

In using modern photogrammetric equipment and methods, junior engineers have excellent opportunities for training in efficient and effective surveying and design procedures and methods. This training is given in cooperation with the fully equipped electronic section, now part of the design section, and is supplemented by a complete program in all phases of highway location and design.

With approximately 400 mi of highway surveys completed by aerial methods, Region 9 personnel are aware of the numerous benefits obtainable from aerial surveys, including reduced survey costs, more complete and accurate data for design, and achievement of better highway locations for the construction funds available.

MICHIGAN STATE HIGHWAY DEPARTMENT PHOTOGRAMMETRIC ACTIVITIES

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The evolution of aerial surveying and photogrammetry within the Michigan State Highway Department has progressed at a slow steady, and fruitful pace throughout the past 10 yr.

In 1951 a Photogrammetric Section was established by the Department as a section of the Route Location Division. Early in 1961, the Photogrammetry Section was transferred to the Design and Survey Division.

Photography

The Department maintains up-to-date files of aerial photography covering the entire State. This photography was purchased from the U. S. Department of Agriculture and is at scales of 1:20,000 and 1:15,840. This coverage is used for area reconnaissance surveys and for preliminary route location purposes. The Soils Division also uses this photography quite extensively in photographic interpretation search for possible borrow pits. In addition, many miles of special photography has been obtained for specific purposes.

Photography for photographic mosaics to be used in route location studies and for photogrammetrically compiling large-scale maps for highway design is obtained from commercial firms on a negotiated contract basis. Each project flown and photographed is rigidly inspected and all photography is thoroughly checked for compliance with specifications based on those prepared by the Photogrammetry for Highways Committee, jointly sponsored by The American Society of Photogrammetry and The American Congress on Surveying and Mapping.

Photography flown for reconnaissance survey and photographic mosaic preparation purposes is generally accomplished with either an 8 $\frac{1}{4}$ - or a 12-in. focal length cartographic camera at a scale of 800 ft to 1 in. All photography for design mapping purposes is obtained with a 6-in. focal length precision cartographic camera equipped with distortion-free lens, at scales of 250, 330, or 500 ft to 1 in., depending on type and nature of highway improvement for which a survey is required.

Michigan's weather is an important factor to be considered when planning aerial photography for the design-mapping program. In the lower peninsula, fall is not well suited to aerial photography for design mapping even though leaves are gone from the deciduous trees, because weeds, grass and corn present a problem by obscuring the ground. Spring is the ideal period for taking aerial photographs. Snow generally disappears in late April and trees are again in full bloom in late May. About 30 days are, therefore, available in which to accomplish all large-scale mapping photography, and of these, perhaps only 5 to 6 days present suitable aerial photography conditions.

Personnel and Equipment

The Photogrammetry Section is composed of a supervisor, an assistant who acts as ground control and compilation supervisor, two stereo-plotter operators, one operator trainee, three draftsmen and scribes, and one draftsman trainee.

The Department has two 5:1 projection ratio Kelsh stereoscopic plotters and a Santoni Stereo-Simplex Model III. If future programs warrant, a Benson-Lehner Terrain Data Translator and a second Santoni Stereo-Simplex Model III will be added.

Ground Control

All ground control is obtained by State forces. Each highway survey mapping project is targeted before photography. Two methods of placing targets on horizontal control points are used:

1. If time permits, the proposed centerline is staked on the ground and targets are set exactly on centerline at an interval of 800 ft for photography of 500 ft to 1-in. scale and at 400 ft for photography of 330 ft to 1-in. scale. Stationing of target points is obtained and coordinates computed for these points, along with P.O. T's, PC's, PI's and PT's. The elevation of at least five vertical control points is obtained per stereoscopic model.

2. To take advantage of good flying weather before survey parties can be assigned to the survey projects for centerline staking, an aerial photographic mosaic on which the proposed centerline has been delineated is used. Targets are set as near as can be ascertained to the proposed centerline. Later, field survey parties will make right-angle ties from the staked centerline to the targeted points.

Yellow oilcloth, cut into strips 9 in. wide and 8 ft long, is used for targets. Targets are anchored to the ground by No. 9 soft wire bent into the form of a croquet wicket. Ten wickets per target are used. After a survey project has been flown and photographed, the targets are retrieved to be used on another job.

Usually no attempt is made to target urban projects, as there is always finite detail which can be used for control points. All plane coordinate computations are done by electronic computers.

Research

Two research projects are planned in use of color photography for soils investigations. Research is also being initiated into the feasibility of constructing scale relief models of interchanges and other troublesome areas for design purposes and for presentation at meetings.

Photogrammetrically Compiled Cross-Sections

Comparison between field measured and photogrammetrically measured cross-sections has been completed on a 6-mi project. Results and conclusions have not been finalized. Preliminary comparison, however, indicates about a 2.5 percent differential.

Design Mapping

Topographic maps are compiled for design purposes at a scale of 100 ft to 1 in. with contours on a 2-ft interval in rural areas, and at a scale of 40 ft to 1 in. with contours on a 1-ft interval in congested land-use areas. In urban areas, planimetric maps are compiled and used extensively at a scale of 40 ft to 1 in. Planimetric maps are checked and annotated by survey parties in the field.

Between the spring of 1958 and 1961 the Photogrammetric Section contracted for, compiled, checked, and transmitted to our Design Division approximately 600 lineal mi of mapping for highway design.