A PROPOSED METHOD OF RECONNAISSANCE FOR CO-ORDINATED AERIAL AND FIELD SURVEYS

H. G. Chickering, Jr., Photogrammetric Engineer, Willamette Valley Tree Farms, Eugene, Oregon

Synopsis: The author, in this article, introduces an interesting method of utilizing a line of sight in the spatial model when making reconnaissance for field surveys by use of aerial photographic prints under a stereoscope. The line of sight is produced by two lines on transparent overlays being brought into stereoscopic fusion. If this spatial line is interrupted in its parallax relationship from the proposed instrument station to the proposed intersected point, by ridge tops, trees, buildings or other obstructions, the use of such positions in the intended manner is impractical. A means of predetermining the adequacy of proposed instrunent stations tends to reduce costs and is of interest to field men on any mapping job.—*Publication Committee*

INTRODUCTION: The common belief that photogrammetric engineering and the strides being made in the development of stereoscopic plotting instruments, will eventually preclude the need for field crews and field surveys, is far from accurate. The exact opposite is much nearer the truth. As the need for original maps will be greater than the supply during the comparatively short span of a lifetime, and the changing terrain conditions will require periodic revision of all maps, it seems that unless progressive steps are taken in the direction of high speed precision mapping, the next century will arrive with the vulnerable coastal areas of these United States, still relatively unmapped. Maps are the basis of all planning, whether civil or military. The cost of mapping in proportion to the allowable time for such mapping must be correlated to the point where a greater amount of work can be completed with the least possible amount of expended effort and money. To further this development toward the balance in the Field Survey-Aerial Survey proportion, the following observation and procedures are set forth.

Field Surveys: Traverse, triangulation, and the level line are the bases of all map construction. However, the three types of surveying must be used in the proper places and in the most economic proportions. The terrain of the area to be mapped will dictate the methods to a great extent, but the methods or the combined application of the field-aerial proportion can do much toward making the field survey more effective and therefore more economical. If it were possible to double the area now being mapped, in proportion to a given amount of field control, it would release the field survey to greater spheres and therefore allow more field work to be accomplished than is possible with the present restrictions on personnel and budgets.

Aerial Surveys: The aerial survey or stereo-topographic map must be controlled in scale and elevation, by field surveys. The accuracy of the required survey is directly dependent on the ultimate use to which the completed mapping project will be adapted, and the range from damsite mapping to quadrangle mapping will normally require accuracies and methods of surveying from second order triangulation to fourth order traverse and levels.

The positions and/or elevations of objects on the ground that are identifiable on the aerial photograph are the essence of the control system for an aerial survey and are called by the identifying name of "Picture Points." These Picture Points, are the means of establishing scale and eliminating or correcting for the ever present tip and tilt factor in all mapping photographic flights. However, the

elevation and position of all points need not be known. Picture Points suitably located on the photograph for scale control, may not be in a position relative to the axis of the line of flight, to sufficiently control the tilt direction of the photograph. Therefore, additional Picture Points for tilt control, requiring elevations only, must be obtained. The differences in elevation of such points can be obtained by level observation or by trigonometric leveling with transit or theodolite.

Ground Reconnaissance for an Aerial Survey: It is the responsibility of the field reconnaissance party to establish the preliminary locations of survey stations in the control net of an area to be mapped. The horizontal control may be triangulation or traverse, or a combination of both. The primary consideration in a triangulation scheme is intervisibility between stations and the structure of the basic figures in the net. This generally necessitates flagging the location of a proposed station, and subsequent observations from the other two apexes of the triangle to determine whether the figure meets the requirements or specifications. If the position of any of the stations must be changed, it will require additional time and expense to relocate and complete the reconnaissance. The prerequisite of the plan is to locate the stations in positions relative to the aerial photograph so that the photograph or flight will be controlled in elevation, in the tip and tilt directions, and in scale. This can be accomplished by establishing the triangulation station at or near objects that can be readily identified on the aerial photograph. It can be facilitated by constant use of stereoscopic pairs of aerial photographs, during the reconnaissance.

Photo Reconnaissance for an Aerial Survey: The use of stereoscopic pairs of vertical aerial photographs, in reconnaissance work, has greatly expedited the field survey, but it is believed that the method explained herein will afford a much more precise and economic type of preliminary survey, than has been used up to the present. The method is of such a nature that it can be easily performed by any student of photogrammetry, and when properly applied, can eliminate the costly relocation of triangulation stations, intersection stations, etc. The "Photographic Reconnaissance Plot" employs the parallax principle of third dimensional viewing in the establishment of the sight lines.

It is a known fact that if two lines are drawn in such a way that a given amount of horizontal parallax is apparent, and if viewed stereoscopically, these lines will appear to float in space. When applied to a sight line, and superimposed onto two vertical aerial photographs viewed stereoscopically, the line in the spatial model simulates the position of the actual sight line on the ground. In the practical application, the operator is required to draw two straight lines on two separate pieces of some transparent material. These transparencies can be readily adjusted on the photos, while viewing them stereoscopically, so that one end of the line represents the set up position of the survey instrument, while the other can be moved to scan the photograph for feasible Picture Points or survey stations. By separating the portion of the line that is in the direction of the line of flight, it can be made to rise and fall at will. This procedure holds true when searching for points that lie within 60° of being perpendicular to the line of flight, but the use of a dotted line must be employed where the line of sight approximates the line of flight. However, this is rarely the case, as flight lines usually parallel the longer boundaries of the mapping area.

It is obvious that the use of any method that will allow the preliminary location of a field survey station, without the usual hill climbing and "trial by sight" rule, will greatly increase the amount of surveying that can be accomplished for a given amount of money, within a given length of time. In some instances, small scale photography may be required for triangulation layout, but the cost is minor, compared to that of a resurvey.

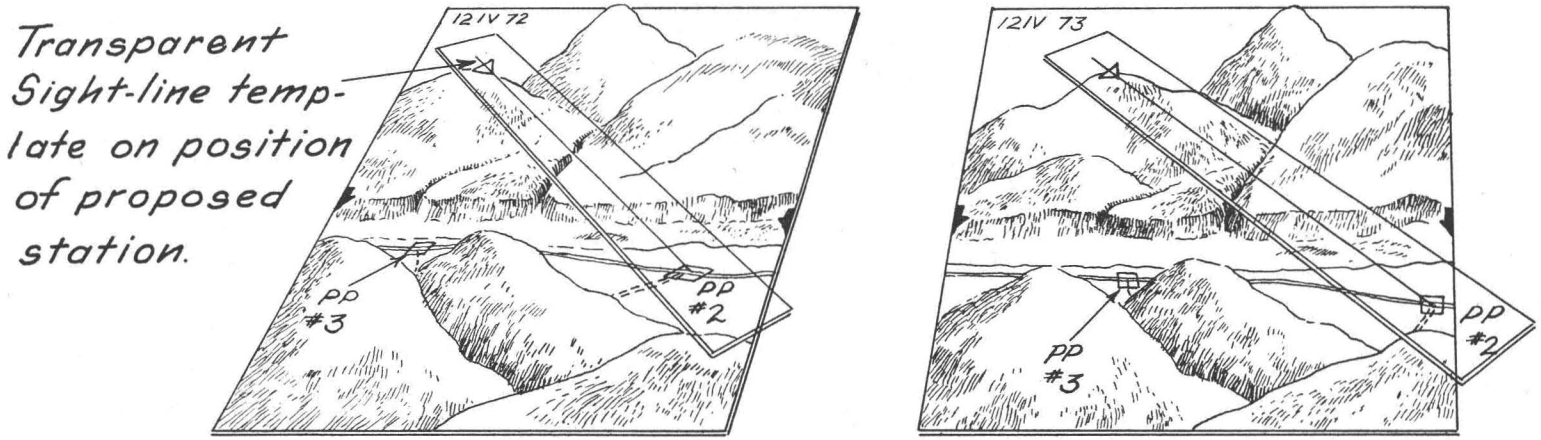

FIG. 1. Sight line templet over stereo-photos.

The horizontal parallax of an objective having a third dimension, when represented on a plane surface and viewed stereoscopically, causes the optical illusion of relief. Therefore, the sight line on a transparent templet will have the characteristics of an actual sight line on a third dimensional model of the earth's surface.

Traverse and Resection Station Combination: The theory of photo-reconnaissance is not applicable to triangulation only, as can be illustrated by a brief review of the proposed application to the task of mapping the Greys River Valley in Wyoming.

The general topography of the area is the typical western river valley with a steep walled canyon and deep cut gorges entering the main stream channel at frequent intervals. One shore of the river is traversed by a second class road that is the normal route for a level line and traverse to control the lateral dimension of the project. The hill slopes on the side of the river traversed by the road are free from brush and trees, but the other side, with the exception of scattered hill tops and slide areas, is heavily timbered. It is evident that triangulation through the valley is not feasible, due to the fact that numerous towers would be required to establish stations on the timbered side of the valley. The geological formation is such that intersection stations to control the outer edges of the photographs would be the only possibility, but the required two or three rays to establish the elevation of these stations is possible only in rare instances. The importance of these possibilities becomes increasingly greater as the relative distance between them increases, and the entire plan can change with the rejection of one or more such stations. It is therefore imperative that the entire plan of a survey be decidedly fixed before parties are sent to the field to accomplish the actual survey.

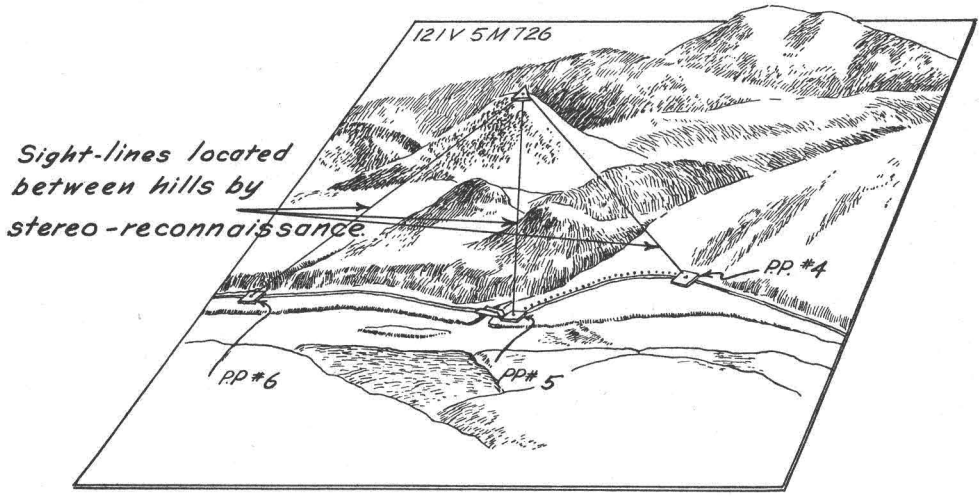

FIG. 2. Intersection method of photo-reconnaissance.

By the application of the sight line method of photographic reconnaissance, it can be determined whether or not the triangulation station on the hilltop can be viewed from three proposed traverse stations on the road. If the sight line is broken or comes in contact with any object in the stereoscopic model, the line must be adjusted to a new position.

Summary: 1. The determination of sight lines for triangulation by "Photo-Reconnaissance Plotting" will:

(a) Reduce the costly and time consuming field survey reconnaissance to a minimum.

(b) Allow office planning and inspection of the figures within a triangulation net, prior to the commencement of field work.

(c) Eliminate the relocation of stations, due to obscured vision, that may normally be determined only by preliminary occupation of the station.

(d) Permit higher accuracy in field cost estimates and allow a greater scope of field work to be done, for a given amount of money, within a given period of time. Mapping completion dates would be advanced, which would in turn advance the completion dates of pertinent reports.

In some cases it may prove necessary to obtain small scale photographic coverage, in order to plot triangulation on widely separated hills. However, the saving in planning and field work would more than offset the additional cost of photography.

2. The office location of a combination of traverse and intersections stations by "Stereo-Reconnaissance" will:

(a) Afford better dispersal and location of field control for mapping, and eliminate the continuous search for suitable intersection targets by the field parties.

(b) Insure the positive identification of Picture Points for tip and tilt control of mapping photography, to be used in stereoscopic plotting instruments. Field crews will not use valuable time in surveying Picture Points of relatively little value and will know exactly which points are definitely required for mapping.

(c) Familiarize Chiefs of Party with the location of field control points desired in an area to be mapped, before departure to the field, and definitely provide sight lines in the effective areas of station location.

(d) Serve as a guide in an effort to relieve the Party Chief from the field selection of the major portion of the required picture points.

NEWS NOTE

PHOTOGRAMMETRY FOR HIGHWAY LOCATION

The following is excerpted from an Aero Service Corporation news release of Oct. 20.

An $80,000 contract for 110 miles of aerial mapping for highway location in New York State was awarded by the Department of Public Works to Aero Service Corporation of Philadelphia, it was announced today. The Department chose the aerial method again, rather than ground surveys, because of the substantial savings in time and costs through aerial topographic mapping.

The contract calls for the Philadelphia company to map a strip one mile wide and 110 miles long, on route 17, from Middletown to Binghamton, New York. Aero Service will begin the aerial photography as soon as the leaves are off the trees. The Brock Camera, a glass plate, precision mapping camera will be used. It is particularly adapted to the rigid requirements of highway work.

The first maps will be delivered within 90 days after flying starts. The entire mapping job will be completed within nine months, as compared with several years required for this work by ground methods.

Aero Service will deliver 56 map sheets, each covering an area approximately one mile wide and two miles long. Five foot contours will be shown; the maps' scale will be 1 inch: 200 feet.