

could supply the necessary professional recruits. During the next several years, while such courses are being established, the civil engineer departments should continue the present or improved courses in photogrammetry and the other fields. However, as soon as such degrees are given by an appreciable number of schools, the mapping course offered in engineering should be gradually modified to meet the needs of engineers and other professional personnel, such as geologists, foresters, petroleum engineers, land planners etc., who need to develop a comprehension of the capabilities of the principal methods of collecting, evaluating and presenting data regarding the earth's surface, and who may need to be familiar with certain photogrammetric techniques needed in their particular speciality.

Chairman McNair: Next, for training in photogrammetry as applicable to highway engineering, we will hear from Mr. Spelman, Division Engineer of the Bureau of Public Roads at Arlington, Virginia. He has been particularly active in this field and especially connected with obtaining personnel and the related problems. He knows the type of training required for highway work, not only in the Public Roads Administration, but also with various State highway departments and other highway groups.

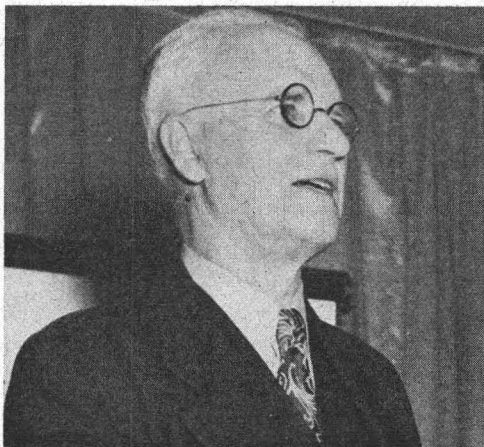
TRAINING IN PHOTOGRAMMETRY FOR HIGHWAY ENGINEERING

H. J. Spelman, Division Engineer, Bureau of Public Roads

IN HIGHWAY engineering, photogrammetry is useful for route selection and for locating sources of construction materials, principally sand, gravel and stone.

In locating sources of materials we are in the field of the geologist and use photogrammetry qualitatively. In route selection we use it quantitatively to determine grades, alignment and cross section, and qualitatively to adjust the location to land use, and to the nature of the land. For example, we may select a location so as to avoid swamps, landslide areas, or similarly bad country, and likewise so as to obviate cutting a fine farm in two, or to avoid great property destruction in an urban area.

Graduates coming to highway work as Junior Engineers should have had some training in photogrammetry. They need knowledge of and training in the use of aerial photographs in reconnaissance of area, reconnaissance of line, in preliminary surveys for the establishment of the



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location of a highway, and in identification of soils and physical objects from aerial photographs.

It is a problem for you gentlemen from the colleges to determine how much

you can add to your present heavy curriculum. As a start, I believe that some work in photogrammetry should be a required course for Civil Engineers.

It is essential in my opinion that the young graduate have a thorough training in surveying and the use of surveying tools by ground methods. Further, I believe, that for highway engineering he must have had courses in route surveying. A course in route surveying today is not up to date unless it covers the use of aerial photographs, and the stereoscopic examination of pairs of photographs in the reconnaissance stages. To use these photographs intelligently, the student must know something of how they are made, how they may be put together, and what errors they are likely to have. He must also know the underlying principles of the camera and the stereoscope.

You in the colleges can not be expected to turn out skilled photogrammetrists, any more than you were expected in the old days to turn out skilled locating engineers. You did give your students training in the theory and methods of using surveying tools and some knowledge of the various stages of route surveying. You now have a new tool in aerial photographs, and the student needs similar instruction.

The colleges should give training in the underlying theory, and just enough training in practice, so that the student understands the uses to be made of the theory. With that background, he can quickly develop the skills in the practice, under supervision, which he will be given when he first takes a job.

Some training in identification of soils and objects from aerial photographs is necessary before they can be used in route location, and that much training is desirable for the Civil Engineer today.

Outlined below are the things about Photogrammetry that the young engineer ought to know:

(1) He should know the theory and use of the stereoscope, and something of the various photogrammetric instruments now in use, and what they are used for.

(2) He should know the types of aerial photographs and their geometry, that all photographs are a perspective view, why fiducial or reference marks are placed upon them; what the principal point is, how it is located and what it is used for; likewise the principal line and principal plane of a photograph; what the nadir or plumb point and isocenter are, and how they can be located. He should know how to determine the amount and direction of tilt in vertical photographs and the amount of obliquity in oblique photographs. He should also know the causes of displacement of images on an aerial photograph, and how to handle the displacements caused by relief and tilt.

(3) He should have some training in stereoscopy. This of course can be given only to those who have two good eyes, or eyes that can be made to see equally well with glasses. He should be familiar with parallax, and know how to determine parallax on a pair of photographs, and how to compute differences in elevation by the use of parallax measurements, both of the approximate and of the precise character. Approximate methods are used in reconnaissance, and precise methods are used in large scale mapping with small contour intervals. He should also know how to determine difference in elevation from the amount of displacement of an image point determined by a radial plot.

(4) He should know how to prepare uncontrolled mosaics. For this, he needs to know how to maintain a flight line for a strip of vertical photographs; how to adjust that strip to scale so that the scale will correspond with adjacent strips. He should know something of the use of mosaics in the solution of location problems.

(5) He should have knowledge of the principles of a radial plot, and its use for making controlled mosaics and for topographic or planimetric mapping. He should be able to make the ground control surveys essential to establishing points for control of the plot. He should of course be familiar with plotting coordinates of the plane type, at least.

(6) It is desirable that he have some initial training in interpretation of photographs.

(7) He should have knowledge of oblique photographs for use in reconnaissance methods and for illustrative purposes to show before and after conditions.

(8) He should know something of the stereophotogrammetric instruments and their use.

In conclusion, confirming our Moderator's opening remarks, I do not believe that the cost of equipment should deter any college from teaching the use of photogrammetry in route survey and aerial identification. The basic training requires little more than some stereoscopes and some aerial photographs; and the latter if marked only with a soft wax pencil may be used over and over again.

Chairman McNair: We will now hear the last talk.

We sometimes have a tendency to call the kettle black, or should we say adopt a holier than thou attitude. Photogrammetrists, in general, I think, resent the feeling of other engineers that photogrammetry is more a technicality or work for technicians than what they prefer to call strictly engineering. But I think the photogrammetrists also have a tendency to think of the pilot and the photographer as a somewhat sub-professional group.

I want to introduce Mr. J. R. Coltharp, President of the Southwestern Aerial Surveys, who has had a very wide experience in engineering, particularly in the photographic and piloting end of the business. He has a bachelor's and a master's degree with a major in photogrammetry, from the University of Texas, ten years' experience as a pilot and ten years' additional experience as a photographer; and a professional engineer's rating or license. Mr. Coltharp has done a great deal of work in training personnel in both photography and the piloting business.

Mr. Coltharp will tell us something about the requirements for training for photographers and pilots as far as commercial mapping is concerned.