f/stop Timing

A different approach to darkroom exposure

by Ralph W. Lambrecht

The amount of light reaching a photographic emulsion must be controlled in order to ensure the right exposure. Exposing the film in the camera is typically done with a combination of lens aperture and shutter timing. The lens aperture, also called 'f/stop', controls the light intensity, and the shutter timing, also called 'speed', controls the duration of the exposure. The f/stop settings are designed to either half or double the light intensity. The shutter speed settings are designed to either half or double the exposure duration. This is accomplished by following a geometric series for both aperture and time. The 'film exposure control' table in fig.2 shows an example of typical settings used in modern cameras and lenses. Therefore, an f/stop adjustment in one direction can be offset by a shutter speed adjustment in the opposite direction. Experienced photographers are very comfortable with this convenient method of film exposure control and refer to both, aperture and shutter settings, as f/stops or stops.

In the darkroom, the need for exposure control remains. Splitting this responsibility between the enlarging lens aperture and the darkroom timer is a logical adaptation of the negative exposure control. However, the functional requirement for a darkroom timer is different from that of a camera shutter, since the typical timing durations are much longer.

Negative exposure durations are normally very short, fractions of a second, where enlarging times vary from about 10 to 60 seconds. Long exposure times are best handled with a clock type device which functions as a 'count down'. Some popular mechanical timers, matching this requirement, are available. More accurate electronic models, with additional features, are also on the market. Some professional enlargers go as far as featuring a shutter in the light path. This gives an increased accuracy, but is only required for short exposure times.

fig.1 This image of old and worn piping was taken in the Botanical Garden on Belle Isle, just south of Detroit, Michigan USA. The final print exposure and the print manipulation were determined by the f/stop timing method.

arithmetic series a constant difference (here 5)	10	15	20	25	30	35	40
geometric series a constant ratio (here 2)	1	2	4	8	16	32	64

film exposure control										
aperture [f/stop]	45	32	22	16	11	8	5.6	4	2.8	2
time [1/s]	500	250	125	60	30	15	8	4	2	1

print exposure control										
aperture [f/stop]	45	32	22	16	11	8	5.6	4	2.8	2
time [s]	1	2	4	8	16	32	64	128	256	512

fig.2 The film exposure is controlled with the taking lens aperture and the shutter timing. Both sequences are geometric and not arithmetic in nature for good reason. The print exposure can be controlled in the same way with the enlarger lens aperture and a darkroom timer.

Traditional Timing

A typical traditional printing session is simplified in the following example. The enlarging lens aperture is set to f/8 or f/11 to maximize image quality and allow for reasonable printing times. The printer estimates from experience that the printing time will be around 25 seconds for the chosen enlargement. Typically, a 5 to 7 step test strip, with 5-second intervals, is prepared to evaluate the effect of different exposures times. A sample of such a test strip is shown in fig.4 and was used to test exposures of 10, 15, 20, 25, 30, 35 and 40 seconds. The test strip is then analyzed and the proper exposure time is chosen. In our sample, a time of less than 20 seconds would be about right. The printer may decide to try 18 seconds and later alter it to increase the time to 19 seconds to give it a slightly darker look. Now, a so-called 'base' time is established. This sequence may be repeated for different areas of interest, for example textured highlights and shadows. If they deviate from the base exposure, dodging and burning may be required. All this is then followed by a 3 second edge-burn to 'pull' the viewer into the picture.

This is a reasonable approach to printing and I have used it myself for years, but it does not utilize some of the benefits of f/stop timing. In the traditional, arithmetic timing method, uniform time increments produce unequal changes of exposure. As seen in fig.4, the difference between the first two steps is 1/2 stop, or 50%. However, the difference between the last two steps is only 14%, or slightly more than a 1/6 stop. Therefore, traditional timing methods provide too large of a difference in the light steps and too little of a difference in the dark steps of a test strip. This makes it difficult estimating an accurate base print exposure time. Now, let's try another method.

Timing in Stops

My involvement with f/stop printing started when I met a fellow photographer and printer in the UK. He convinced me to give it a try. It didn't take long to

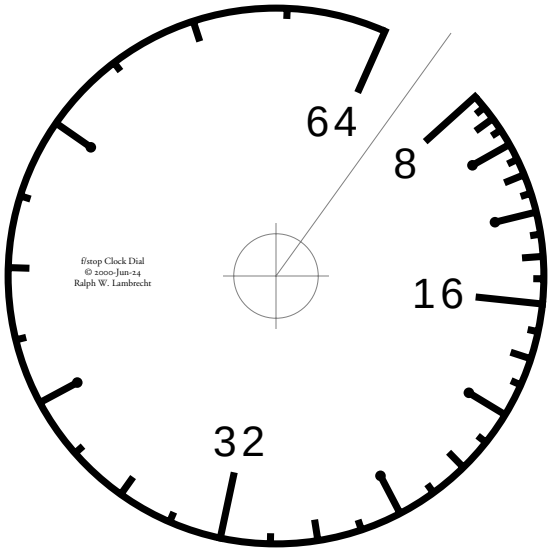

fig.3a (left) An analog f/stop dial from 8 to 64 seconds in 1/3, 1/6 and 1/12-stop increments. You may copy the dial and attach it to any analog timer.

fig.3b (far left) Here the f/stop dial was enlarged and temporarily taped to a 'GraLab 300'.

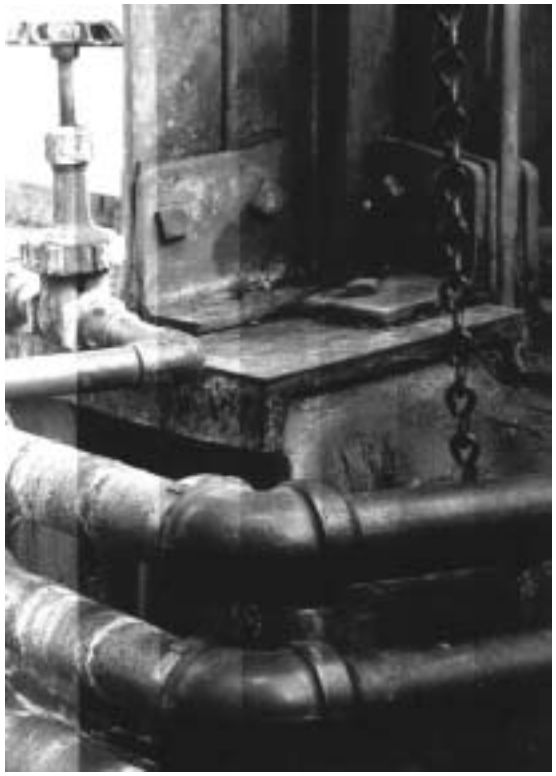

fig.4 (far left) Traditional test strip in 5-s increments. (arithmetic series)

fig.5 (left) New test strip in 1/3-stop increments. (geometric series)

realize the major benefits of this very logical technique. After a small learning curve and the typical discomfort with any unfamiliar technique, f/stop timing has now become the standard in my darkroom. It provides me with a new feeling of printing control and the capability of being able to predict repeatable results. I will explain the benefits of f/stop timing in the chronological order of a typical printing session from the test strip, through the exposure adjustment for a work print, to the fine tuning with dodging and burning, but first some general notes.

Perfectly equal timing is only possible with the f/stop timing sequence, and fig.3 provides an analog version that will help us to understand the effect. It is a continuation of the well-known camera shutter speed doublings from 8 up to 64 seconds, and it is subdivided first into 1/3 then 1/6 and finally 1/12 stop. I selected the ranges because times below 8 seconds are difficult to control with an analog timer, and times well above one minute, I find, are too time consuming for a practical darkroom session. Increments down to 1/12 stop are used as a result of multiple print reviews with customers, critics and fellow printers. For normal paper grades, between grade 2 and 3, enlarging time differences of a 1/3 stop (~20%) are significant in tonal value, 1/6 stop (~10%) can easily be seen and differences of a 1/12 stop (~5%) are minute, but still clearly visible, if viewed next to each other. Smaller increments may be of use for paper grades 4 and 5, but I rarely have a need for it. The analog dial clearly shows how f/stop timing fractions increase with printing time. Fixed increments of time have a larger effect on short exposure times and a smaller effect on long exposure times.

The numerical f/stop timing table in fig.6 is a more convenient way to determine precise printing times than the previous analog table. It also includes dodging and burning times as small as 1/6-stop increments. It can be used with any darkroom timer, but a larger version may be required to see it clearly in the dark. I

Dodging [f/stop]						Base Exp	Burning [f/stop]					
-1	-5/6	-2/3	-1/2	-1/3	-1/6		+1/6	+1/3	+1/2	+2/3	+5/6	+1
-4.0	**-3.5**	**-3.0**	**-2.3**	**-1.7**	**-0.9**	**8**	**1.0**	**2.1**	**3.3**	**4.7**	**6.3**	**8.0**
-4.2	-3.7	-3.1	-2.5	-1.7	-0.9	8.5	1.0	2.2	3.5	5.0	6.6	8.5
-4.5	**-3.9**	**-3.3**	**-2.6**	**-1.9**	**-1.0**	**9.0**	**1.1**	**2.3**	**3.7**	**5.3**	**7.0**	**9.0**
-4.8	-4.2	-3.5	-2.8	-2.0	-1.0	9.5	1.2	2.5	3.9	5.6	7.4	9.5
-5.0	**-4.4**	**-3.7**	**-3.0**	**-2.1**	**-1.1**	**10.1**	**1.2**	**2.6**	**4.2**	**5.9**	**7.9**	**10.1**
-5.3	-4.7	-4.0	-3.1	-2.2	-1.2	10.7	1.3	2.8	4.4	6.3	8.3	10.7
-5.7	**-5.0**	**-4.2**	**-3.3**	**-2.3**	**-1.2**	**11.3**	**1.4**	**2.9**	**4.7**	**6.6**	**8.8**	**11.3**
-6.0	-5.3	-4.4	-3.5	-2.5	-1.3	12.0	1.5	3.1	5.0	7.0	9.4	12.0
-6.3	**-5.6**	**-4.7**	**-3.7**	**-2.6**	**-1.4**	**12.7**	**1.6**	**3.3**	**5.3**	**7.5**	**9.9**	**12.7**
-6.7	-5.9	-5.0	-3.9	-2.8	-1.5	13.5	1.6	3.5	5.6	7.9	10.5	13.5
-7.1	**-6.3**	**-5.3**	**-4.2**	**-2.9**	**-1.6**	**14.3**	**1.7**	**3.7**	**5.9**	**8.4**	**11.1**	**14.3**
-7.6	-6.6	-5.6	-4.4	-3.1	-1.6	15.1	1.8	3.9	6.3	8.9	11.8	15.1
-8.0	**-7.0**	**-5.9**	**-4.7**	**-3.3**	**-1.7**	**16**	**2.0**	**4.2**	**6.6**	**9.4**	**12.5**	**16.0**
-8.5	-7.4	-6.3	-5.0	-3.5	-1.8	17.0	2.1	4.4	7.0	10.0	13.3	17.0
-9.0	**-7.9**	**-6.6**	**-5.3**	**-3.7**	**-2.0**	**18.0**	**2.2**	**4.7**	**7.4**	**10.5**	**14.0**	**18.0**
-9.5	-8.3	-7.0	-5.6	-3.9	-2.1	19.0	2.3	4.9	7.9	11.2	14.9	19.0
-10.1	**-8.8**	**-7.5**	**-5.9**	**-4.2**	**-2.2**	**20.2**	**2.5**	**5.2**	**8.4**	**11.8**	**15.8**	**20.2**
-10.7	-9.4	-7.9	-6.3	-4.4	-2.3	21.4	2.6	5.6	8.8	12.5	16.7	21.4
-11.3	**-9.9**	**-8.4**	**-6.6**	**-4.7**	**-2.5**	**22.6**	**2.8**	**5.9**	**9.4**	**13.3**	**17.7**	**22.6**
-12.0	-10.5	-8.9	-7.0	-4.9	-2.6	24.0	2.9	6.2	9.9	14.1	18.7	24.0
-12.7	**-11.1**	**-9.4**	**-7.4**	**-5.2**	**-2.8**	**25.4**	**3.1**	**6.6**	**10.5**	**14.9**	**19.9**	**25.4**
-13.5	-11.8	-10.0	-7.9	-5.6	-2.9	26.9	3.3	7.0	11.1	15.8	21.0	26.9
-14.3	**-12.5**	**-10.5**	**-8.4**	**-5.9**	**-3.1**	**28.5**	**3.5**	**7.4**	**11.8**	**16.7**	**22.3**	**28.5**
-15.1	-13.3	-11.2	-8.8	-6.2	-3.3	30.2	3.7	7.9	12.5	17.7	23.6	30.2
-16.0	**-14.0**	**-11.8**	**-9.4**	**-6.6**	**-3.5**	**32**	**3.9**	**8.3**	**13.3**	**18.8**	**25.0**	**32.0**
-17.0	-14.9	-12.5	-9.9	-7.0	-3.7	33.9	4.2	8.8	14.0	19.9	26.5	33.9
-18.0	**-15.8**	**-13.3**	**-10.5**	**-7.4**	**-3.9**	**35.9**	**4.4**	**9.3**	**14.9**	**21.1**	**28.1**	**35.9**
-19.0	-16.7	-14.1	-11.1	-7.9	-4.2	38.1	4.7	9.9	15.8	22.4	29.8	38.1
-20.2	**-17.7**	**-14.9**	**-11.8**	**-8.3**	**-4.4**	**40.3**	**4.9**	**10.5**	**16.7**	**23.7**	**31.5**	**40.3**
-21.4	-18.7	-15.8	-12.5	-8.8	-4.7	42.7	5.2	11.1	17.7	25.1	33.4	42.7
-22.6	**-19.9**	**-16.7**	**-13.3**	**-9.3**	**-4.9**	**45.3**	**5.5**	**11.8**	**18.7**	**26.6**	**35.4**	**45.3**
-24.0	-21.0	-17.7	-14.0	-9.9	-5.2	47.9	5.9	12.5	19.9	28.2	37.5	47.9
-25.4	**-22.3**	**-18.8**	**-14.9**	**-10.5**	**-5.5**	**50.8**	**6.2**	**13.2**	**21.0**	**29.8**	**39.7**	**50.8**
-26.9	-23.6	-19.9	-15.8	-11.1	-5.9	53.8	6.6	14.0	22.3	31.6	42.1	53.8
-28.5	**-25.0**	**-21.1**	**-16.7**	**-11.8**	**-6.2**	**57.0**	**7.0**	**14.8**	**23.6**	**33.5**	**44.6**	**57.0**
-30.2	-26.5	-22.4	-17.7	-12.5	-6.6	60.4	7.4	15.7	25.0	35.5	47.2	60.4
-32.0	**-28.1**	**-23.7**	**-18.7**	**-13.2**	**-7.0**	**64**	**7.8**	**16.6**	**26.5**	**37.6**	**50.0**	**64.0**

fig.6 The f/stop timing table including adjustments for dodging and burning.

select base enlarging times from the timing table and I record all deviations in stops, or fractions thereof, for test strips, work prints and all fine tuning of the final print, including dodging and burning operations. Now, let's get started.

1. The Test Strip

Assuming a typical printing session, I select the following timing steps in 1/3-stop increments from the timing table: 8, 10.1, 12.7, 16, 20.2, 25.4 and 32 seconds. The resulting test strip is shown in fig.5. Please note that the range of exposure time is almost identical to the traditional test strip. However, a comparison between the two test strips reveals that the geometrically spaced f/stop version is much easier to interpret. There is more separation in the light areas and still clear differences in the dark areas of the test strip. After evaluation of the test strip, I determined that the right exposure time must be between 16 and 20.2 seconds and I will try the center value of 18.0 seconds from the timing table.

2. The Work Print

The next step is to create a well-exposed work print. The aim is to end up with a full size print, exposed at the optimum base time. This base time is usually the right exposure time to render the textured highlights at the desired tonal value. The first full sheet is exposed at 18.0 seconds, developed and evaluated. I find this print just slightly too light and decide to increase the exposure by a 1/12 stop to 19.0 seconds, knowing that this will darken the print only marginally. I end up with the same result as in the traditional timing method, but with much more confidence and control.

In a typical printing session the paper grade would now be adjusted to render the important shadows at the desired tonal values, but this is not the subject of this chapter, and I will therefore, skip this step. We now have a work print with the right base exposure time at 19.0 seconds. A well-exposed work print with good overall contrast is the foundation for all print manipulations, intended to improve the final image.

3. Dodging and Burning

Fine tuning all of the tonal values, through dodging and burning, takes place once the right base printing time, at a particular enlarging scale for an image, has been found. I recommend to test strip

the desired exposure times for all other areas of importance within the image and then to record them all as deviations from the base exposure time in units of f/stop fractions. The table in fig.6 provides dodging and burning times in relation to several base times.

In this case, I found it advantageous to dodge the center of the print for a 1/6 stop, or as read from the table, for the last 2.1 seconds of the base exposure time and recorded it as (-1/6) on a printing map. The final printing map is shown in fig.7 for your reference. A stubborn upper left hand corner needed an additional 1-stop burn-in (+1) to reveal the first light gray. According to the table, this was equivalent to 19.0 seconds. The top, left and right edges needed an additional 1/3 stop (+1/3) and the timer was set to 4.9 seconds to achieve that exposure. A minor adjustment for the bottom edge of 1/6 stop (+1/6) concluded the session, and the lead picture shows the final image.

The final printing map will be stored with the negative and can be used for any future enlarging scale. A new base exposure time must be found, when a new enlarging scale becomes necessary, but the f/stop differences for dodging and burning always remain the same. This printing map will also remain useful even if materials for paper, filters and chemicals have been replaced or have aged. It will also be easier to turn excessive burn-in times into shorter times at larger lens apertures in order to avoid reciprocity failures.

Traditional printing has standard edge-burning times, such as 3 seconds, as an example. This can be a relative large amount for a small print with short base exposure times, and it can be a very short time for a large print with a relatively long base exposure time. Adding a 1/3 stop to the edges is a far more consistent way to work.

Some experienced printers have adopted the practice of using percentages of the base exposure time for all dodging and burning procedures. This approach is not as consistent but very similar to f/stop timing, and these printers should have little or no trouble switching to f/stop printing, because they are already half way there.

Hardware Requirements

You don't need any additional equipment to give f/stop timing a try. With the tables provided in this chapter and your current darkroom setup, you have everything needed to get started with this logical way to print. Any timer can be controlled to perform f/stop timing, especially when the exposure times are longer than 20 seconds.

However, if you don't have a decent darkroom timer yet and if your budget allows, then go out and trade a bit of money for a lot of convenience and time saved, by investing in a good f/stop timer. There are only a few electronic f/stop timers available on the market. They usually provide f/stop and linear timing with a digital display. Some even come with memory features to record the sequence of a more involved printing session.

Conclusion

In this chapter, it was shown that altering the print exposure time in an f/stop sequence is a logical adaptation of negative exposure control. You are using it with your camera because it works. Why not use it in the darkroom too?

Two significant advantages are obvious. First, test strips become more meaningful, with even exposure increments between the strips, which allow straightforward analysis at any aperture or magnification setting. Second, printing records can be used for different paper sizes and materials without a change. After a little experience with the technique, it becomes second nature to visualize the effect of, say, a 1/3-stop print exposure, without worrying about the actual time. This is particularly useful for burning down critical areas or when working at different magnifications and apertures. Several well-known printers record fractions of an f/stops to describe their printing maps. Using f/stop timing makes printing easier, more flexible, and simpler to create meaningful printing records for future darkroom sessions.

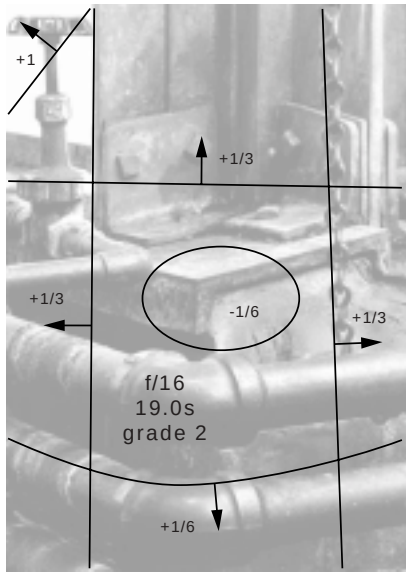

fig.7 Dodging and burning is recorded in f/stops deviations on the printing map.