*A Photographic Edge-Isolation Technique**‡

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THE oldest of all art forms is the representation of objects and ideas by lines. A capable artist can usually project his thought by using a minimum of lines. The idea, then, of representing real objects by using edges formed during a photographic process is not inconceivable. The primary difference between photographic representation and artistic rendition (Figure 1) is that the former fulfills one of the basic requirements of mapping, that of measurability, while the other does not.

The process of mapping from aerial photographs includes observing and interpreting pertinent information contained in an aerial negative. Photographic film acts as a memory unit, recording information transferred to it by an optical system. Differences in luminance due to color variation, sun angle, and shadows of the terrain and objects upon it are recorded in their relative positions as differences in density. If the unit distance on the film is small, the density differences are sharply defined and are termed "edges." These edges reveal much of the information the interpreter needs to locate and identify images on the photograph. For some purposes and under certain circumstances, edges alone, without intervening tonal variations, can convey sufficient information.

In aerial photographs, imagery of maximum significance to the interpreter or photogrammetrist is characterized by the size, shape, and pattern of the edges formed during the photographic process. Unbroken, straight, or smooth continuous curved lines usually indicate man-made or man-modified objects. Continuous but irregularly curved lines indicate natural features, such as drainage systems. Closed erratic patterns generally indicate vegetation. Note that all of these features have a common characteristic—they can be represented by a single line describing their edges.

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EDGE ENHANCEMENT

To emphasize the detail of maximum significance while subduing detail of lesser importance, it is necessary to emphasize, in some degree, all of the edges as they appear in the aerial negative and in precisely the same location. Basically, at present, there are two means which may be used for edge enhancement: (1) electronic image-intensifier systems, and (2) direct photographic processes. It is not within the scope of this paper to discuss or evaluate systems other than the one specifically described here in.

Photographic processes of edge enhancement are simple and readily applicable to topographic mapping. One method of gaining "edge-contrast" by use of a film masking technique, was described by Messers. Yule[1] and Clerc[2] in 1945 and 1955 respectively. A paper describing the application of the same masking technique to aerial photographs was presented by Messrs. John St. Clair and Mylon Merriam in 1960.[3] Results achieved by this method are promising.

[1] Yule, J. A. C., *Journal of Photographic Society of America*, Vol. 11:123, 1945.

[2] Clerc, L. P., *Photography, Theory and Practice*, 3rd ed., London. 1955, p. 374.

[3] St. Clair, John and Merriam, Mylon, "The Use of Photography to Achieve Basic Principles of Map Design," PHOTOGRAMMETRIC ENGINEERING, June 1960. Vol. xxvi, no. 2, p. 498.

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‡ Abstract is on page 349 of 1962 YEARBOOK.

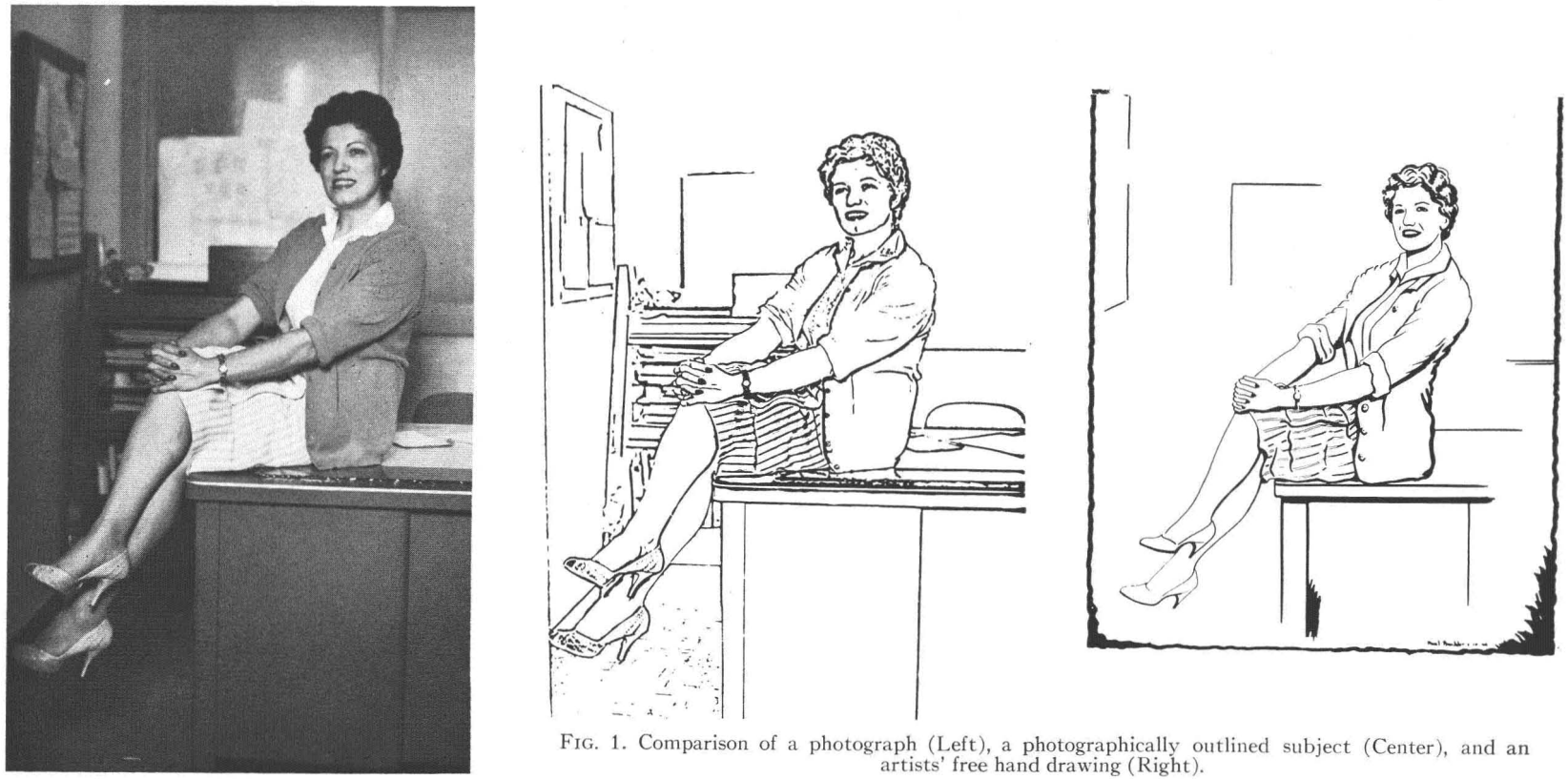


FIG. 1. Comparison of a photograph (Left), a photographically outlined subject (Center), and an artists' free hand drawing (Right).

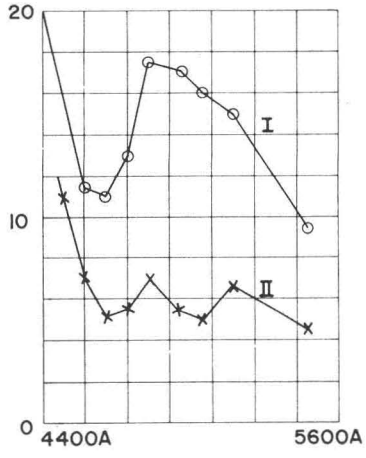
EDGE ISOLATION

In 1959, a technique was tested in the Topographic Division of the Geological Survey whereby the compression of density in an aerial photograph could reach a near maximum while preserving and in many cases increasing the contrast of fine detail. It was theorized that to completely eliminate tones of lesser importance, more control over contrast was required. The ensuing process was called "edge isolation," and the first tests indicated that it was adaptable to negatives of extreme density which are beyond the normal range of automatic-dodging printers.

PRINCIPLES

Other than film, the only equipment necessary for the edge-isolation process is a special contact printer manufactured under the trade name "Fluoro-Dodge."[4] The operation of this printer is based on photo-luminescence, which is the property of certain substances to absorb radiation of one wave-length and emit radiation of another wave-length. The photo-luminescent substance used in this system is zinc sulfide. In conjunction with its photo-luminescent property or, more specifically, phosphorescence due to ultraviolet absorption, zinc sulfide is also inversely sensitive to red and infrared. In other words, red and infrared radiation suppresses the luminescence of the zinc sulfide phosphor, as shown in Figure 2.

[4] Watson, Alfred J., The Fluoro-Dodge method for contrast control. PHOTOGRAMMETRIC ENGINEERING, September 1958. Vol. xxiv, no. 4, p. 638.



EFFECTS OF INFRARED ON FLUORESCENCE

CURVE I FLUORESCENCE SPECTRUM

CURVE II FLUORESCENCE SPECTRUM WHEN SCREEN IS EXPOSED TO INFRARED

FIG. 2

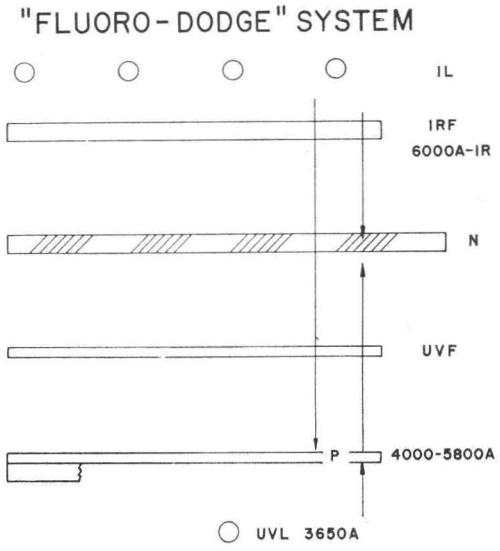


FIG. 3

The components of the Fluoro-Dodge system are outlined in the schematic diagram

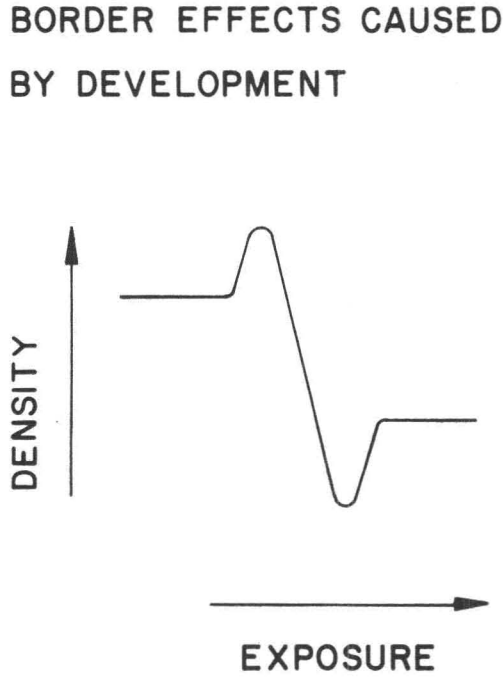


FIG. 4

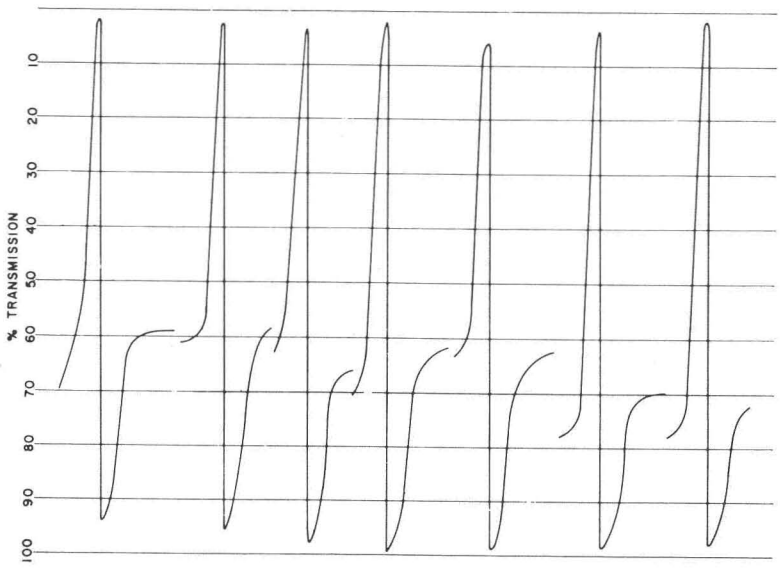


FIG. 5. Microtrace across seven consecutive steps of a standard density step wedge after compression.

shown in Figure 3. The lamp (*UVL*) radiates a range of ultraviolet rays with a peak emission at 3650 Angstrom units, exciting the phosphor screeen (*P*), which luminesces. The filter (*UVF*) absorbs the ultraviolet rays shorter than 4000 Angstrom units and transmits visible light. The filter (*IRF*) transmits infrared above the visible range, emanating from the incandescent lamps (*IL*), quenching luminescence from the phosphor screen (*P*). The quenching action of the infrared through a negative (*N*) converts the phosphor screen into a point-to-point image-modulated light source.

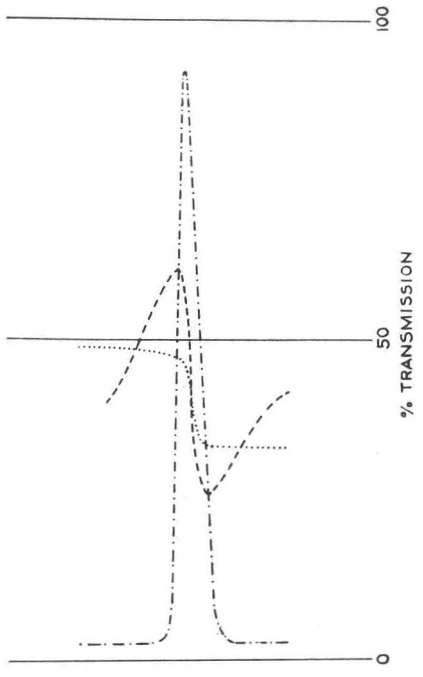


FIG. 6. Transition from a density step to a line.

FORMATION OF A LINE

A determining factor in the formation of a line of finite width by the edge-isolation process is the distance between the photographic negative and the phosphor screen. Infrared diffusion from the areas of less density across the edges into areas of greater density, emphasizes the border. The effect produced is similar to the border effects of normal development (Figure 4). Figure 5 is a microtrace across seven consecutive steps of a standard density step wedge after compression has taken place. By manipulation of a developer and exposure, it is possible to obtain any desired degree of masking on the final negative.

Proper selection of film and developer combinations enables the operator to control the degree of edge emphasis. For this application,

FIG. 7. Stone Mountain, near Atlanta, Georgia. Large clear area, upper center, is in dense shadow formed by a high cliff. Note the pattern on the opposite side of the mountain, indicating drainage systems leading to the small lakes and ponds in the wooded area at lower levels.

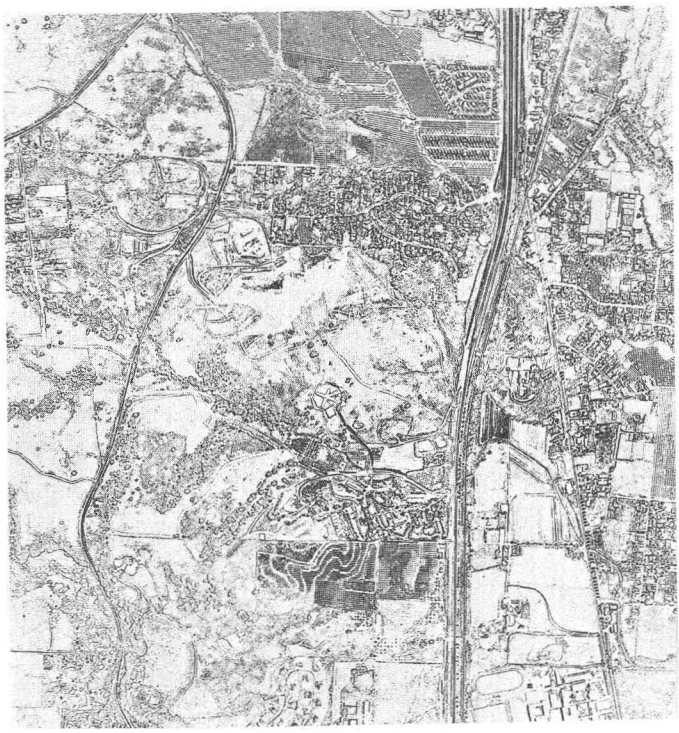


FIG. 8. Semirural area in Southern California. Here the difference between the lines formed by natural vegetation and those formed by manmade objects is very apparent. Areas in both figures 7 and 8 were used in a study in contrast control presented to the Society in 1961 (Contrast Control for Diapositives by James C. Lewis).

FIG. 9. Part of Alexandria, Virginia, much of the culture shown on this photograph is of recent origin and does not appear on published maps.

FIG. 10. Alexandria, Virginia, area at smaller scale. The first step of this edge-isolated photograph was made with Kodak auto-screen ortho. The edge effect is very pronounced, without total loss of intermediate tone.

the edges should be completely isolated from intermediate tones and rendered as clear lines against an opaque background. Figure 6 illustrates the transition from a simple density difference to total edge isolation.

PROCEDURE

The emulsion for this transformation must have extremely high density and contrast capabilities and must be coated on a stable base. In the first step, a positive transparency is made on high-contrast orthochromatic film from the original negative, with maximum quenching and developed in a moderately contrasty developer, such as Kodak D-19. The dark lines along the image borders, as described above, will have a density higher than that of the surrounding background. The clear lines adjacent to them allow additional passage of infrared on the succeeding step and thus further accentuate the dark lines, which are then printed in negative form.

The final negative is printed in the same way as the positive transparency. After the initial exposure, however, the exposed negative remains in the printer for a short time to allow the afterglow of the phosphor screen to expose the film in the background areas. The extent of edge isolation depends on the characteristics of the developer used for this negative. For complete isolation or total elimination of tone, the film is processed in a caustic developer, such as Kodalith. The background becomes opaque, and only clear lines are left to represent the original image edges.

The accompanying slides demonstrate the type of line which can be expected. They are, of course, greatly magnified and show some degradation (Figures 7, 8, 9, 10).

The edge-isolation process offers some attractive possibilities for saving time and money, especially in producing special-purpose maps for which standard cartographic symbolization is not necessary. Currently, all mapworthy features must be represented by graphically constructed symbols, manually located. The photographic processing of image symbols by edge isolation provides a semi-automatic method of representing prominent terrain features and in many respects, the symbolization is superior. When made from orthophotographs, the imagery is accurately positioned and the resulting product is a very useful planimetric map. In addition, edge-represented maps do not require halftone screening for reproduction by lithography. Patterns valuable to geologists and others interested in the general configuration of the terrain are often more easily detected in edge-isolated prints than in the original photograph.

The relative simplicity of processing edge-isolated prints could result in their widespread use. It is, however, impossible to predict at this time all the benefits which may result from this process.

*AP/1—A New Concept in Stereoplotting**

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IN PREPARING this paper the original intention was to briefly review the principles of the Analytical Stereoplotter and then to give some detailed information on its design and construction. And finally to discuss briefly the uses to which the instrument could be put. I found, however, that during the past year or two in which we have been developing the prototype this information has already been made available in several papers. Mr. Helava, the inventor of the instrument itself, has presented some excellent material on the principles as well as the contemplated use of such instrument and now I notice in a recent issue of "PHOTOGRAMMETRIC ENGINEERING," that Dr. Johnson of the Bendix Research Laboratories Division has presented a very thorough discussion of the basic concepts involved in the prototype instrument.

Also I must confess that I myself have been

* Paper presented at the Semi-Annual Meeting of the American Society of Photogrammetry, October 1961, New York.