job in using aerial photographs for highway location and design work.

Certificates Awarded

Thirty-eight students have been graduated from the "Short Course in Photogrammetry." Eighteen from the first school conducted in 1951, and twenty from the second school. Thirty-five were employees of the Mississippi State Highway Department, one from the State Forestry Department and two from the Arkansas Highway Department. It is planned to give other States the opportunity of sending students to schools to be held at future dates.

At the conclusion of both schools each student was awarded a certificate stating he had satisfactorily completed the Short Course of Study in Photogrammetric Engineering. The certificates were signed by the three Commissioners of the State Highway Department, the Director, the Chief Engineer and the Instructor and bore the State Highway Department Seal.

A DISCUSSION OF "A TRAINING COURSE IN PHOTOGRAMMETRY," by W. J. Crecink, Jr.

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IN-SERVICE training courses in photogrammetry for highway engineers are not only advisable; they are essential. To my knowledge, no college or university in the United States, or in other countries, has on its curriculum a course in photogrammetry specifically for highway engineers. Until this is done and graduating engineers possess the education and practical training in photogrammetry necessary for highway engineering purposes, it will be the task and responsibility of each highway department to conduct schools and provide such education and training for its new engineer employees as well as for its present staff of engineers.

It is not desirable, nor is it fully practicable, to employ photogrammetrists per se and expect them to be productive immediately in a highway engineering department. Before their photogrammetric knowledge and experience could be properly applied in the highway engineering field, it would first be necessary for them to learn the principles of highway engineering and to obtain practical experience in highway location, design and construction. Moreover, there are only a limited number of photogrammetrists who could be so engaged, too few to fill the needs of all highway departments.

Highway engineering has been broadened so greatly that each highway department has a staff of specialists, each particularly adept in a certain phase of highway engineering; together these specialists form a team which now does the engineering essential to providing us with modern highways.

The highway engineers of today are confronted with an especially large number of complex, inter-related, inter-dependent problems that have to be solved cooperatively to provide safe, convenient, comfortable and serviceable highways for modern day motor vehicles of passenger automobiles, trucks, and buses. The problems are being multiplied daily by the rapid manner in which the number of those vehicles, of all kinds, is increasing. As more and more people travel by motor vehicle, highway engineers cannot cope with the rapid increase in complex highway engineering problems without first obtaining sufficient information of the kind and amount as needed about topography and land-use. Otherwise, the team of specialists on the many cooperating highway engineering staffs, who contribute to the planning and location, design, construction and maintenance of the vast system of highways throughout the United States (also in other countries), can not work effectively or efficiently to attain the goal —the best highways and services possible for the funds available.

It has often been stated that photogrammetry is the modern means of reliably obtaining a large portion of the information and data required by highway engineers which must be in the form of topographic maps (dimensions of the topog-

raphy and land-use) and of records and knowledge about the controls of highway location which go beyond form, extent and position and include kind or type, prevalence or number, quantity, condition, quality and value. Also it is a means of enabling them to use such information in the solution of their problems. Hence it can be repeated that highway engineers must learn the principles of photogrammetry to make full use of this modern method of obtaining and using the required information when needed in each of their specialties.

In his paper, Mr. Crecink ably mentioned many of the advantages of photogrammetry and reported on the progressive work of the Mississippi Highway Department, it being one of the pioneers to initiate an in-service training program for its engineers where they can properly learn about the principles of photogrammetry and its uses and how to apply them in their highway engineering work.

He overlooked one important advantage however, and perhaps the most important. Wherever comparisons have been possible, results obtained by the engineer who made use of photogrammetric methods in the location and design of a highway were better than those obtained by ground survey methods between the same terminal points; that is, a better highway route was attained, which would provide a better traffic facility at lower construction and maintenance cost. This is especially true in regions where the topography, land-use or both are such that the highway location and design problems are difficult and complex. It is not in the time-and-money lesser cost of the survey alone that photogrammetric methods have their greatest advantage (as many people believe), but it is in the better results the methods make possible when properly and fully used by highway engineers.

In the past there has been reluctance by many highway engineers to accept as practicable and adopt the new photogrammetric methods. Apparently much of this reluctance is caused by their fear of the unknown or an uncertainty of what they can accomplish by use of the new methods; hence, the need for in-service training in the application of photogrammetry to the solution of highway engineering problems within each State highway department.

Unfortunately there are only a limited number of engineers qualified to provide such training. Whenever a highway department does not have such an engineer on its staff, or one cannot be made available for instruction purposes, the progressive highway department should take advantage of courses like the ones taught by Mr. Brown and described by Mr. Crecink. They can do this by sending key engineers to obtain the essential know-how. Then they, in turn, can teach others within their department.

During the past several years, I have had the opportunity to conduct and serve as the instructor of five in-service training courses in the application of photogrammetry and aerial surveys for highway engineering purposes. Each school for the courses was cooperatively sponsored by the State highway department and the Division of the Bureau of Public Roads in which the State lies.

The first of such courses was at Denver, Colorado, in July 1950. Thirty-six highway engineers attended and thirty-one completed the course—eighteen from the Colorado State Highway Department, nine from the Bureau of Public Roads and four from the New Mexico State Highway Department.

The second course was given in April 1951 at Sacramento, California. Thirty-six engineers attended and thirty-five completed it—twenty-two from the California Division of Highways, one from the California Division of Water Resources, three from the Arizona State Highway Department and nine from the Bureau of Public Roads.

The third course was given in June 1952 at Raleigh, North Carolina. The school for this course had a third cooperative sponsor, the Civil Engineering Department of North Carolina State College. During the school Professor Charles R. McCullough of the College gave excellent lectures on the interpretation of soils by the examination of photographs. He also supervised the laboratory sessions where the engineer-students interpreted photographs for such purposes, and outlined drainage ways and areas affected by a route location. Mr. I. W. Brown gave one timely lecture on drainage, and the writer of this discussion gave the lectures on photogrammetry and its application and supervised laboratory sessions where the engineers solved highway route location problems. Thirty-five

engineers attended and thirty-two completed the course—twelve from the North Carolina State Highway and Public Works Commission, one from the Florida State Road Department, one from the Mississippi State Highway Department, two from the Alabama State Highway Department, two from the Tennessee Department of Highways and Public Works, two from the Georgia State Highway Department, and twelve from the Bureau of Public Roads.

The fourth course was given in November 1952 at St. Paul, Minnesota. Forty-six engineers attended and thirty-eight completed the course—twenty-one from the Minnesota Department of Highways, two from the North Dakota State Highway Department, two from the U. S. Forest Service, four engineers visiting from Turkey who were here to study our highways and obtain highway engineering training, and nine from the Bureau of Public Roads.

The fifth course was given in December 1952 at Madison, Wisconsin. Forty-two engineers attended; thirty-nine completed the course—thirty-three from the Wisconsin State Highway Commission, three from the U. S. Forest Service, and three from the Bureau of Public Roads.

The first two courses were of two weeks duration, the third one at North Carolina only one week, and the last two were two and one-half weeks. The first week was devoted to lectures and demonstrations and the second week, or week and one-half, to laboratory work in which the engineers, by use of available maps and photographs and application of the principles and procedures outlined in the lecture periods, solved highway route location and other problems. There was not as much time available for these courses as desired. The lack of sufficient time was caused by the fact that the highway departments could not allow a large number of key engineers to be away from their work for more than about two weeks.

In general the engineers selected by their respective departments to take these courses were engineers whose assigned work would make possible their applying photogrammetric and aerial survey methods in their engineering work and who would also train others while so doing. Mostly, the engineers who attended were those who were charged with the responsibility of highway planning, location, design, construction, and soil and other surveys; also administrative engineers who were desirous of obtaining enough information about photogrammetry to be able to properly evaluate specifications and to plan for such work as needed.

Essentially the courses included lectures on the following: The history of photogrammetry and aerial surveying; the types of aerial photographs and their geometry; the principles of stereoscopy, photographic mosaics, radial line plot, the identification of photographic images and the interpretation of aerial photographs; stereophotogrammetric instruments—their principles, uses and accuracies; the uses and procedures of photogrammetry in each stage of highway location, using where applicable each type of aerial photograph, the verticals, obliques and continuous strip.

It can be noted that Mr. Crecink did not indicate the particular stage of highway engineering in which the methods taught at the Mississippi school are most applicable. It has been my experience that it is highly essential that each highway engineer be fully oriented in the proper use of photogrammetry in each of the various stages of highway engineering. If this is not done, some engineers will endeavor to make an area reconnaissance by use of extremely large scale photographs, which, of course, will increase the cost of the work in terms of both time and money; whereas a few small scale photographs would be adequate and cost less to use. Others will expect to obtain for preliminary survey of a highway route large scale information and make large scale maps with contours at small intervals from extremely small scale photographs. Likewise, most highway engineers need considerable schooling on the possibilities and limitations of photogrammetric instruments in each of the stages of highway engineering, otherwise they will expect a contour finder or a stereocomparagraph to serve them in the preliminary survey stage when they should be making use of precise instruments like the Kelsh Stereoscopic Plotter, the Stereoplanigraph, Multiplex and Wild Autograph, either in their office or by contract. Others will be planning to use the precise stereophotogrammetric instruments for the stereoscopic examination and interpretation of photographs for reconnaissance purposes, although the ordinary stereo-

scope and a parallax measuring device would suffice.

Incidentally, Mr. Brown attended the course at North Carolina where many of the photogrammetric principles he has incorporated into his second course were given. Those principles and procedures were given in all schools previous and subsequent to the one at North Carolina. It is indeed complimentary to the courses at the other schools that he has adopted the principles and procedures given in them; particularly the method of determining differences in elevation of the topography from pairs of photographs without ground control surveys. His entire school further emphasizes how well photogrammetry makes it easier and more advantageous for engineers and everyone concerned to cooperate for better results and more easily attained when photogrammetry is used by highway engineers.

In conclusion, it is obvious that there will be a continuing and growing demand by highway engineers for schools in photogrammetry. This is exemplified by the success of the two schools conducted by the Mississippi State Highway Department and by the fact that it is planning to conduct a third school in the near future. This State Highway Department can be complimented for its pioneering initiative and progressive work as well as for the fact that it is probably the first highway department to fully staff, plan and teach a course in photogrammetry for its highway engineers. It has used judicious judgment and foresight in establishing its policy of selecting young engineers to attend such a school, who have initiative and good eyesight along with their highway engineering training and experience.

To their success in Mississippi can be added the many complimentary remarks and the wholesome enthusiasm of the majority of the engineers who attended and completed courses at the five schools which I have had the pleasure of conducting across the nation.

Today we hear so much about chain reactions. In the field of applying photogrammetry and aerial surveying in the solution of highway engineering problems, chain reaction will be rapid and effective as more schools are conducted by qualified engineers.

NEWS NOTE

Electronic "Giant Brain" Has Memory Improved

A new memory for the ENIAC (Electronic Numerical Integrator and Computer), first electronic "giant brain," was demonstrated early in July to Army Ordnance officials at the Philadelphia Research Center of Burroughs Corporation (formerly Burroughs Adding Machine Company).

The new static magnetic memory is the first memory device of its type ever designed and constructed. Using new magnetic techniques, it is one of the fastest in existence today.

Access to information is at the rate of 50,000 "words" per second—a word is a ten decimal digit number, for example, 9,378,462,571. The high rate of reading and storing information is made possible by using a new type of magnetic core, specially designed by Burroughs, and used for the first time in this memory.

Constructed under a commission from the U. S. Army Ordnance Department, the Burroughs memory will increase and quicken the ENIAC's operation, to give it the flexibility and capacity needed to solve large-scale problems. ENIAC's memory capacity will be increased six times by the addition of the Burroughs unit to its original small internal memory. The ENIAC will now be able to "memorize" 120 words at any particular instant.

Now housed at the Army's Ballistics Research Laboratories, Aberdeen Proving Ground, Maryland, the ENIAC is used to compute shell trajectories, firing and bombing tables, the problems of air flow around revolving missiles traveling faster than sound, and of atomic fission. The Burroughs memory will enable the ENIAC to compute these problems in less time.