REPORT OF THE COMMITTEE ON PLOTTING INSTRUMENTS——AMERICAN SOCIETY OF PHOTOGRAMMETRY——JANUARY 1940*

THE developments in the field of stereoscopic plotting instruments during 1939 will be treated in two parts; the first, dealing with mapping work accomplished with plotting instruments and; the second, with improvements in design of such instruments.

This report is restricted to accomplishments not of a military nature.

Part I—Mapping Completed

The Aero Service Corporation announced its purchase during the year of photogrammetric equipment and other assets of Brock and Weymouth, Inc. One of the first mapping projects completed following this transfer was a quadrangle of sixty square miles on contract from the Tennessee Valley Authority. This map shows 5 and 10-foot contour lines at an original scale of 1:15,840 but will be reproduced at the scale of 1:24,000 as one of the series of topographic maps of the Tennessee Valley. The Brock equipment was used on other projects regarding which the Committee lacks definite information.

The American Geographical Society advises that its plotting instruments have been reconditioned during the year and will be engaged for some time to come in preparing maps resulting from the Cabot Expedition to the Sierra Nevada de Santa Marta of Colombia and of the Wood Yukon Expedition in Alaska.

The Brazos River Conservation and Reclamation District reports that its Multiplex instruments were employed during 1939 in mapping some 200 square miles on upper tributaries of the Brazos River for the purpose of facilitating the selection of sites of small dams constructed for the purpose of developing water supplies for municipal and ranch purposes. These maps were drawn at a scale of 1:7,500 but later enlarged photographically to a scale of 1:4,800. It is stated that the capacities of these small reservoirs as determined from the Multiplex maps were generally within 4% of the volume determined by field surveys. The permissible tolerance in this case was 15%. The Multiplex instruments were employed also in studying aerial photographs stereoscopically in connection with land acquisition and geologic studies, reservoir clearance, removal of pipe lines, highways, cemeteries, and bridges from the reservoir area.

As a matter of interest it may be stated that the Brazos District has employed the Multiplex instrument in mapping approximately 2,900 square miles, using a 10-foot contour interval and a scale of 1:12,000. All Multiplex work on this program was completed prior to 1939.

Fairchild Aerial Surveys, Inc. reports the completion of a considerable amount of mapping with the Stereoplanigraph, the scales ranging from 1:480 to 1:31,680. The operation of this instrument with gradually increasing efficiency throughout the year raised production to a monthly output of 400 square miles. Most of the maps completed showed 40-foot contours at an original scale of 1:15,840 of a rather mountainous area. In areas of low relief the production was 250 square miles per month in a region requiring 20-foot contour lines. This production rate was attained by three operators and three assistants working on a basis of a 22 hour day and a 25 day month.

Development of the Fairchild planimetric plotter was completed during

* Presented at the Annual Meeting for the Committee by its Chairman, T. P. Pendleton. Members of the Committee: R. K. Bean, L. H. Caldwell, L. T. Eliel, R. H. Field, C. W. Keuffel, D. W. Mann, O. M. Miller, W. B. Rayton, E. A. Shuster, Jr., and B. B. Talley.

the year and 1,400 square miles mapped with it at a scale of 1:4,800. These maps showed roads, railroads, and drainage lines, the horizontal control for which was prepared by the slotted template method. The original drawings were accomplished at a scale of 1:14,400 and later enlarged photographically to a scale of 1:4,800. It is reported that the instrument works satisfactorily except in those cases where tilts of unusual degree are encountered. To overcome this handicap a simple technique was developed for the purpose of rectifying these tilts and thus bring the map to an acceptable degree of accuracy.

The Geological Survey work with plotting instruments of the Aerocartograph and Multiplex types was continued with considerable success. Recent work with the Aerocartograph, not all of which was accomplished during the calendar year of 1939 however, was largely confined to topographic mapping in the Hightown, Virginia, Quadrangle, utilizing both vertical and oblique photographs of the T-3A type and in preparing planimetric maps of areas in Massachusetts and Rhode Island, using 9×9 inch photographs that were made with a camera having a principal distance of 167 millimeters. The latter photographs were adapted for planimetric mapping with the Aerocartograph by reducing them to a degree permitting their use in the plate carriers of this instrument. The results of this experimental work indicate that this instrument may be employed advantageously in the future in supplying base maps for use by plane table topographers in lieu of base maps made by the radial line or similar methods.

The Aerocartograph also mapped an area of 170 square miles in Montana for the Geologic Branch, Geological Survey, using photographs made with a Hugershoff camera of 135 millimeters focal length. This map was plotted at a scale of 1:15,840 and 50-foot contours were shown.

Photogrammetric methods were used in Alaska in completing 1,375 square miles of topographic maps at scales of 1:96,000 and 1:180,000 showing 200-foot contour lines, the work being accomplished with the Wilson Photo Alidade, an instrument described to the Society several years ago by Mr. R. M. Wilson, U. S. Geological Survey, its designer. Aerial photographs used in this work were obtained with a camera of 8¼ inch focal length.

In addition to the above work a project of photographic compilation was started covering an area of approximately 5,000 square miles in the Tanana Valley, Alaska. The photographs for this project were taken by the Geological Survey during the summer of 1938. The camera used was the Geological Survey's T-2 four lens camera. The picture scale is approximately 1:30,000 and the publication scale of the compilation will probably be 1:250,000.

The Multiplex work of the Geological Survey was confined to areas in the Tennessee Valley, being a continuance of the co-operative topographic project with the Tennessee Valley Authority which was undertaken in 1936. The gradual perfection of the equipment, the use of the wide-angle camera, and the effect of increasing the number of operators from fifteen to thirty have had a marked effect on the yearly production. The new men were employed about the first of the year but were restricted to purely training work for the first six months of their experience. Since July 1 they have been on actual production and are now reaching a degree of skill such that their contributions to the monthly output of work is quite marked. An output in January 1939 of 168 square miles was gradually increased during the year until a maximum of 326 square miles per month was obtained. The total output of work for the year was 3,484 square miles of which 16% was 1:10,000 scale planimetric maps and the balance 1:10,000 and 1:15,840 scale topographic maps. The program for work during

the next fiscal year contemplates a small amount of Multiplex work with 5 and 10-foot contour lines.

PART II—IMPROVEMENTS IN INSTRUMENT DESIGN

The Geological Survey was active in the preparation of specifications for additional Multiplex equipment and the solution of operation problems incidental to the use of wide-angle lenses of the Topogon type. The method being employed at present to compensate for distortion in this type of camera lens has been mentioned in a paper read before this meeting of the Society by Mr. R. K. Bean. This procedure need not be elaborated on other than to state that this method of compensating for lens distortion will be employed only until such time as it may be possible to eliminate or greatly reduce the resulting elevation errors in a manner permitting direct measurements of elevation to be made.

Several years experience with the wide-angle Multiplex equipment by the Geological Survey has pointed to the desirability of incorporating certain changes in the design of this equipment to improve its performance. No attempt to describe these changes fully will be made at this time but it may be of interest to list briefly the more important ones.

The Multiplex printer and the vertical projectors have been changed in design so that they will have a reasonable expectancy of a long life of usefulness. To accomplish this the specifications have been drawn in such manner that gradual improvements can be accomplished in the performance of the equipment by relatively simple and inexpensive changes in the projection lens of the Multiplex printer. For the same reasons the Multiplex projectors and the printer will accommodate circular photographs made with lenses of focal lengths varying from 98 to 135 millimeters and having a field of view not exceeding 93°. Naturally the projectors will also accept either square or rectangular photographs made with aerial cameras of any focal length whose field does not exceed 93°.

Radical changes have been specified for the method of supporting the diapositive plate both in the vertical projectors and in the Multiplex printer. The glass stage plate now used in the projectors has been entirely eliminated, because they accumulate scratches in time and the dust collecting on their lower sides is very difficult to remove. The particular purpose served by this plate in the instruments now in use is to indicate the position of the principal point of the vertical projector. Its elimination naturally requires that some other method of indicating the position of this point be employed. The solution suggested in the new design is the use of a three-legged observing microscope properly centered in the projectors by means of a conical hole, slot and plane support which can be adjusted during the calibration of the instrument in such manner as to bring the cross-hairs of the microscope into coincidence with the principal point of the projector. After this support has been properly adjusted with respect to the projector lens the inner orientation can be accomplished by special cams which will move the diapositive until its principal point coincides with the cross-hairs of the properly positioned centering microscope. This method of securing the inner-orientation makes possible centering of the plates prior to the time that the projector is put in position on the Multiplex supporting bar, and being accomplished with a magnification not less than twelve diameters, it is believed that it will be somewhat more precise than the method now in use.

The diapositive plates will be supported in the projectors and in the Multiplex printer by four bosses located in each instrument in corresponding positions.

The plates will be held in contact with the bosses by means of four springs which will apply their pressure immediately above the four bosses. Serious elevation errors due to the use of warped plates, or uneven emulsion surfaces, could be avoided by using this method of support providing there was an equality of corresponding angles in the printer and projectors. This equality of angles not being obtainable at present, the errors must be minimized by giving special attention to the selection of the diapositive glass and the uniformity of emulsion thickness.

The size of the diapositive plates will be increased from 45×60 millimeters to 64×64 millimeters and plate glass rather than ordinary glass used to avoid the serious errors that result from lack of planeness of the glass support. The adoption of these larger plates should result in a material improvement in the quality of the plastic model as the magnification of the diapositive plates will be reduced from 17 to 12 diameters.

Other changes in the Multiplex projectors and tracing table are largely of a mechanical nature and have been specified with the idea of removing the minor defects of the present equipment. These changes are too numerous to mention in this report.

The design of the Multiplex printer is radically different from the design of the printers now in use both in regard to the type of lens employed and in the construction of the printer itself. The new printers will accommodate film widths from 19 to 30 centimeters and will be of decidedly heavier construction to assure their holding their calibration exactly. To avoid the delay and reduce the expense of resetting the printer lens to the exact position required by every aerial camera lens that may be employed, the new printers will be quipped with a lens and diapositive plate support controlled by micrometer movements through a limited range. The main effect of this will be to accelerate the original printer calibration and make possible ready recovery of these settings should it be necessary to employ the same aerial camera at a later time.

The printers will be equipped with lenses having distortion aberrations of such degree as to compensate in so far as may be possible for the distortion inherent in the wide-angle aerial camera lenses now in use. If it were possible to do this perfectly the effect on the projected model would be such that it could be considered as being distortion free. This is an ideal that can hardly be accomplished satisfactorily at the first attempt but experience acquired in this direction should be helpful in securing more perfect compensation in the future. The printer has been designed in such manner that the benefit of aerial camera or Multiplex printer lens improvements can be readily secured by substituting printer lenses of proper design for the ones which are outmoded.

MEMBERS, look in your wallet to see if your membership card in the American Society of Photogrammetry for 1940 is there. If not, please forward your check to the Secretary-Treasurer, Box 18, Benjamin Franklin Station, Washington, D. C., immediately. Your support is needed to carry on the work of the Society.