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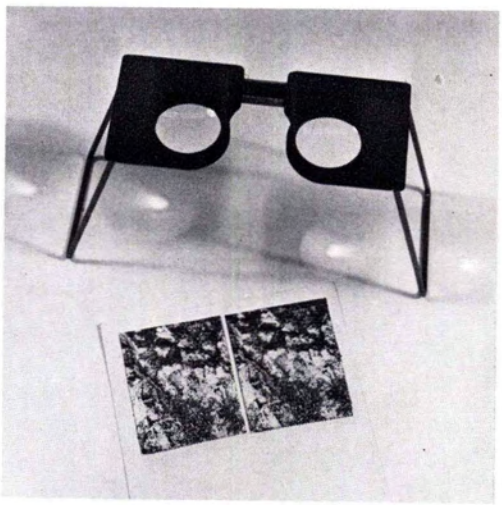

FRONTISPIECE. Completed stereogram prepared for viewing with a pocket stereoscope.

Constructing Stereograms

ABSTRACT: *A step-by-step method for constructing aerial photo and ground stereograms is described. Ground stereograms are useful supplements to aerial photo stereograms in training situations. Satisfactory ground stereograms can be taken without special photographic equipment. However, the use of a stationary camera platform is advisable.*

INTRODUCTION

AN OLD RECIPE FOR rabbit stew starts out, "First you shoot a rabbit." The point is, of course, that in producing any finished product you begin by obtaining the ingredients. And sometimes a few directions may be needed on gathering the ingredients as well as how they are utilized. An illustrative situation is found in the production of aerial photographic keys and other descriptive material employing stereograms. The instructions often simply state something like "assemble stereograms." Curiously, very little published material can be found on actually constructing stereograms. Moessner[2,3] has written brief descriptions of his techniques. The *Manual of Photographic Interpretation*,[1] as comprehensive as it is in other respects, completely omits any reference to stereogram construction.

The following techniques are those used by the author; they are presented for two reasons:

1. To guide those who are constructing stereograms for the first time, and
2. To stimulate those readers of PHOTOGRAMMETRIC ENGINEERING who have developed better techniques to come forward with their own recipe for "rabbit stew."

AERIAL PHOTO STEREOGRAMS

Stereograms are mounted stereographic pairs of photographs which present three-dimensional views of known conditions or objects of interest. In photo interpretation work, stereograms are compared to photographs of unknown conditions, and identification of those conditions are made through similarity of photographic appearances. The term *stereogram* is generally identified with vertical aerial photographs although ground views can be photographed and presented as stereograms. In the following text, stereograms will mean aerial photo stereograms unless otherwise specified.

Stereograms are made from the overlapping portions of two aerial photos mounted

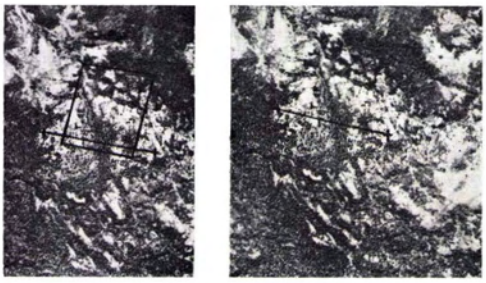

FIG. 1. Outlining the stereogram area.

side by side, properly oriented and spaced for stereo viewing. The width of each photo of a stereo pair should not be greater than normal image separation used by most viewers. This is usually about $2\frac{1}{4}$ inches. The height of the stereograms, however, can be any practical distance.

A glossy photo finish is recommended if the stereograms are to be reproduced. However, if only a single set of stereograms are being assembled to use as a guide in interpreting semimatte prints, it would be preferable to have the stereograms in semimatte also.

The first step in constructing an aerial photo stereogram is to select the proper pair of photos. This pair should be one where the object or condition to be illustrated lies between the principal and conjugate principal point and is closest to the flight line. Photos should be oriented so that the shadows fall toward the observer if possible.

The following step-by-step procedure is recommended.

1. LOCATE FLIGHT LINE

Locate principal and conjugate principal points on both photos of the pair. Draw a line between these points on both photos. This is the flight line. All photo markings such as center points, flight lines, and stereogram outlines should be made with something easily erasable such as a grease pencil.

2. DESIGNATE STEREOGRAM AREA

Outline the stereogram area on one of the photos (Figure 1). The horizontal axis of the stereogram must be parallel with the flight line. The vertical axis must be perpendicular to the flight line. Keep in mind that the stereogram pair members should be no more than $2\frac{1}{4}$ inches wide. If the flight line does not cross the stereogram at any point, draw a line parallel to the flight line across the center of the stereogram. Extend the line beyond the edge of the stereogram. Draw a line in the same relative position on the other photo of the pair but make it parallel to the flight line of that photo.

3. REMOVE STEREOGRAM FROM PHOTO

Cut out stereogram from photo (Figure 2). Wipe off grease pencil marks from face of photo. Note whether it is the right or left member of the photo pair on the reverse side at the photo top (Figure 3).

4. COMPLETE STEREO PAIR

Take the remaining portion of the photo from which the stereogram pair member has been removed and, using it as a templet,

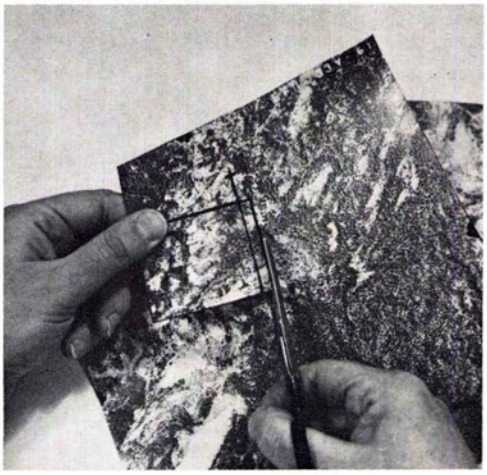

FIG. 2. Cut out the stereogram.

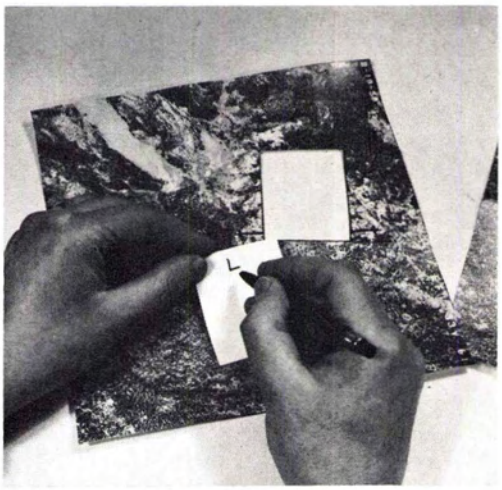

FIG. 3. Designate whether the photo chip is the right or left member of the pair.

center it over the stereogram area on the other photo (Figure 4).

Correct horizontal positioning is obtained by aligning the flight line on the templet photo with the flight line on the exposed portion of the bottom photo. Vertical positioning is achieved by aligning photo details along the vertical edges of the cutout area on the templet photo to the same details on the portion of the bottom photo. Because the two photos represent the same area photographed from two different angles, it is unlikely that the details will match exactly on all points of the photo. For instance, a road at the bottom of the photo may be matched up on both photos but this would leave the image of a stream near the top displaced. The two photos may also be of a slightly different photo scale. The proper centering of the top photo over the bottom photo is best done by averaging out the displacement of images while maintaining horizontal alignment.

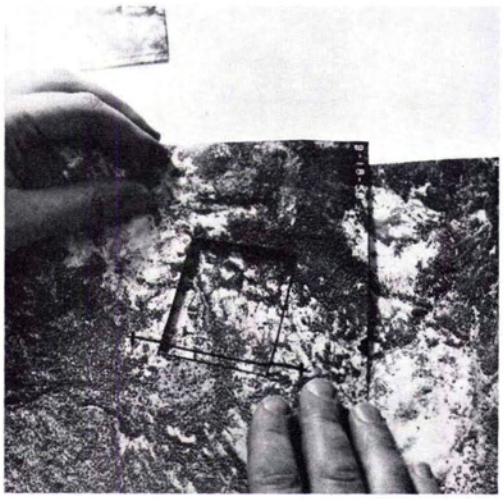

FIG. 4. Using the remaining portion of the photo as a templet to outline the same area on the other photo.

FIG. 5. Pin-pricking the corners of the area on the new photograph.

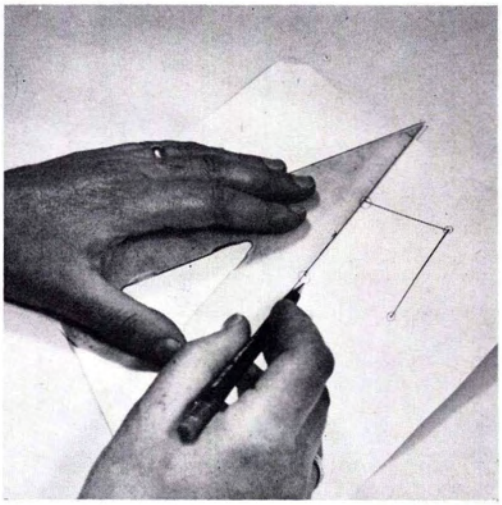

FIG. 6. Pencil lines on the back of the photo connect the pricked holes.

When the templet photo is satisfactorily centered over the bottom photo, pinprick the four corners of the cutout area on the bottom photo (Figure 5). Turn the pinpricked photo over and draw pencil lines connecting the four points so as to outline the cutout area (Figure 6). Cut out the other part of the stereogram. Note on the reverse side at the top whether it is the right or left member of the photo pair.

The stereogram is now ready for mounting.

5. CHECK STEREOGRAM FOR CORRECT ORIENTATION BEFORE MOUNTING

Place the stereo pair members side-by-side and view them with a pocket stereoscope. If a reverse stereo effect is obtained (ridges appear as valleys, valleys appear as ridges, and trees appear as holes in the ground), the right and left members have been reversed and they should be repositioned. If difficulty is experienced in getting a good stereo image and eye strain seems to be present, the photos may be improperly aligned. This can be checked by carefully aligning the pair so that the vertical edges are parallel and then

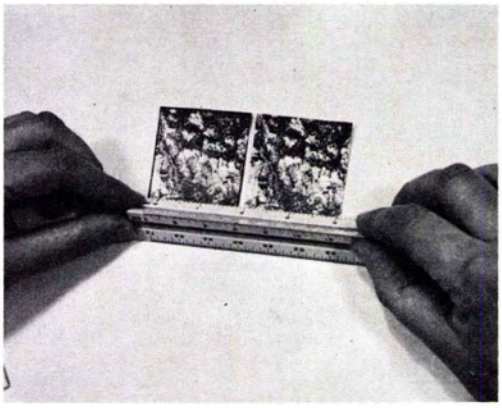

FIG. 7. Aligning the edges of the two parts of the stereogram.

measuring the distance between identical images on the two photos (Figure 7).

The image separation should be about the width of the stereogram, around $2\frac{1}{4}$ inches for most images on the pair if the area depicted is fairly level terrain. If a significant difference exists between the image separation for objects at the top and bottom of the photo, it is likely that the photos were improperly aligned. They should be discarded and a new stereo pair constructed. However, in stereo pairs where considerable elevation change occurs, image separation at high and low points will be significantly different even for properly aligned photos.

6. MOUNT THE STEREO PAIR

Outline the stereo pair in pencil on stiff card stock. The members of the pair should be separated by a strip approximately 0.1 inch wide. Coat both the backs of the photos and the outlined area on the card with rubber cement and let dry for a minute. Fasten down photos, working from the edge of the photo adjacent to the center 0.1-inch strip outward. Line up the edge of the photo to the strip very carefully (Figure 8). Double-coated rubber cement forms a very firm bond that adheres immediately and cannot be shifted once it is laid down. Double-coated transparent adhesive tape or photographic dry mounting tissue can also be used for mounting photos. When both members of the pair are mounted, the stereogram is complete (Frontispiece).

GROUND PHOTO STEREOGRAMS

The instructional values of aerial photo stereograms are enhanced if they are combined with ground views of the object or condition illustrated. This is especially true if the ground view is presented as a stereogram. Special ground stereo cameras which consist of a pair of lenses mounted side by side are excellent for this purpose. However, these cameras are generally unavailable. However, satisfactory stereo pictures can be taken with a single lens camera by following a few simple rules.

A twin-lens reflect camera that produces $2\frac{1}{4}$-inch by $2\frac{1}{4}$-inch photos is excellent for stereogram work. Its contact prints can be used directly in the stereogram. The 35mm camera can also be used. However, it should be kept in mind that if a 35mm camera is positioned in the conventional horizontal position, the resultant stereo pair will lack *height*. That is because when the 35mm format is enlarged to a $2\frac{1}{4}$-inch horizontal base, the vertical dimension will only be $1\frac{1}{2}$ inch. If stereograms with greater vertical coverage are desired, the camera should be positioned vertically.

The camera may be either hand held or mounted on a slotted wooden platform attached to a tripod. If the camera is hand held, a stereo pair may be taken by snapping a picture, moving a few inches sideways at the same level, and snapping another photo of the same point of interest. Normally this gives a stereo depth up to 1,000 feet. An increase in spacing will exaggerate the stereo effect which may not be desirable for a natural-appearing photo. Stereo pairs taken with hand-held cameras are somewhat crude. Uncontrolled side movement can result in excessive camera displacements and objects in the foregound may not be in stereo. Problems also occur in keeping the camera level both times and covering the same field of view.

FIG. 8. Fastening the photos down with adhesive.

Therefore, the use of a platform is recommended.

The camera platform need not consist of anything more than a wooden base with a slot down the center to accommodate the camera's tripod socket, a threaded well in the center of the bottom for the tripod head, and a narrow guide strip on the back. The platform should accommodate a camera displacement of three or four inches. In operation, the camera is placed at one end of the platform, an exposure is made, the film is cycled, the camera is slid to the other end of the platform and the second exposure is made as rapidly as possible. Details on the construction of the platform and operation of the camera are found in an article by Steigerwaldt (*4*).

Several advantages accrue from photographing stereo pictures from a fixed platform rather than with a hand-held camera. The steady platform allows for longer exposures and smaller lens openings which give better depth of field. The camera can be kept in good alignment by means of the guide on the back of the platform, and uniform camera displacement can be maintained.

Ground stereo pairs are mounted on card stock in the same manner as described for aerial photos.

References

(1) American Society of Photogrammetry. *Manual of Photographic Interpretation*. 868 p. 1960.
(2) Moessner, Karl E. Combined Vertical and Horizontal Stereograms. U. S. Forest Serv., Intermountain Forest & Range Expt. Sta. *Res. Note No. 35*. 1956.
(3) ———. *Training Handbook*. Basic Techniques in Forest Photo Interpretation. U. S. Forest Serv., Intermountain Forest & Range Expt. Sta. 1960.
(4) Steigerwaldt, Edward F. Stereotypes for Aerial Photo Interpreters. *Jour. Forestry* 48: 693–696. 1950.