Camera Adjustments

There are three main adjustments on good-quality cameras: shutter speed, f-stop, and focusing. Although most cameras today make these adjustments automatically, it is valuable to understand these adjustments to use a camera effectively. For special or top-quality work, a manual camera is indispensable (Fig. 25–4).

Shutter speed This refers to how long the shutter is open and the film exposed. It may vary from a second or more ("time exposures") to $\frac{1}{1000}$ s or less. To avoid blurring from camera movement, speeds faster than $\frac{1}{100}$ s are normally used. If the object is moving, faster shutter speeds are needed to "stop" the action. A shutter can open and close "behind the lens," as in Fig. 25–1, or be a "focal plane" shutter which is a moveable curtain just in front of the film.

Digital camera shutter

Digital cameras have "electronic shutters," which are the brief sampling times for collecting pixel charges; they may also have a mechanical shutter which is normally open so you can view the shot on the built-in LCD screen, but closes just before the shot is taken, opens briefly to shoot, and reopens afterward. Digital still cameras that take short movies must have a fast "sampling" time and a fast "clearing" (of the charge) time so as to take pictures of at least 12 or 15 frames per second.

FIGURE 25–4 On this camera, the f-stops and the focusing ring are on the camera lens. Shutter speeds are selected on the small wheel on top of the camera body.

f-stop The amount of light reaching the film must be carefully controlled to avoid **underexposure** (too little light so the picture is dark and only the brightest objects show up) or **overexposure** (too much light, so that all bright objects look the same, with a consequent lack of contrast and a "washed-out" appearance). To control the exposure, a "stop" or iris diaphragm, whose opening is of variable diameter, is placed behind the lens (Fig. 25–1). The size of the opening is varied to compensate for bright or dark lighting conditions, the sensitivity of the film[†] used, and for different shutter speeds. The size of the opening is specified by the ***f*-number** or ***f*-stop**, defined as

f-stop

$$f\text{-stop} = \frac{f}{D},$$

where f is the focal length of the lens and D is the diameter of the lens opening (Fig. 25–1). For example, when a 50-mm-focal-length lens has an opening $D = 25\,\text{mm}$, we say it is set at $f/2$. When this lens is set at $f/8$, the opening is only $6\frac{1}{4}\,\text{mm}$ $(50/6\frac{1}{4} = 8)$. For faster shutter speeds, or low light conditions, a greater lens opening must be used to get a proper exposure. This corresponds to a smaller f-stop number. The smaller the f-stop number, the larger the opening and the more light passes through the lens to the film. The smallest f-number of a lens (largest opening) is referred to as the *speed* of the lens. It is common to find $f/2.0$ lenses today, and some even faster. The advantage of a fast lens is that it allows pictures to be taken under poor lighting conditions. Good quality lenses consist of several elements to reduce the defects present in simple thin lenses (Section 25–6). Standard f-stop markings on good lenses are 1.0, 1.4, 2.0, 2.8, 4.0, 5.6, 8, 11, 16, 22, and 32 (Fig. 25–4). Each of these stops corresponds to a diameter reduction by a factor of about $\sqrt{2} = 1.4$. Because the amount of light reaching the film is proportional to the *area* of the opening, and therefore proportional to the diameter squared, each standard f-stop corresponds to a factor of 2 in light intensity reaching the film.

Focusing

Focusing Focusing is the operation of placing the lens at the correct position relative to the film for the sharpest image. The image distance is smallest for objects at infinity (the symbol ∞ is used for infinity) and is equal to the focal length. For closer objects, the image distance is greater than the focal length, as can be seen from the lens equation, $1/f = 1/d_o + 1/d_i$ (Eq. 23–8). To focus on nearby objects, the lens must therefore be moved away from the film, and this is usually done on a manual camera by turning a ring on the lens.

[†]Different films have different sensitivities to light, referred to as the "film speed" and specified as an "ASA number" or "ISO number." A "faster" film is more sensitive and needs less light to produce a good image. Faster films are grainier so offer less sharpness (resolution) when enlarged. Digital cameras may have a "gain" or "ISO" adjustment for sensitivity. Adjusting a CCD to be "faster" for low light conditions results in "noise," the digital equivalent of graininess.