terms seems to be that efforts toward a clear and unmistakable terminology should never weaken if we are to maintain a fruitful exchange of ideas and experiences, and to facilitate the training of scores of new photogrammetrists and photo interpreters.

A second conclusion: If we compare the solid, impersonal structure of an instrument model, in a Multiplex for instance, with the evasive, distorted form of a visual model under a stereoscope, we realize that the weakest point of visual stereoscopy is metric information. This is the domain of measuring instruments. Estimating heights and slopes from the visual stereoscopic model cannot be expected to give more than very crude values. An old shepherd or a young boy scout may be able to tell you the time from the behavior of the sheep or the shadow of trees, but you can do much better by looking at a watch.

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COMMENTS ON "THE INTERPRETATION OF TRI-DIMENSIONAL FORM FROM STEREO PICTURES"*

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GEOMETRICAL reconstructions such as in Figure 4 of the abovementioned paper are very useful when discussing the formation of the stereo-model by intersection of identical light rays in instruments like the Multiplex. Unfortunately those reconstructions may lead to faulty conclusions when discussing depth perception.

Even though in natural vision the ability of our eyes to converge and to accommodate appears to be interrelated, there are many observers, the author included, who are able to accommodate on near or far objects with the lines of sight parallel or even divergent. When viewing a pair of stereo photographs with the lines of sight in these positions, a stereo image is seen but not at infinity or, in the second case, behind the back of the observer, as geometrical reconstruction would suggest.

It has already often been stated,—for instance by Salzman in "Note on Stereoscopy" (PHOTOGRAMMETRIC ENGINEERING, 1950, p. 475), that depth perception is a function of retinal disparity.

In order to uncouple any undesired train of thought between the geometry of a stereo-model and human depth perception by the unaided eyes, it is prefer-

* The author of this paper was Dr. C. M. Aschenbrenner. See PHOTOGRAMMETRIC ENGINEERING, Vol. XVIII, No. 3, pp. 469–472.

able to use the expressions "sight direction" to identical objector image points, and "retinal angle," respectively a/f, a^1/f^1 etc. and α, α^1 in Figure 1a of this paper.

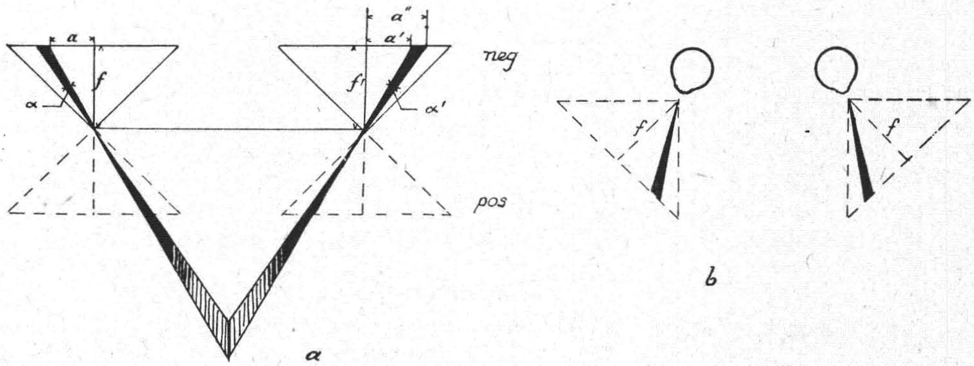

FIG. 1

If it is desired to obtain "natural" depth impression—that is as if our eyes were located at the camera stations—then the photographs should be presented to the eyes in such a way that:

1. The retinal angles are the same in both cases.
2. The sight direction is the same in both cases.
3. A sharp image is formed on the retina.

From Figure 1b will be seen, that these conditions may be fullfilled also when the lines of sight diverge. With the unaided eye f should be at least 25 cm.

For sharp vision, wide-angle photographs may be placed at a distance of 25 cm. from the eyes, but then the sight directions are altered by the disturbance of the a/f ratios, while at the same time the retinal angles decrease. A decrease of the retinal angles means a decrease of the retinal disparity, therefore a decrease of depth impression, and not an increase as geometrical reconstruction would suggest. See Figure 2a; Figure 2b shows that a change of the eye base b has no effect on the sight directions or the retinal angles.

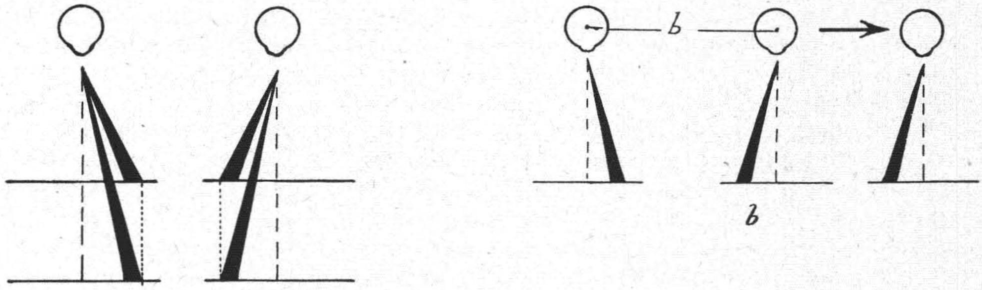

FIG. 2

Observers with an eye base larger than normal, who in natural vision have a better stereoscopic vision,[1] do not obtain a greater depth impression when view-

[1] In natural vision or aerial photography the increase of the eye or air base b to nb does give less than n times the increase of the "retinal angles," due to the fact that the distance from object to eye or camera increases at the same time, thus reducing the effect.

ing photographs. For the same reason the popular belief that the increased base-length of a mirror stereoscope provides an increased depth impression appears to be incorrect. On the contrary, the increase of f which is common in this type of stereoscope, causes a decrease of depth impression.

Until now the discussion has been of stereoscopic observation with the unaided eyes. As soon as optical means are introduced, the sight directions or retinal angles may be altered with the result of a change in the proper depth impression.

Imperfect mirrors will cause local deformations; improperly adjusted mirrors of good quality will cause the stereo-image to slope.

The introduction of magnification by lenses tends to cause an increase of the retinal angles and therefore an increase of the depth impression. The sight directions are altered simultaneously.

Based on the preceding, it now appears possible to construct a stereoscope which will give a natural depth impression.

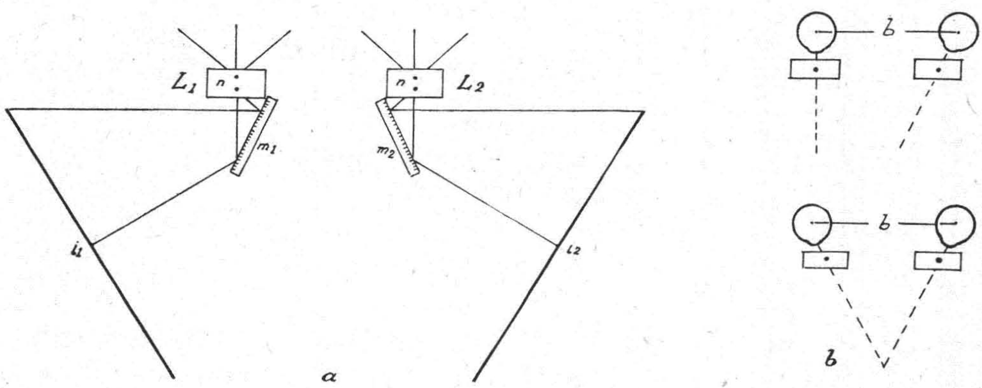

FIG. 3

In Figures 3a L1 and L2 represent lenses of the same type and focal distance as the lens of the camera with which the photographs to be observed were taken. Due to the short focal distance and the size of the photographs, it is impossible to introduce the usual two mirrors in each half of the stereoscope. With one mirror, m_1 and m_2 respectively, and the large photographs i_1 and i_2 placed in a sloping position, enough room is provided to place the lenses at the desired (eye) distance. The interchange of left and right caused by the use of one mirror only, must be avoided. This may be done by placing the photographs in a reversed position; the prints should then be made on film or glass and observed from the back side.

With the prints placed correctly in the focal plane of the lenses the sight directions and the retinal angles remain unchanged provided no film shrinkage occurred. Parallel bundles of rays are emerging from the lenses serving as oculars; so with the eyes focused at infinity a sharp retinal image is formed.

The center of rotation of the eyes lies on some distance from the nodal points n. Dependent upon the necessary convergence, the distance between the halves of the stereoscope—lens, mirror and print as a unit—may be altered for easy observation. See Figure 3b. According to Figure 2b this does not change the depth impression.