tions which may fairly be described as massive.

Turning to the question of error-propagation it is evident that problems exist here which require specific research. In the computation methods which use only the correspondence condition, the propagation of errors is tied almost entirely to the y-errors of the measurements. That is, the propagated errors of orientation are almost completely insulated from the x-errors. The same is largely true of the scale errors if several points are used for each scale transfer. This last remark, by the way, explains why the 3-table instruments have no strong advantages for the older methods of computation. The newer methods of strip formation employing the coincidence principle are certainly vulnerable to the x-errors of the measures, for the relative orientations are directly affected by these. On the face of it, the new techniques with their additional conditions should give the better answer, but since new errors are introduced, the author would like to see this proved.

For most survey organizations, aerotriangulation is a substitute for the more expensive ground survey, so that almost all aerotriangulation processes are partly governed by economic considerations. Any innovations implying higher costs or greater complexity therefore require careful examination before they are brought into use by such organizations. If the author appears to be unduly critical of the recent developments, it is because of his experience with aerotriangulations in which costs had always to be considered along with accuracy. The views expressed here are those of the author, and are not necessarily those of the Ordnance Survey.

Comments on Stereographs

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THE article, "An Application of Models and Stereo Images to Teaching Photographic Geometry," by Raymond M. Nelson interested me.* One can see that stereophotos in color of these models would be very effective in teaching photographic geometry to students not accustomed to visualizing three dimensions while looking at a drawing which, perforce, is limited to two dimensions.

But why limit the idea to photographic geometry? I have often wondered why the publishers of our text books on solid geometry and related subjects have never seen fit to utilize the stereograph to illustrate the more complex figures; and I almost have been moved, at times, to propose the idea. As a matter of fact, I have gone so far as to prepare stereoscopic drawings of an ellipsoid for my own use. I have hesitated to report this, because the idea has, I believe, been in use for many years, particularly, by European photogrammetrists; but Mr. Nelson's article provides a good opportunity to mention my experiment in a comment.

I learned that stereographs are easily constructed; particularly, if the lines and planes involved are not curved. Fair drafting ability, a slight acquaintance with descriptive geometry, and a ratio to use in computing the separation of conjugate images—these, along with common drafting instruments and materials, are all that is needed.

For my experiment, I used a ratio of 2.6 to 14. Why that particular ratio? Well, I decided that 2.6 was about the normal pupillary distance, and that I would use that distance for the separation of points appearing on the plane of the paper. Then I took 14 inches as a good distance for normal vision and assumed that rays from a pair of points in the picture plane would merge at that distance. It was then a simple matter to construct the two converging lines and actually measure the separation at varying distances from the picture plane. However, it is preferable to reverse the figure so that the picture plane is at the vertex. Then the separation of the lines is applied as a correction to

* PHOTOGRAMMETRIC ENGINEERING, Vol. XXIV, No. 3, June, 1958.

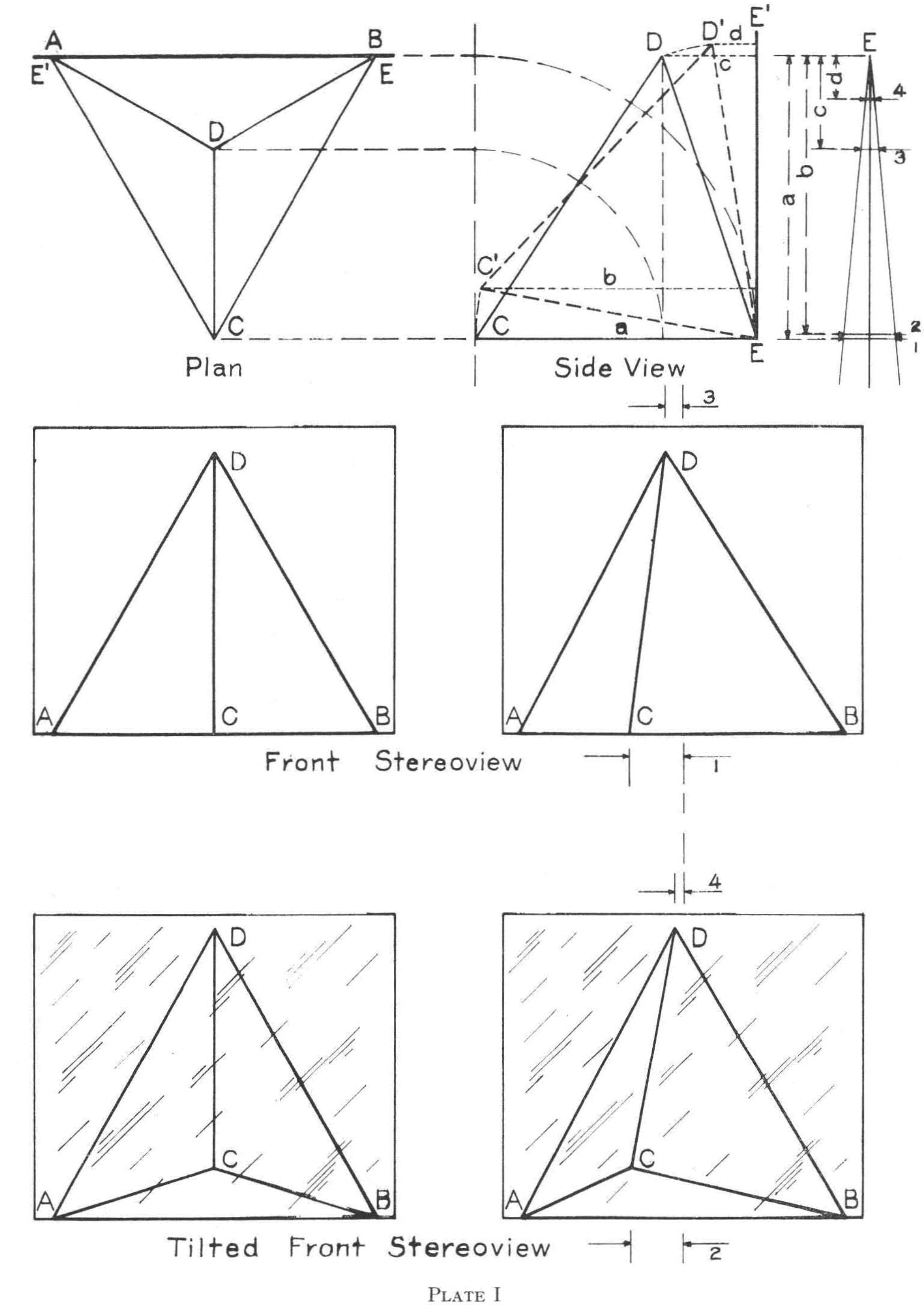

PLATE I

the basic separation—minus if the point is in front of the plane; plus, if behind it. This makes possible constructing the drawing at a large scale; this is a great advantage when non-circular curves are involved.

As a simple example in construction, we might consider a regular triangular pyramid with two base vertices, A and B, in the plane of the paper.

Plate I shows the construction work necessary to prepare two stereographs of such a pyramid; one with the base horizontal, the other with the top vertex, *D*, tilted back toward the picture plane, *EE*, through an angle of 10 degrees.

At the top of the drawing are the plan, side view, and two lines intersecting at such an angle as will cause them to separate 2.6 inches in 14. The heavy dashed lines in the side view indicate the position of the tilted pyramid.

Just below the plan is the front view of the horizontal pyramid, and at the right of it is a similar view which has been altered to make of the two views a stereoscopic pair. The alteration is effected by moving vertices *C* and *D* to the left by amounts equal to the separations at 1 and 3, respectively, of the intersecting lines at the upper right corner of the drawing. These are the separations measured at distances *a* and *c*, respectively, from the picture plane which is here indicated by the single letter *E*.

Below the horizontal front view is the front view of the tilted pyramid; and to the right of the latter is its stereoscopic pair, altered by using the separations at 2 and 4 of the intersecting lines mentioned above. In this stereograph an attempt has been made to simulate a glass picture plane by the use of identical shading lines in each view. However, close viewing will indicate that the "glass" must have been of very poor quality. Those perfectionists among us who might insist on optical glass for the picture plane, would be well advised to use photog-

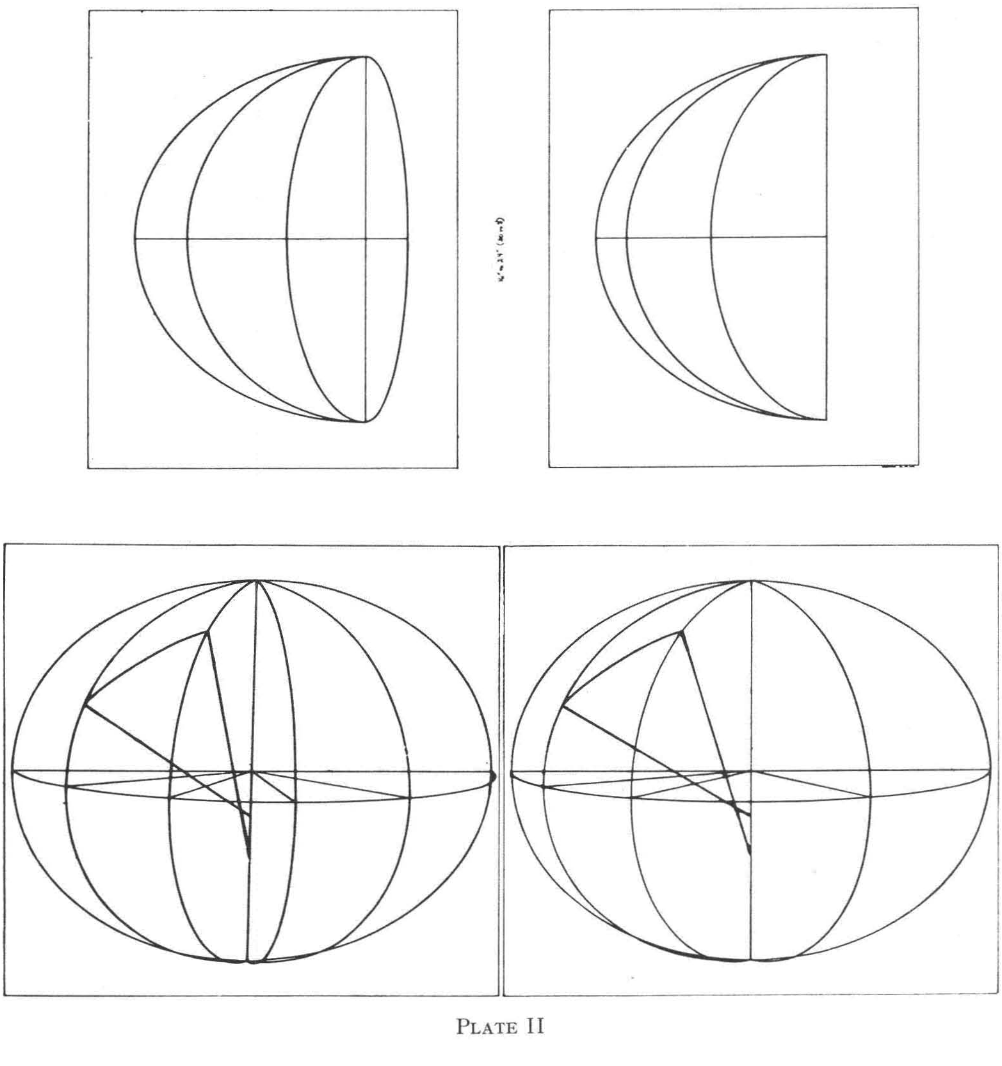

PLATE II

raphy in advance to prepare two identical backgrounds on which the figures can later be constructed.

Plate II shows two stereographs of an ellipsoid. The one at the top is an untilted view of the left front-quarter showing three dihedral angles of 30 degrees. The other is a tilted view of the full front-half showing four dihedral angles of 30 degrees, beginning at the left. The axis of tilt is the major axis of the ellipse shown, and it lies in the plane of the paper. The top of the ellipsoid has been tilted toward the observer through an arc of $7\frac{1}{2}$ degrees. A geodetic line spanning 30 degrees of latitude and longitude is shown, along with normals to the ellipsoid at each extremity of this line.

A complete description of the method used to construct the stereographs shown in Plate II would require more time than I have allotted myself for this comment. However, the basic principles used were identical to those used in constructing the pyramid. A somewhat better acquaintance with descriptive geometry than is required to draw the pyramid would naturally be needed, but only the fundamentals of the subject are involved. Accurate drafting of the curves is the critical factor.

The ellipsoid shown was used to clarify some of the figures involved in computing latitude and longitude. The time required for construction seemed insignificant when compared to the advantage gained by being able to visualize clearly the complex relations of the various lines to each other and to the spheroid. For example, the stereograph of the tilted figure illustrates very clearly the fact that normals do not intersect when differences of both latitude and longitude are involved. It also shows that latitude is measured, not at the center of the spheroid, but at the intersection of the normal with the equatorial plane.

Although the matter of illustrating text books and works on geodesy might seem to be outside the province of photogrammetric engineers, our familiarity with stereoscopy does place on our shoulders the responsibility to point out how the stereoscopic principle can be used to advantage in other fields. Why not solicit a talk on the subject at the next Annual Meeting from some prominent geometer or geometry teacher?

The Terrain Data Translator

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and
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INTRODUCTION

A NEW photogrammetric measuring device known as the Terrain Data Translator (TDT) has recently been developed and field tested by the Benson-Lehner Corporation of Los Angeles, California. The primary purpose of the TDT is to provide ground cross-section and profile notes in digital form directly from the stereo model as viewed in the double projection, or Kelsh type, stereoplotter, or directly from a topographic map sheet. Preliminary test results indicate that this unit permits increased accuracy and significant savings in terms of both time and money.

The TDT operator can select recorded output of the terrain data in any combination of three forms: typed records, punched cards, or punched paper tape.

The initial development of the TDT prototype was made possible through a close interchange of information between the California State Division of Highways, the Los Angeles aerial mapping firm of Pafford and Associates, and the Benson-Lehner Corporation. The valuable cooperation and great personal interest offered by these three groups in establishing the basic design criteria for the TDT has resulted in the production of an instrument that is both practical and economical in operation. The TDT system is easily installed and does not

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