OPTICAL ENGINEERING NOTE #7
VIEWING A PRINT IN TRUE PERSPECTIVE

The photographs that are used to illustrate the principles explicated in the Kodak Pamphlet M-15, **VIEWING A PRINT IN TRUE PERSPECTIVE**, were taken of the Chicago skyline in March of 1994. Nikkor lenses of 21, 50 and 200 millimeters focal length were used on a trusty old Nikon F. The film was Kodak Technical Pan 2415, developed in the **POTA**[1] formula.

The first series of enlargements shows the effect of magnification on viewing distance. A view facing due west from Columbus Drive and Monroe was photographed with a 50mm focal length lens, considered normal for 35 mm format camera. The negative was blown up 4.5X, 7X, and 10X magnification, so the Viewing Distances are 22.5cm, 35cm, and 50cm, respectively. (Viewing Distance = Magnification X Focal Length.)

The prints should be arranged at those distances, with the edge of a table as the zero point. Their centers should form a horizontal axis, which is the level where the viewer's eye should be placed.

Looking at the smallest enlargement is sometimes uncomfortable, as 22.5cm is nearer than many persons' near points. People will back off, but then the rest of the photos won't line up.

The other series of shots were taken with the camera pointed Northwest, centered on the **Stone Container Building**, formerly known as the **Associates Building**. The camera body was held rigidly on large tripod, and pictures were taken with the three lenses mentioned above, all pointing in the same direction.

The negatives were all printed at 10X magnification; the Viewing Distances are then 21, 50 and 200 centimeters. The printing frame for the photographic paper was taped to the enlarger base; alignment of this set is simple, as all the prints have a common lower edge.

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[1]. 1.5 gm Phenidone, 30 gm Sodium Sulfite, One liter H2O, 15 minutes at 20C.

The wide angle and normal prints are cut at 1/3 and 2/3 up, so that successive prints will grow out of the first. Again the wide angle print may intrude on the limits of most people's near points, but then again, everyone should be myopic like me!

PERSPECTIVE PROBLEMS

1. What would be the normal viewing distance for a 16mm movie projected onto a 30 by 40 inch screen? (Let 40" = one meter.) HINT: Find magnification first. See the **Handout**, **BASIC OPTIC MATH**.

2. How many times would the 21mm focal length lens's negative have to be enlarged so that the size of the slanted front of the Stone Container Building matches the one in the 10X enlargement of the 200mm negative? What would be the horizontal and vertical dimensions of the print?

VIEWING A PRINT IN TRUE PERSPECTIVE

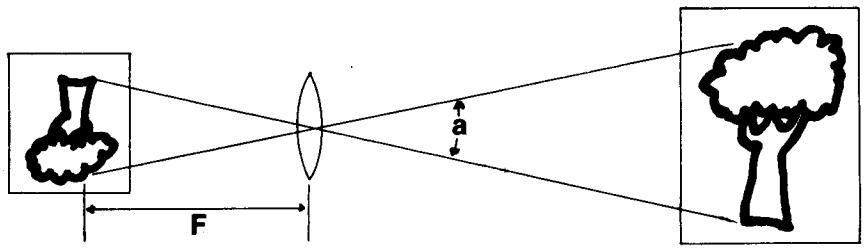
The rendition of perspective, that is, showing on a flat surface the size and position of objects in a scene as they appear to the eye, is a basic tool of the artist. The photographer acting as an artist to control the perspective of his photographs may select a camera lens and a viewpoint to present his subject dramatically. If a viewer is not aware of the photographer's interpretive approach, he may be misled by the photograph as to the actual appearance of the original scene.

A person judges relative distances and the true size of objects in photographs by the relative sizes of those objects as depicted in the print. When the camera viewpoint is fixed, the comparative size of objects is maintained in photographs made with any focal length lens. The magnification of all objects is changed proportionately with a change of lens focal length. Similar areas of negatives made with lenses of different focal lengths (from the same viewpoint) will, when appropriately enlarged, be identical.

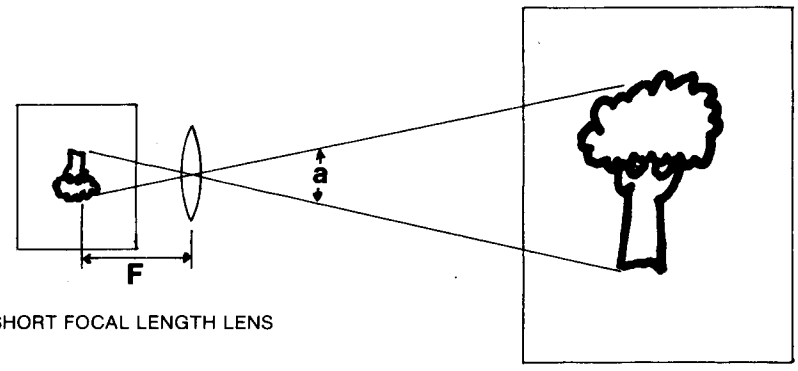
For technical purposes, it is often desirable and sometimes necessary to make prints for viewing in true, or natural, perspective. Apparent realism of the scene is heightened when the print is viewed correctly. The viewer is able to make a more reliable judgment of the information presented. Enlarged prints to be used as evidence in a court of law should be rendered for viewing in true perspective.

HOW TRUE PERSPECTIVE IS ACHIEVED

To begin, consider the geometric relationships between the camera and an object at the time a picture is taken (Figure 1). From a fixed vantage point, an object or series of objects intercept the same angle at the lens regardless of the focal length of the lens. The object or objects are simply rendered larger or smaller, depending on the focal length of the lens. If this same angular relationship is reestablished between the finished photograph and the viewer's eye, the print will be viewed correctly and the eye will see the scene in true perspective.



LONG FOCAL LENGTH LENS



SHORT FOCAL LENGTH LENS

FIGURE 1

FINDING THE CORRECT VIEWING DISTANCE

To reproduce the same angular relationship established by the camera position, the eye must be one lens-focal-length from a contact print of the camera negative (Figure 2). For enlargements from the negative, the viewing distance must be increased to view the print in true perspective. The correct viewing distance for any enlarged print is equal to the lens focal length multiplied by the number of times the negative is enlarged; or viewing distance *(D)* = focal length *(F)* x enlargement *(N)*.

NORMAL VIEWING DISTANCE

Although the relationship just given defines correct viewing distance for true perspective, we must also consider the comfort of the viewer and the way in which prints will finally be viewed. Prints for courtroom use, for example, will usually be hand held. According to vision tests, the average person holds an object or reading material about 15 inches (about 40 centimeters) from his eye, and this distance is widely accepted as the *normal viewing distance* for hand-held materials.

TRUE PERSPECTIVE FOR NORMAL VIEWING DISTANCE

The relationship, $D = F \times N$ can also be used to determine the degree of enlargement needed for true perspective at the normal viewing distance. To find the degree of enlargement (number of times), rearrange the relationship thus: $N = D/F$. The information in the table, which is based upon this relationship, can serve as a guide in selecting the proper combination of camera, camera lens, and degree of enlargement required to produce prints for hand-held viewing at the normal viewing distance.

Note that the enlargements from negatives made with the normal focal length lens for that format are very close to the 8 by 10-inch or 18 by 24-centimeter size normally recommended for hand-held viewing. With the slight cropping of the negative that is usual, this is very nearly the correct size for proper perspective, and it may be adopted as a standard format.

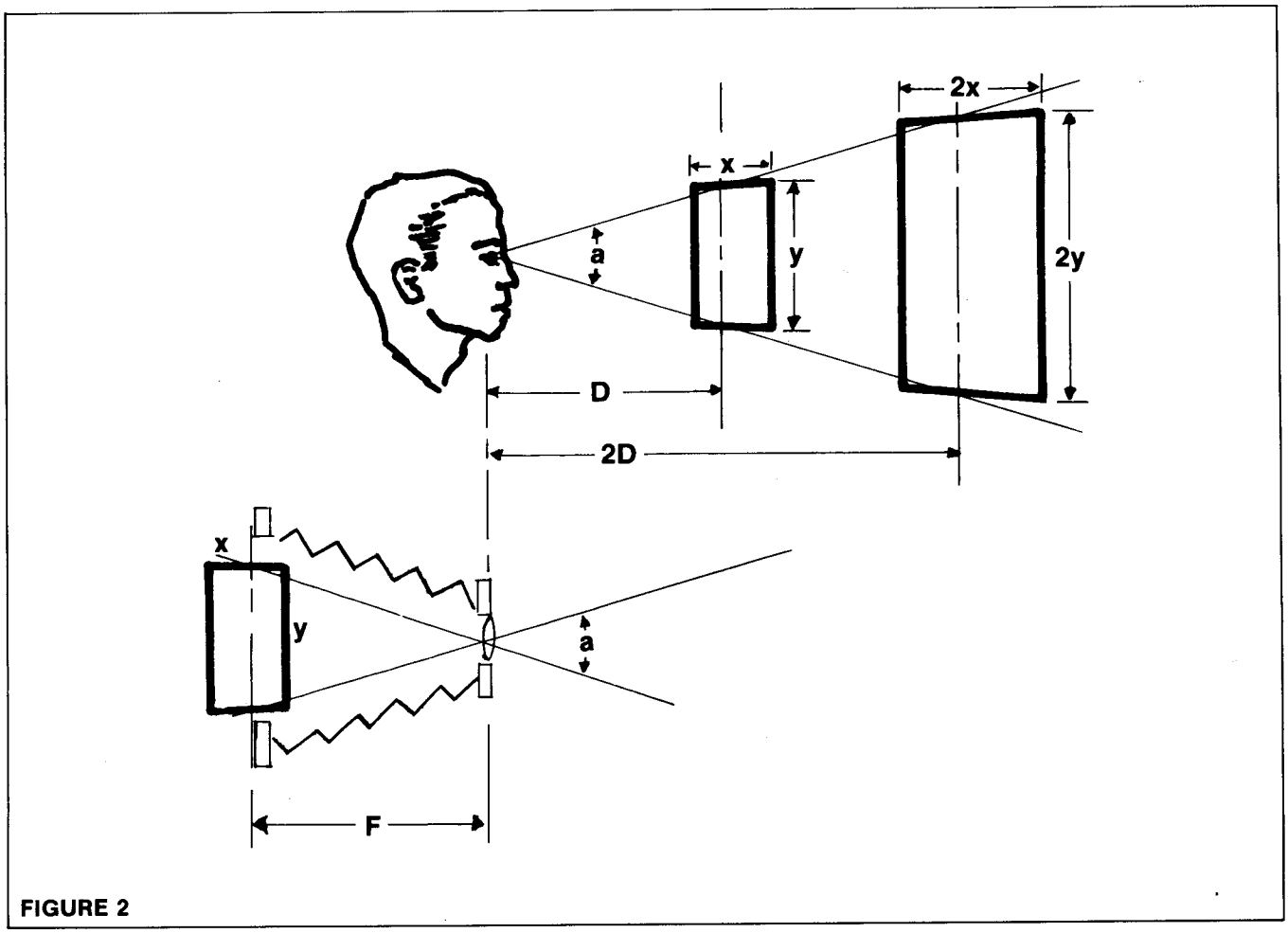


FIGURE 2

TABLE: ENLARGEMENT SCALE FOR NORMAL VIEWING DISTANCE

(about 15 inches or 40 centimeters)*

NEGATIVE SIZE			LENS FOCAL LENGTH		ENLARGEMENT	PRINT SIZE	
FORMAT	CENTIMETERS	INCHES	MILLIMETERS†	INCHES	NO. OF TIMES	CENTIMETERS	INCHES
Normal 35 mm frame	2.4 x 3.6	1 x 1.4	35	1.4	11	28 x 40	11 x 15
			50	2	8	20 x 28	8 x 11
			85	3.3	4.5	12 x 16	4 1/2 x 6
			100	4	4	10 x 14	4 x 5 1/2
Normal 126 frame	2.8 x 2.8	1.1 x 1.1	28	1.1	14	40 x 40	15 x 15
			38	1.5	10	28 x 28	11 x 11
			50	2	8	22 x 22	9 x 9
			90	3.5	4.5	12 x 12	5 x 5
	5.7 x 5.7	2 1/4 x 2 1/4	50	2	8	46 x 46	18 x 18
			80	3.1	5	28 x 28	11 x 11
			120	4.8	3	18 x 18	7 x 7
			150	5.9	2.5	14 x 14	5 1/2 x 5 1/2
		4 x 5	100	4	4	40 x 50	16 x 20
			127	5	3	30 x 40	12 x 15
			135	5.3	2.8	28 x 36	11 x 14
			165	6.5	2.5	26 x 30	10 x 12
			180	7	2.2	22 x 28	9 x 11
			270	10.5	1.5	16 x 20	6 x 8
		8 x 10	250	10	1.5	30 x 40	12 x 15
			300	12	1.3	26 x 30	10 x 12
			380	15	Contact	20 x 26	8 x 10
			500	20	Reduction (0.8)	16 x 20	6 x 8

*The degree of enlargement and print size is approximate in accord with the approximation of normal viewing distance.

†10 millimeters = 1 centimeter

When the lens focal length is approximately the diagonal of the film format (the usual definition of normal focal length), the correct viewing distance for a print made from the entire negative is approximately equal to the diagonal of that print.* This fact must be kept in mind if enlargements are to be made for other than hand-held viewing.

*This can be shown from the relationship, $D = F \times N$.

By definition $F_{normal} = d_{neg}$

and $N = \frac{d_{print}}{d_{neg}}$

where d_{neg} and d_{print} are the diagonals of the negative and print respectively.

Then $D = F \times N$

becomes $D = d_{neg} \times \frac{d_{print}}{d_{neg}}$

and, therefore $D = d_{print}$.

CROPPED VERSUS UNCROPPED NEGATIVES

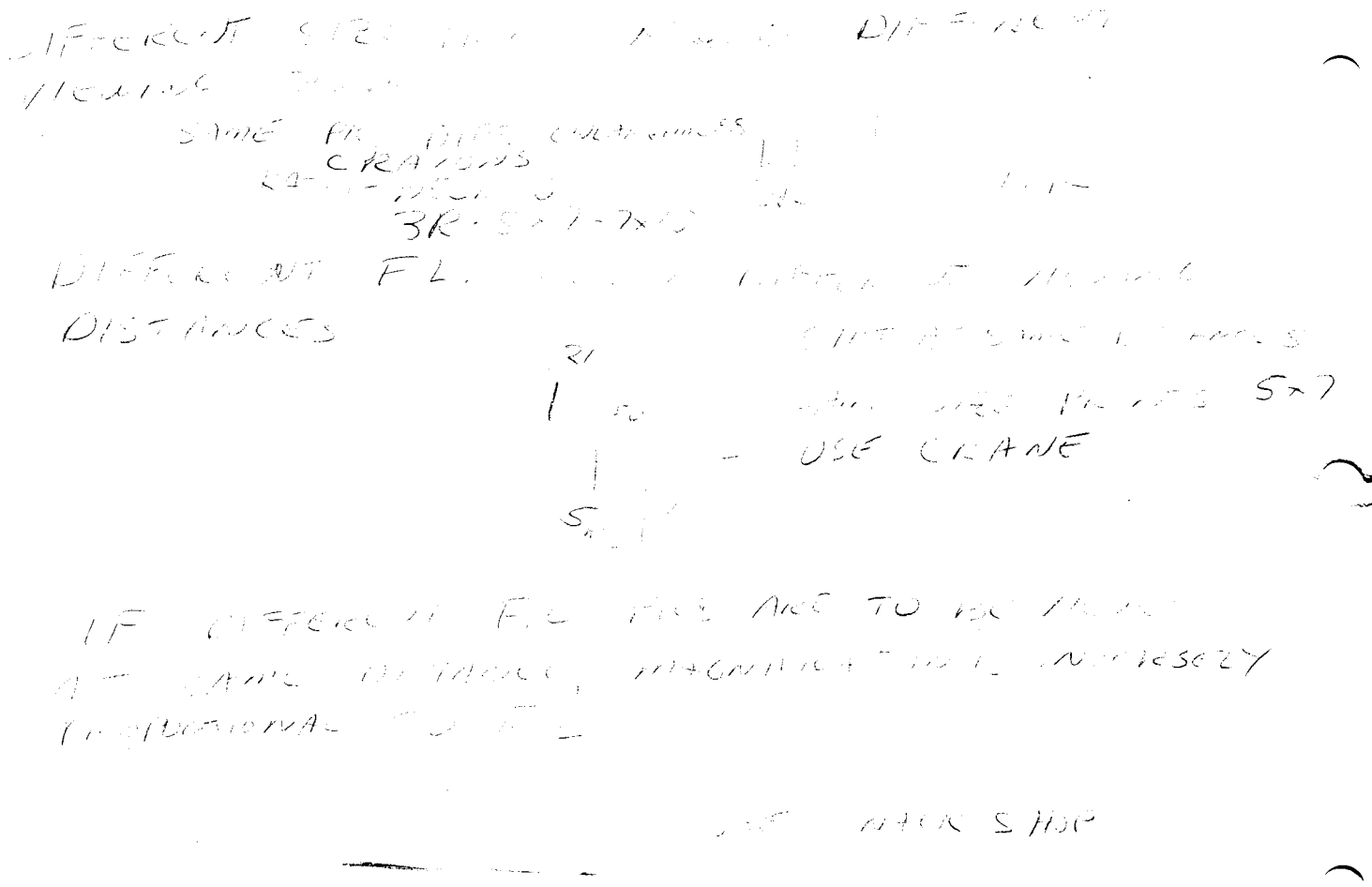
The final print sizes shown on the table assume enlargement from the entire negative format. When cropped negatives are to be used, cropping can be done by masking the actual negative or the projected image on the enlarger easel. Remember that for true perspective, the degree of enlargement is dependent only on the viewing distance and the focal length of the camera lens, *not* on the area of the negative used. For example, a 4 by 5-inch negative made with a 127 mm (5-inch) lens is to be enlarged for hand-held viewing at 15 inches. The data for 4 by 5 cameras shows that a 3 times enlargement is needed and that the enlarged print size will be 12 by 15 inches. If the usable portion of the 4 by 5 negative is only 2 by 2 1/2 inches, then the enlargement is still 3 times, but the correct print size for true perspective is now 6 by 7 1/2 inches.

PRINTS FOR WALL DISPLAY

The principles discussed here also apply when prints are to be viewed at distances greater than the normal hand-held distance of 15 inches. Large prints, for instance, may be viewed at a distance of 5 to 7 feet (about 2 meters or 200 centimeters). For example, assume that a display print is to be made from a 35 mm format (2.4 x 3.6 cm) negative that was taken with an 85 mm (3.3-inch) lens on a 35 mm camera. The print is to be viewed at a distance of 6 feet. Using the relationship, $N = D/F$, find the number of times the entire negative should be enlarged.

$$N = \frac{D}{F} = \frac{72 \text{ inches (6 feet)}}{3.3 \text{ inches}} = 22 \text{ times}$$

Enlarging a 35 mm (1 by 1.4-inch) negative 22 times will give a print 22 by 31 inches. If the entire negative area is not needed, the projected image can be cropped on the enlarger easel to fit regular-size enlarging paper (20 by 24 inches).



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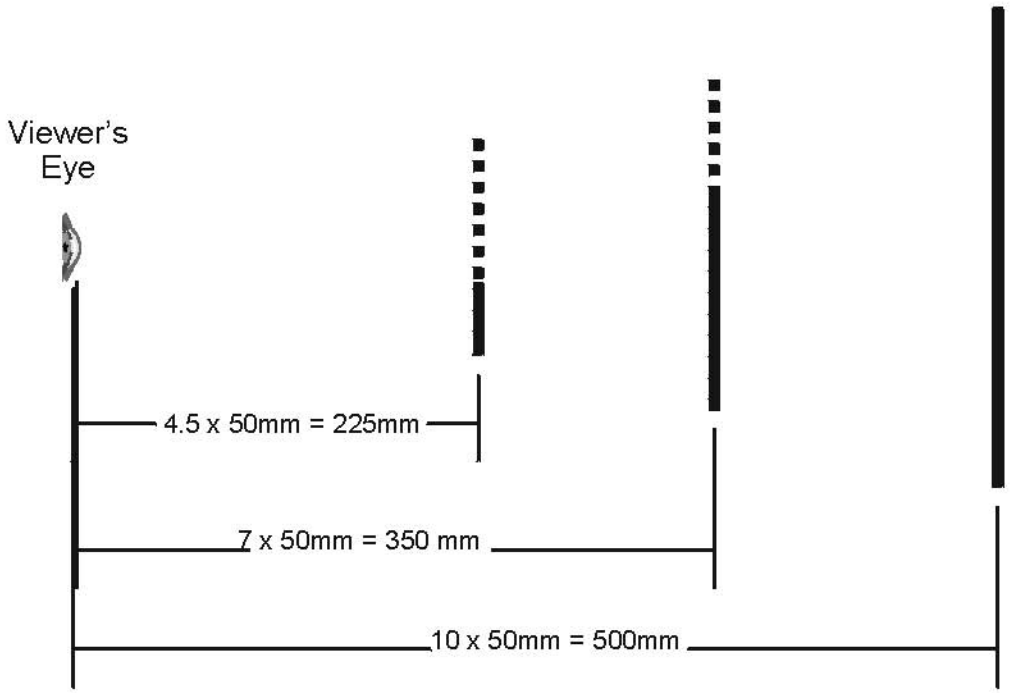
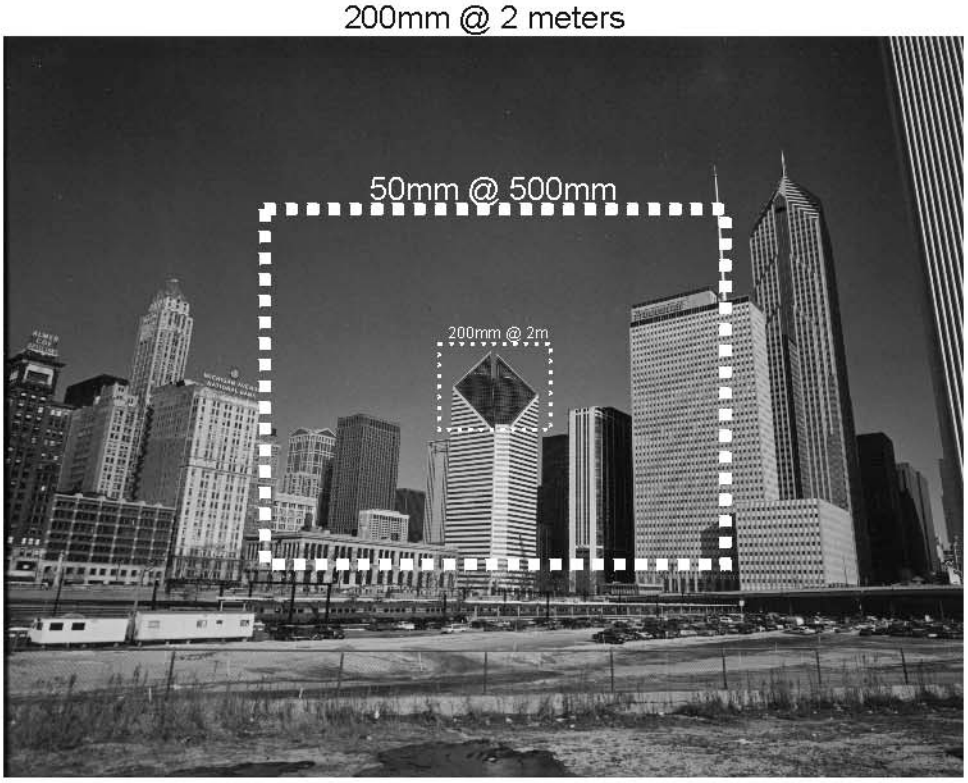
10 by 14 @ 500mm

7 by 10 @ 350mm

5 by 7 @ 225mm

Nested Enlargements of a Cityscape





Nested Wide Angle, Normal, and Telephoto Views of a Cityscape with their Viewing Distances