THREE-DIMENSIONAL PRINTS FROM COLOR FILM*

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ABSTRACT

Two methods are described for producing anaglyphic transparencies using commercially available subtractive three-color photographic film. Each employs the No. 21 (Monobromofluoresceine) and No. 39 (Duplicating) filters as both exposing and viewing filters. The first method is accomplished with a standard photographic copying camera by registering the two components of the stereoscopic pair on the copyholder and successively exposing the left-view and right-view images through their respective filters, on the same sheet of film. In the second method the left-view and the right-view images are exposed simultaneously, each through its respective filter, in superimposition on a single sheet of color film. This method employs a standard camera and an optical device which by means of a split beam mirror and a total reflecting mirror superimposes the two images at the film plane. Also described is a mapping device for field use of the anaglyph. The device projects the anaglyph on a datum board by means of split beam mirrors mounted in the eyepiece. The projected image permits mapping or note-taking during stereoscopic study through the taking filters.

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THREE-DIMENSIONAL prints have many values in practical use. In forestry work, to cite only one example, three-dimensional prints are much easier to handle in the field than conventional 9 by 9 inch contact prints used with a stereoscope. Wherever stereoscopic observation is necessary, there is a place for using a three-dimensional print, provided it is of adequate quality and it can be furnished at a reasonable cost.

MAKING ANAGLYPHS WITH COLOR FILM

Anaglyphs—three-dimensional prints depending upon color separation of the two component images—can be made quickly and inexpensively from standard color film by any photographer. The process can be adapted either to the taking of three-dimensional prints from vertical aerial photographs, or to the taking of direct three-dimensional photographs.

The print is made by exposing the color film twice, once with each of two mutually exclusive filters. In the first tests of the method, Wratten X2 and A filters were used. In more recent tests, the Wratten G and C5 filters were adopted. These proved less satisfactory, however, as the yellow G filter admitted more light under normal light conditions than the blue C5 filter. The best combination appears to be the Wratten No. 21 and No. 39 filters. These approximately split the visible spectrum between them. The No. 21 (Monobromofluoresceine) filter admits light of wave lengths longer than 530 millimicrons and the No. 39 (Duplicating) filter admits light between 300 and 520 millimicrons. In using these filters, the light source should be controlled so that the total light transmitted by the two filters is approximately the same. Under these conditions, the filter factors are the same. The same considerations apply when viewing the anaglyphs with the same filters.

To make an anaglyph from vertical aerial photographs, either Kodachrome or Ansco Color film may be used. The copying camera should have ground-glass focusing. First, one contact print (or enlargement) is placed before the copying camera and is photographed with the first of the pair of filters. Second, the overlapping print of the stereo-pair is placed before the copying camera in such

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a position that its image is superimposed on the first (usually with a slight lateral displacement parallel to the line of flight). This may be accomplished by superimposing the two photographs, taping them down with drafting tape, and flipping the prints so that the proper one is exposed to the proper filter. The second print is then photographed on the same film using the second of the pair of filters. Because the filters are mutually exclusive as to light admitted, the result is a perfect double image. By viewing this analgyph with a pair of spectacles using the one filter before one eye and the other before the other eye, a high

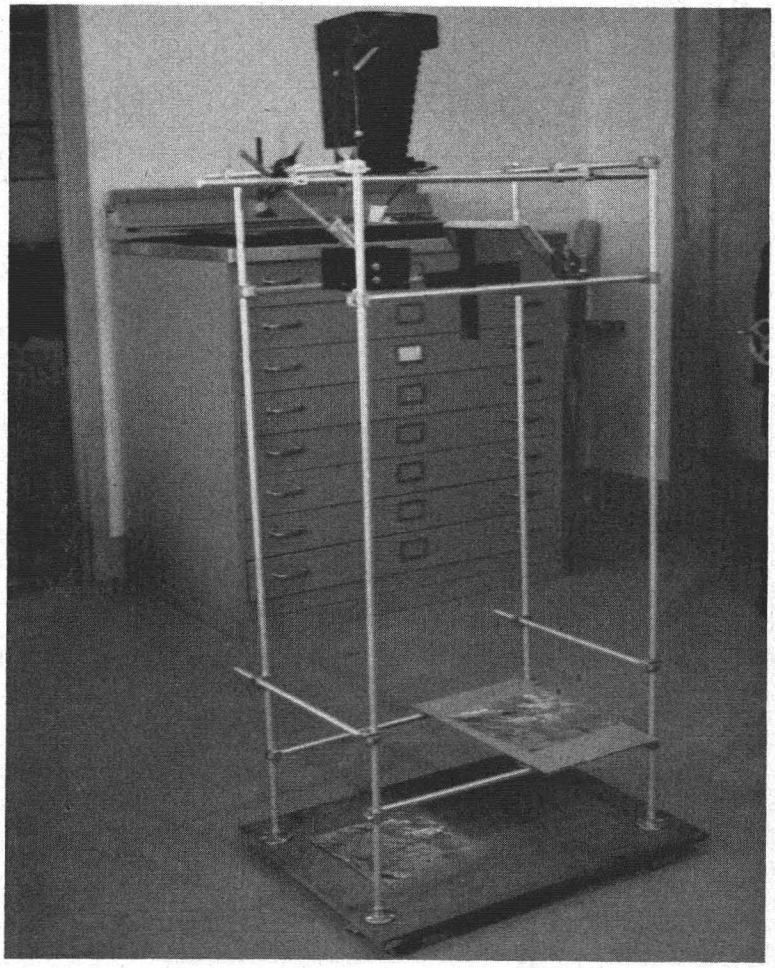

FIG. 1. Anascope.

quality three-dimensional image is obtained. The process is conducive of clear distinct images. The cost of the process is only the sum total of the cost of the film and the time required for the simple copying operation. The whole procedure is easily adapted to mass-production techniques.

Although the two photographic images can be superimposed readily with any copying camera by the use of two successive exposures, the operation may be shortened by use of a special superimposing device. Such an instrument, termed the *Anascope*, may be constructed without difficulty on the camera lucida principle. Figure 1 portrays a mock-up of this device that was used in

making the first trial anaglyphs by this process. It is essentially a camera lucida, permitting the two aerial photographs to be viewed simultaneously on the ground glass. One filter is placed below the image-dividing semi-transparent mirror; the second filter is placed to the side of this mirror between it and the contact print. By balancing the light received by the two prints so that their images are equally strong on the ground glass, a good anaglyph can be photographed in a single exposure.

Using Anaglyphs in the Field and Office

Once obtained, the color film anaglyph provides a readily usable three-dimensional image for field use. It is compact, detailed, and easily handled. It can be mounted in a plastic envelope and viewed with bicolored spectacles. The spectacles, of course, should use the same filters required for the preparation of the print.

A compact reconnaissance mapping device can be constructed for field use of the anaglyphs. An early version of such an instrument is pictured in Figure 2.

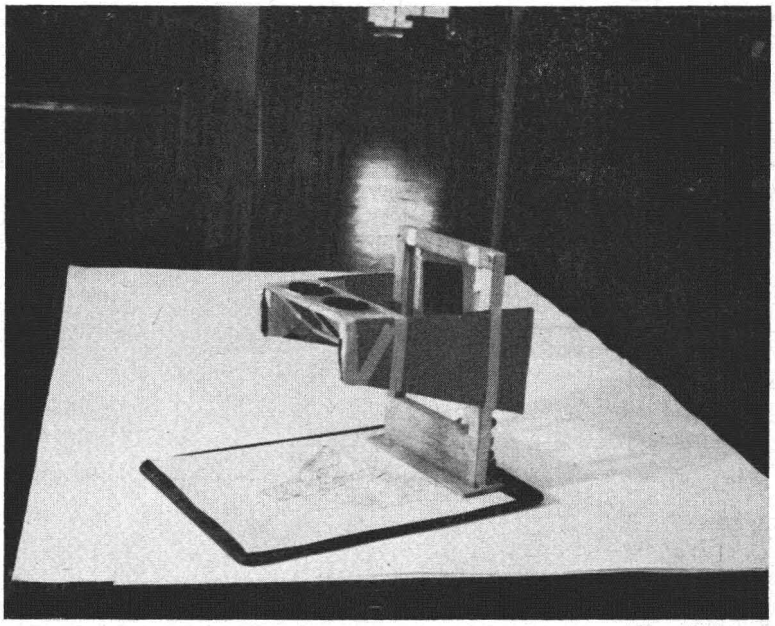

Fig. 2. An early version of an instrument for field use of anaglyphs.

In this device, the anaglyph is placed between a clear glass and a frosted glass plate mounted at right angles to the tatum board. The photographic image is superimposed on to the sketch paper on the tatum board by means of semi-transparent mirrors mounted in the eyepiece. The two requisite complementary filters are also mounted in the eyepiece to permit stereoscopic study of the anaglyph. This single compact device permits the stereoscopic study of the aerial photographs and, at the same time, permits mapping and note-taking by superimposing the stereoscopic image on the writing surface.

In the office, the color film anaglyph can be used in mapping. It can be mounted between two standard lantern slide glass plates and projected with any standard projector or enlarger. The three-dimensional picture can thus be superimposed on the base map or control plot at any required scale. Detail can be

transferred to the map simply by tracing from the spatial image. Incidentally, it may be noted that the anaglyph can be projected for large audiences. This adaptation has been the basis for three-dimensional motion pictures in the past.

Taking Direct Anaglyphs

The color film anaglyph process can also be applied to the taking of direct three-dimensional pictures. Whereas, in the conventional three-dimensional camera or split-beam attachment, the two images are registered side by side on the film, they are superimposed in the anaglyph technique. This permits doubling the size of the stereoscopic view without increasing the amount of film required. In photographing still objects, one exposure is taken with one filter. The camera is then moved the requisite distance to the side (2 or more inches, as determined by well-known stereoscopic theory), and the film is reexposed with the complementary filter. In photographing moving objects, a split-beam attachment is required, but this attachment should be so adjusted that it superimposes the two images rather than places them side by side. As with the prints made from aerial photographs, the anaglyphs are viewed with the same pair of complementary filters.

Strange as it may seem, direct color anaglyphs taken by the above process give full color rendition. Half of the visible spectrum is registered through one filter and viewed by one eye. The other half is recorded through the second filter and viewed by the other eye. The resulting composite image is not only three-dimensional: it is also in color.

Color film anaglyphs seem to present real possibilities in the practical solution of stereoscopic photography problems. They are simple to make, high in quality, and relatively inexpensive. Perhaps their main use will be in simplifying stereoscopic study of aerial photographs in the field. They are also promising, however, in low-cost mapping and in direct photography.