you'll have to calibrate the working charts with SBR values in stops, rather than the N-numbers that you used for the Zone System charts.

The SBR vs developing time chart (Figure 2) is simple and straightforward. The SBR vs EFS chart (Figure 3) isn't really complicated, either, but it requires one adjustment that will seem strange to photographers who aren't familiar with the *schizophrenia* of the incident meter. That is, you must *double the film speeds* to counteract the 1-stop exposure increase that the meter dial will impose on the cell's shadow reading. If you're charting the data by hand this is obviously easy. It's also simple enough if you've used my Macintosh *Plotter* program to plot the curve family and print the Zone System charts, but you'll have to modify the ISO value in the first data screen and run the program again if you want the doubled speed value to appear in the final chart printout. Be sure to return to the data screen and restore the normal ISO value when you're through with the incident charts because the Incident System is the only metering procedure that needs these artificially inflated speeds.

Use these charts just as you do the Zone System data. Take high and low readings with the incident meter, subtract the low reading from the high reading to discover the difference in stops, then add 5 to arrive at the total SBR. Consult the EFS chart to find the appropriate effective film speed; set that value into the meter dial, reset the dial pointer on the low reading (if necessary), select the aperture and shutter speed settings, and shoot. Record the holder number and the SBR number. When you return to the darkroom consult the developing chart to find the appropriate developing time for the SBR, and process accordingly.

The Incident System is remarkably forgiving and will almost never get you into serious trouble even if you use it clumsily. For best results, though, you should choose your metering positions with the same care that you use in selecting metering points for the Zone System. In both systems your most potent control lies in what you meter and *how you interpret* the meter readings.

Both systems permit creative metering for deliberate manipulation of image gradation and contrast, but they do it in very different ways. Unlike the Zone System, which almost *never* deals with the extreme limits of the subject range,

Figure 1

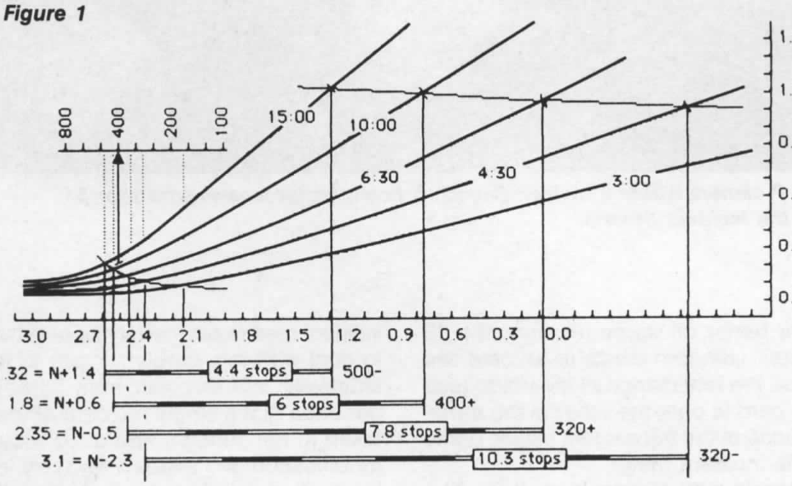
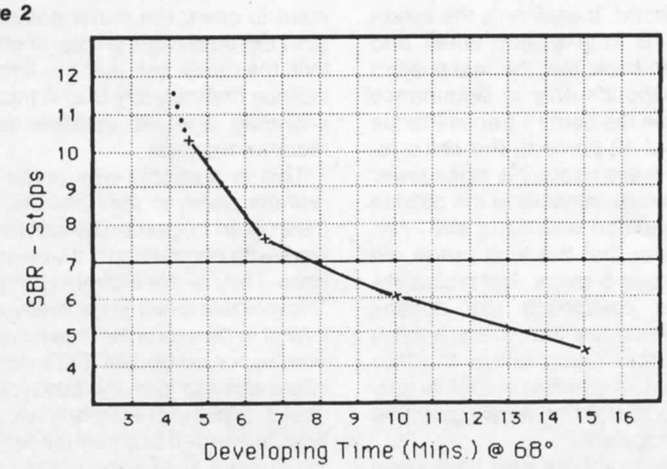


Figure 2



the Incident System *always* does. In other words, the Zone System establishes a relationship between selected subject areas of intermediate gray tone and assumes that the extremes will be properly taken care of. The Incident System works just the other way. It establishes the extreme limits of the subject range and lets the intermediate values fall where they may.

When you place the incident meter in the most brightly illuminated area of the subject space you have automatically defined the light condition in which a white object will be rendered with proper "highlight" value (equivalent to the upper limit of Zone VIII) *if a white object is actually present* in that location. Similarly, the meter position in the shadow area defines the light condition in which a black object will be rendered with visible tone (equivalent to the lower limit of Zone II) *if a black object is present.*

If you are trying to reproduce the subject more or less representationally, it doesn't matter whether these extremes of reflectance actually exist at the metering locations or not. You must provide for them, regardless, so that the other values will be rendered properly. In other words, if you establish a subject range that's capable of rendering black and white satisfactorily, the intermediate gray scale will be reproduced proportionately. Removing the black object or the white object (or both) from the scene doesn't affect the gray rendering of other portions of the subject at all, so the exposure isn't necessarily affected.

Of course, an image without the reference extremes of black and white might not appeal to you aesthetically, but that's not a technical problem. Anyhow, it's easy enough to manipulate the image contrast (within the limits of the materials you are using) by simply changing your metering points. In all cases, moving the meter away from the light (when taking the high reading) will automatically reduce the SBR, which will increase image contrast and shift the lighter grays toward white. Moving the meter out of the deep shadows into lighter shadow (for the low reading) will also reduce the SBR, increase image contrast, and reduce or eliminate deep shadow detail.

Both systems permit creative manipulation of image gradation and contrast, but the Incident System establishes the extreme limits of the subject range and lets the intermediate values fall where they may.

Of course, the reverse is also true; moving the meter toward a brighter light to take the highlight reading—even out of the subject space, if necessary—will increase the calculated SBR, which in turn will reduce overall contrast and gray the image highlights. Poking the meter farther back into deep shadow for the shadow reading will also increase the SBR, decrease overall image contrast, and open up the shadows for greater detail and separation.

Notice that moving either metering point from one level of illumination to another will affect the SBR directly. This, in turn, will affect both the effective film speed and development time so that both image density and contrast are automatically adjusted. In general, the highlight metering location affects development most obviously. The shadow metering point affects both exposure and development.

As you work with the Incident System you'll soon discover that some types of subjects can't be metered directly. For example, if you're trying to photograph the Grand Canyon, it's clear that you can't very well walk into the actual subject space with your meter. The high reading will probably present no problem because the sun shines just as brightly on the distant landscape as it does where you're standing (discounting excessive haze, and assuming that you and your subject are both in the sunlight), but the low reading may be more difficult. If you need to know the illuminance value of a distant tree or rock shadow, it's usually safe to take a substitute reading in the shadow of a similar tree or rock close by. Read your own body shadow as a substitute for open shade in the subject area, shade the meter cell to various degrees with your hand, the dark slide, or your focusing cloth to simulate more deeply shaded areas.

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Figure 3

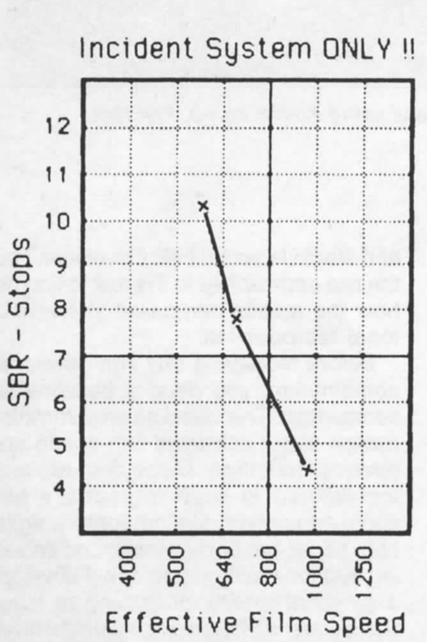
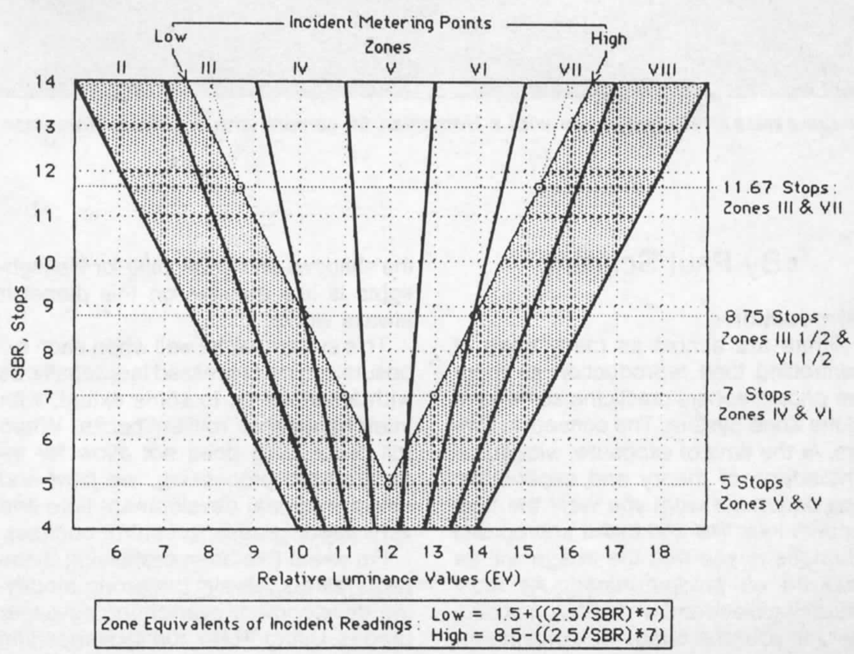


Figure 4



The Incident System

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Use these same techniques to simulate shadows that are physically too small to accommodate your meter, such as the nose or chin shadow of a portrait subject, or the deep crevices in tree bark. In every case, adjust your substitute shadow until it matches the intensity of the real shadow area in the subject. When you're satisfied that they're the same, use the substitute shadow reading as the basis for your exposure calculation.

With practice you'll find that creating a substitute shadow isn't much of a trick, but creating a substitute highlight is generally impossible (you can resort to educated guessing, of course, but that negates the value of the systematic approach). When problems of this sort arise, I suggest that you pick up your spotmeter and work with the Zone System. There'll be other cases where spotmetering is similarly awkward or risky and it will be advantageous then to switch back to the Incident System again.

In fact, the two systems complement each other well. Under most conditions they're both appropriate and you can use the one that you feel most comfortable with. In other instances, one will be distinctly preferable. If you learn to use them both you'll be well prepared for just about anything.

If you have been using the exposure/development program that I wrote for the Tandy Radio Shack PC-5/6 Pocket Computer (DARKROOM & CREATIVE CAMERA TECHNIQUES March/April 1987), you may be interested to know that my latest version can be used with this Incident System as well as the Zone System. It also features numerous other improvements, including separate, specific reciprocity compensation for each of the T-Max films. I'll be happy to send a listing of the revised program, and a few pages of instructions for using it, to anyone who requests it and encloses a self-addressed business size envelope. Please include 50¢ postage.

A version of the program, with instructions, is also included in the 2nd edition of my book, *Beyond The Zone System,* published by Focal Press, and has been reproduced with permission of the publisher in a collection of reprinted articles from DARKROOM & CREATIVE CAMERA TECHNIQUES, entitled *Mastering Black-and-White Photography.* □

Photographer/writer Phil Davis is the author of Beyond the Zone System *(Curtis and London, 1981) and* Photography *(William C. Brown, 1986). With his partner Bob Routh, he also teaches Beyond the Zone System Workshops.*