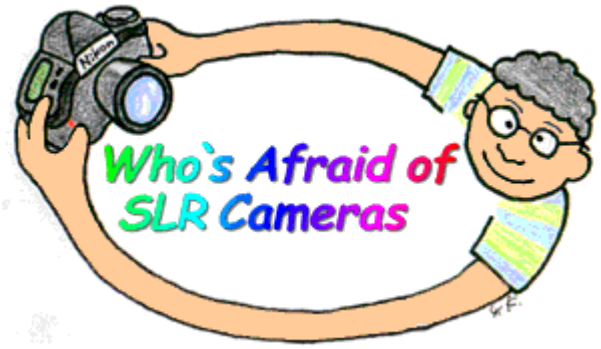
Nikon

- Introduction to Single Lens Reflex Cameras -



Part 8. : Introduction to Exposure

Exposure is perhaps the most difficult aspect of photography to understand because there are four different, yet interdependent, factors at work: subject brightness, film sensitivity, aperture, and shutter speed. Another reason why exposure is such a complicated facet of photography is because "correct exposure" means different things to different people.

It is probably best to think of exposure in terms of what changes the overall lighting of the picture.
This is a simplification, of course, so let's take a closer look at what "exposure" really is.

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1. Reacting to the subject's brightness

Exposure cannot be adjusted on one-time-use cameras.
Why, then, is it possible to take unexpectedly well-taken photos with such cameras *?*
The first reason is that taking pictures in well-lighted places is understood by all camera users.
When you move into darkened environments, you'll need a flash to compensate for the dearth of light (With a standard one-time-use camera with a flash, the shooting distance is approximately one to four meters.).
A second feature of one-time-use cameras that must be considered is that they use color negative films.
It can make a few adjustments, in which exposure compensation of ±2EV is possible during the printing process, and works well especially for overexposed pictures (we will talk about this process in the next issue).
It is because of these two features that one-time-use cameras seldom take poorly exposed pictures.
Today, all SLR cameras sold in Japan(Nippon) have a built-in TTL exposure meter; if it is an AF camera, it will have a built-in auto exposure (AE) control system, which eliminates guesswork when shooting.
Despite these features, many photographers end up holding poorly exposed photos.
Why *?* Because with SLR cameras, you can do so many things, but you have to know the different functions in order to make use of the camera features. The shooting process will vary in different situations --- and might even become quite complicated --- so you might not be able to get the results you desire by going on full automatic.

So, exposure is our topic.
Try to free yourself from your reliance on automatic modes,

including AE.
They're always the easiest, but not always the best. Second, keep in mind that using reversal films is standard practice.
In short, try making adjustments manually.
And remember that part of the fun of controlling exposure is that you can determine the degree of light and dark in your photos, the results of which will be readily apparent on a reversal film.

1.1. How exposure used to be set

In the early days of exposure technology, the goal was to calculate the correct subject brightness. (Not much has changed *!*)
If the photographer could determine his subject's brightness, then he could adjust the aperture and shutter speed to match the film sensitivity.

1.1.1. Actinometer

Pictured here is a Watkins Bee Meter, made in England around 1902.
Though it could easily be mistaken for a pocket watch, it's workings are not quite as complicated:
Inside the Bee Meter is POP (Printing Out Paper), which turns black when light hits it.
Exposure measurements could be taken several times by rotating the POP. In the bottom center of the device is a circular window, divided into halves.
The gray right half illustrates the standard density; by exposing the POP in the left half and measuring the time it takes the paper to turn the same shade of gray as the right half (standard density), brightness can be calculated.

1.1.2. Visual densitometer

This is a Diaphoto, manufactured in Germany around 1924. Under the pentagram is a window.
Actually, it is a window within a window.
The larger, curved window displays gradations of shading

(darkness), while the blackened circular window is used to view the subject.
The photographer would look at the subject through this window and rotate the gradation scale until the subject was unable to be seen.
Then, he would check the scale in the upper left to read the appropriate exposure.
The only drawback of this gadget is that the human eye itself adjusts and adapts in different lighting situations.
As the photographer studied his subject through the window, the compensation his eyes made to the lighting differences could influence the final exposure value.

1.1.3. Exposure meter calculating measure

Here we see Seki's Salon Exposure Meter, which appeared in Japan (Nippon) around 1940.
If the photographer set the dial to a given film sensitivity, season, time, climate, and bulb wattage, he could divine the correct exposure value.
Different models continued to appear up to 1980, including some that could be attached to the accessory shoe.
Even today, exposure meters of this type can be found on film boxes and in user manuals, in chart form.
Some modern exposure meters have a similar dial.
And just to show that simplicity sometimes outwits technology, it is much easier to understand the meaning of the exposure value and the relationship between aperture and shutter speed when you're using an analog type than it is when using a digital model.

1.2. Film sensitivity, aperture and shutter speed

The brightness (illuminance) of direct sunlight during the daytime is 100,000 lux, while during nighttime it is only 0.0003 lux (Lux is defined as "the SI unit of illuminance; equivalent to one lumen per square meter.").
This means that lux during the daytime is about 300 million times greater than at night. If you convert this to the "steps" used in photography, the total is 28 (300 million is approximately 2 to the 28th power).

Further, if you use a film with a sensitivity between ISO 25 and 3,200, there is only a 7 step difference ; because the aperture adjustment range for most lenses is about 7 steps, there are a total of 14 steps available.
And if shutter speed can be adjusted to between 1/4000 to 4 seconds, the adjustment range is also 14 steps.
Ironically, this is about equal to the adjustment capability of the human eye. Therefore, by making changes with film sensitivity, aperture and shutter speed, the adjustment range of a camera approaches that of the human eye.
Obviously, a long time exposure like 4 seconds will not work well when shooting a moving subject. It is here we find the magnificence of our eyes.
But on the other hand, by exposing for a long time, like few minutes or even hours, a picture of any dark subject can be taken -- the maginificence of a camera.

In Part 3, Part 4, and Part 5, we discussed film sensitivity, aperture, and shutter speed.
Now, it is important to note that 1 step differences in film sensitivity, aperture and shutter speed have the same effect on exposure.
For example:
1) Increasing film sensitivity by one step (ex. ISO 100 to 200),
2) Opening the aperture by one step (ex. from f/16 to f/11),
3) Decreasing shutter speed by one step (ex. from 1/125 sec. to 1/60 sec.)
Each of these procedures has the same effect on a picture's brightness or darkness.
Known as the reciprocity law, this is the basis of determining the exposure.

Reciprocity law failure

As mentioned in the previous chapter, if the light hitting the film is either too bright or too dark, then the **reciprocity law** does not hold true.
When this occurs, it is referred to as reciprocity law failure, which reflects a film's limits in regards to brightness or darkness.
In normal shooting circumstances, there will be no problem.
But when photographing night scene or when a strict color gradation is required, reciprocity law failure can become problematic.

In such cases, adjusting the exposure or using color filters are the procedures necessary to remedy the situation.
For details, check your film's data sheet.

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2. Measuring "light"

Modern cameras employ photocells that react to light and adjust themselves electronically in order to measure an object's brightness.
The most common type of photocell in use today is the SPD (silicon photo diode) semiconductor, which has a quick reaction time and is able to take very accurate measurements.
It does have one drawback, however: it is sensitive to infrared light.
Here, we'll talk briefly about how the exposure meters are made, and give you examples of different metering modes.
Learning the characteristics of them will give you better idea of what exposure is.

2.1. How an SLR measures reflected light

We see objects because of the light that is reflected off their surfaces. Photography works on the same principle --- the film image becomes visible because of the light reflecting off a subject.
Therefore, if you can measure the amount of light an object reflects, then you can obtain an accurate exposure.
This is how a reflected-light exposure meter operates.
And all the exposure meters built in the camera are this type.

Incident-light exposure meter

Whereas a reflected-light exposure meter measures the amount of light coming off the subject, an incident-light exposure meter gauges the amount of light that is actually hitting the subject. Professionals use this meter to complement the measurements obtained by a camera's built-in metering system.

Auto exposure is the result of shutter speed and aperture adjustments based on the value measured with a reflected-light exposure meter.

This process is basically the same as the one that occurs in the human eye, when the pupil opens or closes in response to the amount of light in the environment.
Our pupils, the aperture in our eyes, automatically adjust to allow a controlled level of light to reach the retina.
If a scene is too bright and the pupil cannot adjust to compensate, we instinctively shield or shut our eyes.
The human eye has at least one advantage over a camera, though, and that is the human brain. We are able to discern if an object is actually white or if bright light reflecting off the object is making it appear white.
A mechanical exposure meter would find it hard to make this distinction.
The upshot of this is that it is not always a good idea to let the camera determine the exposure.
Sometimes the human touch is the only thing that will help create a good photo.
Here are some situations in which auto exposure works well and some in which it doesn't.

(Photo 4.a.)
A case where AE works well

1) If the subject is generally grayish
If the subject has different colors

(Photo 5.a.)
A case where AE results in underexposure

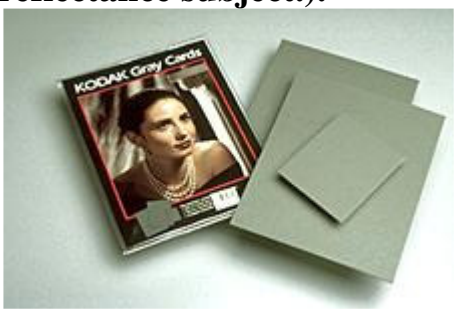
1) If the subject is generally white
2) If the background is mostly white (if the light source comes from within the frame)

(Photo 6.a.)
A case where AE causes overexposure

1) If the subject is generally black
2) If the background is mostly black

A reflected-light exposure meter calculates exposure value based on the general assumption that a subject's reflectance is 18 %. (This is known as standard reflectance.

An object with a reflectance of 18 % is referred to as a standard reflectance subject.).



The picture to the left shows a set of standard gray cards that are available in photography shops. Available are cards with no bright colors, no luster and a light reflectance of 18 %.

A color with a light reflectance of 18 % will be grayish, perhaps about the tone of a weathered asphalt road.
If a subject is neither white nor black, and has a relatively deep hue, then auto exposure will function without trouble.
But what about white objects *?*
A white subject has a very high reflectance, usually around 100 %.
However, because a reflected-light exposure meter sets a subject's reflectance at 18 %, a white object's high reflectance will cause it to compensate by stopping down the aperture or increasing shutter speed. The resulting picture will be underexposed.
The exact opposite is true of a black object : The camera will think there is virtually no light hitting the object and the final photo will be overexposed.
This problem comes from a clash between humans and machines.
Either the camera manufacturer has to work harder to make the cameras work more accurately, or the humans have to learn to use the camera more efficiently.

2.2. The meaning of "standard reflectance:18 %"

The reflectance of the black and white portions of a black-&-white print is about 3 % and 96 %, respectively.

Think of this like the way you look for aperture value or shutter speed and divide it into two (or double it).
If you search for the medium value, it becomes the following values :

(Figure 1.)

Thickness of Black & White Print = Thickness of subject

Gradation

Black == == == == == == == == == White

Reflectance of B&W Print (%) = Reflectance of subject (%)

3% 6% 12% 24% 48% 96%

4.5% 9% 18% 36% 72%

Steps of aperture and shutter speed (EV)

-2EV -1EV 0 +1EV +2EV

-2.5EV -1.5EV -0.5EV +0.5EV +1.5EV +2.5EV

As you can see, the reflectance value of 18 % is equidistant from white and black.
There are 5 steps of black and white value in a B/W print.
A pure white is +2.5 EV step and a pure black is -2.5 EV step.
This is important to remember when adjusting exposure.

Center-weighted, spot and matrix metering

Modern cameras have different metering functions.
Though most cameras employ reflected-light exposure meters, there are additional functions to compensate for the weaknesses we discussed above.

2.3.1. Center-weighted metering (name of this feature varies by the manufacturer)

This is the basic built-in exposure meter that can be found in both old and new SLR cameras.
Generally, it measures the light in the entire frame, yet pays more attention to the center of the frame (the ratio of exposure emphasis between the center of the frame and area around the center is 3 : 1) because during normal shooting circumstances you usually place the subject in the center of the frame, which in most cases provides adequate exposure.

Center-weighted metering is also helpful for exposure compensation.

2.3.2. Spot metering

A feature most associated with high-end equipment, spot metering is activated by rotating the metering mode selection dial or by pressing the spot metering button.
This function ignores the brightness in the frame's periphery and measures only that light in the central spot area.
For example, if it measures a 4 mm diameter spot in a 24 x 36 mm frame, then the ratio to the entire frame will be about 1 %.
Nikon's F5 and F100 models can select five focusing areas, top, bottom, left, right, and center. They also correspond to spot metering areas.
This is effective when trying to achieve the appropriate exposure by measuring a subject's brightness with standard reflectance inside the viewfinder, or when adjusting exposure without the camera's help.

On the other hand, spot metering is probably not the best method to use if you don't know where in the viewfinder to measure for appropriate exposure. A little off the topic, but there was a Japanese manufacturer that released an Manual Focus SLR camera with **only spot metering**. The following year, there was a sister model entitled "a camera with **center-weighted metering**, good for quick shooting and general photography" (it was mentioned in the "Camera Catalogue", which introduced this MF SLR camera by the manufacturer. This book is sold in "Japan Camera Show" (Camera Expos), published by Japan Camera Industry Association.) Inversely speaking, the spot metering is "not suitable for quick shooting and general photography". Perhaps, it is that difficult to make use of this feature.

2.3.3. Matrix metering (name and system of this feature varies by the manufacturer)

This method, whose name will vary from manufacturer to manufacturer, meters scene brightness by dividing the scene

into several segments.
Matrix metering benefits from a database of tens of thousands of pictures, and can make up for many of the shortcomings of reflected-light exposure metering.
In backlighting and other scenes where exposure adjustment is difficult, it can deliver the correct exposure.
However, it is difficult to determine upon which subject the exposure is based.
Still, if you want to make the camera do all the work, this is the feature for you.

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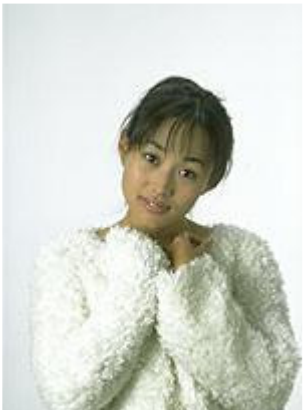
3. What is "correct exposure" *?*

Ask ten people and you'll probably get ten different answers.
However, there are ways to determine just what "correct exposure" means.
The first is to keep records, or to compare your photo to the original subject whenever possible.
The other is to ask yourself, "Is the picture I had envisioned *?*
Do I find it satisfying *?*"
If your answer is "yes," then the exposure was right on the money.

3.1. The fundamental idea of exposure compensation

Put simply, you have to consider the lightness and darkness of the picture, and decide if they are correct.
If your subject is white, choose positive compensation; if it is black, choose negative compensation.
Use Figure 1. as a guide to how much compensation a certain subject needs.



(Photo 5.b.) Positive compensation for a white subject

(5.c.) A white subject appears white

(Photo 5.d.) Negative compensation for a black subject

(5.e.) Black subject appears black

3.2. Choosing a correct exposure compensation

Always bear in mind the fundamentals. Feeling comfortable with the various aspects of exposure will help you beef up the creativity or "aesthetics" of your photos.
For example, you might want to stay faithful to the inherent qualities of your subject, yet manipulate them using different types of lighting effects.
Just remember that positive compensation makes a subject brighter and negative compensation makes a subject darker.
For the compensation range, see Figure 1.

(Photo 7.a.) Compensated to the positive side...

(7.b.) the picture becomes bright.

(Photo 7.c.) If you don't compensate...

(7.d.) it becomes a "normal" picture.

(Photo 7.e.) Compensated to the negative side...

(7.f.)the picture darkens.

There is one way to achieve the correct exposure for certain: Shoot several pictures with different exposures, using the auto-bracketing function, and choose the one you like best after the film has been developed.

Bracketing

The term "bracketing" is used in military, a term used to shoot at the target accurately, or to "straddle".
Imagine aiming a high-speed warship. First, calculate the "future position" of the ship.
Then, shoot the front and back of the "future position".
If the two shots "straddle" between the target, then make adjustments repeatedly.
After several firings, it will hit the target continuously.

In photography, it means first taking expected-to-be correct exposure, and then taking several overexposed shots and several underexposed shots.
By doing this, at least one might come out correctly exposed, or at least exposed in a way that satisfies you.
Basically, it's shooting using a wide range of calculated settings.

If you use a Polaroid® film or a digital camera, from which results can be seen almost instantly, you can execute highly effective exposure adjustment, like the bracketing technique, by looking at the picture you just took and basing your next shot on

its exposure qualities.

Whether or not you use manual or automatic mode doesn't matter.
Just as an experiment, try using a reversal film, shooting different exposures of +2, +1, 0, -1, and -2, and see how varied the results are.

We'll stop our discussion of exposure right here.
Don't be afraid to experiment, which is always the best way to learn in photography.

In the next issue (Part 9.), we'll take a look at printing.

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