Report on Group Meeting on Aerial Photography and Photogrammetry Applications to Highway Work

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THIS group meeting was held on February 26, 1959, in the Illini Union Ballroom, University of Illinois. H. M. Karara, Assistant Professor of Civil Engineering at the University of Illinois, was chairman, and the following were the discussion leaders:

A. Brandenberger
Assoc. Prof. of Photogrammetry
Ohio State Univ.
Columbus, Ohio

H. L. Brantley
Chief, Aerial Surveys Branch
Illinois Div. of Highways
Springfield, Ill.

E. M. Raley
Asst. Chief Engineer
Photronix Inc.
Columbus, Ohio

N. Chryssafopoulos
Asst. Prof. of Civil Engineering
Univ. of Illinois
Urbana, Ill.

The following is a summary of the principal items which were discussed during the meeting.

Discussion of the first question, "*What is Photogrammetry, and what are its basic principles?*", was led by Prof. Brandenberger. The principal items discussed were as follows:

1. Aerial photogrammetry predominates over terrestrial photogrammetry in highway work.
2. Although rectified single-image photographs may sometimes be used, the bulk of the work is done using double-image photographs in special stereoscopic plotting instruments (automatic plotters).
3. Ground work is still required to establish control points, but much of this work is replaced by the technique of aerial triangulation.
4. Photogrammetric methods are about 40 per cent faster than the corresponding ground methods, and there is less possibility of having observational mistakes in photogrammetric procedures than there is in ground procedures.
5. The accuracy of a first-order stereoplotter in planimetry and height is about 1:7,000 of the flying height. The accuracy of a second-order stereoplotter in planimetry and height is about 1:3,000 of the flying height. The accuracy of an aerial triangulated strip is a function of many variables, the length of the strip being one of them.
6. For highway work, aerial triangulated strips of up to 10 models are recommended, although some strips may be as long as 20 models.
7. The slotted-templet method of aerial triangulation is a special case of the more general spatial triangulation procedure. It is 5 to 10 times less accurate than spatial triangulation in a first-order plotter and is restricted to planimetric triangulation.

Discussion of the second question, "*What are the main advantages of photogrammetry over classical methods of field mapping?*", was led by Mr. Brantley. The principal items discussed were as follows:

1. Medium-scale maps are used for studying general location of the route, while large-scale maps (200 ft. = 1 in., 5 ft. contours) are used for more detailed study.
2. For general route-location, photogrammetric means may cost as much as the classical means for getting data. However, the photogrammetric method provides a wealth of extra information for many other phases of the work.

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3. Information obtained by photogrammetric methods is generally more reliable, although perhaps not as precise, as that obtained by classical methods; that is, photogrammetric methods may have larger errors than classical methods, but they have fewer mistakes (blunders).
4. It is easier to obtain additional field information (e.g. cross-section data) by photogrammetry than by classical methods. Thus, photogrammetry is more adaptable than classical work for relocation.
5. Photogrammetric methods are faster than classical methods.
6. Photogrammetry could have its greatest application in work for interchanges and bridges sites rather than in the general alignment problem.
7. For the time being, accuracy should not be reduced for the sake of time and expense in photogrammetric work.

Discussion of the third question, "*What is the role of aerial photographs in the different phases of highway design, and how and to what extent can the highway design be mechanized?*", was led by Mr. Raley. The principal items discussed were as follows:

1. Photogrammetrically-determined quantities in highway work are generally 1 per cent to 2 per cent higher than field determined quantities. For this reason, many contractors prefer photogrammetrically-determined quantities over field-determined quantities.
2. In the past, photogrammetric work has been checked against field work. This practice is questionable, however, since many photogrammetric-techniques provide more accurate results than their corresponding ground-techniques. In general, the ground-survey standard is much lower than the photogrammetric-standard.
3. Photogrammetric methods provide a very economical, fast, and accurate means for gathering data.
4. The electronic computer is a valuable addition to photogrammetric methods. In order to have a good job done, however, a lot of thought must be put into organizing the work beforehand. Electronic computers are "high speed idiots" controlled by people who do the thinking.
5. We must use automation (photogrammetry plus electronic computation) in highway engineering to keep up with the automation in the automobile industry.
6. In reconnaissance, aerial photography plays an important part in refining the "10-mile corridor." It can be used for drainage analysis, soils interpretation, land use studies, and potential development studies. The electronic computer has little use in reconnaissance work.
7. In the more detailed route location where the horizontal alignment should be pinned down, large-scale maps (1 in. = 200 feet, 5 ft. contours) produced photogrammetrically are almost invaluable. They provide a means for answering a lot of design questions, and they may be used to calculate earthwork quantities to within 5 per cent of the final design quantities.
8. Photogrammetry combined with electronic computing has great use in the design phase of highway location. Accuracy is demanded in this phase, although no more accuracy than that necessary should be obtained. Superfluous accuracy costs too much.
9. Photo interpretation can be used to guide the soil exploration program in highway work. It does not eliminate drilling, however, as it gives only surface data.
10. Photogrammetry and electronic computation can provide accurate positioning of property corners. Photo mosaics with right-of-way boundaries and other property lines drawn on them provide excellent pictures of the highway right-of-way and adjacent property.
11. The earthwork estimate can be prepared quickly by photogrammetric-electronic computer means. Photogrammetry does the cross sectioning, and the computer analyzes the cross sections.
12. Photogrammetry and electronic computation are valuable tools in highway engineering work. However, they are only tools. They remove much of the drudgery from the engineer so that he may do actual *engineering* work.

Discussion of the fourth question, "*How can the geologic and soil studies be made by means of aerial photographs?*", was led by Professor Chryssofopoulos. The principal items discussed were as follows:

1. Soil is a very important part of the highway, since it forms the foundation upon which the road is built.

2. Aerial photographs can be used to determine what the parent material is. Various features visible in the photographic image can be used to interpret the nature of the material lying on the earth's surface.
3. Aerial photographs can be used to locate natural deposits or road-building materials, many of which are hidden from observation on the ground.
4. Aerial photographs can be used to locate sand dunes which move and so provide difficulties in highway construction and maintenance.
5. Color tone in aerial photography can be used to distinguish between moist and dry soils. This provides an indirect way of distinguishing course-grained soils from fine-grained soils.
6. Aerial photographic interpretation does not eliminate ground work, however; it supplements the ground work.

*Kodak Panchromatic Negative Films for Aerial Photography**

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ABSTRACT: *A review of the progress leading to the manufacture of the presently available aerial negative films is given.*

The results of investigations into the factors influencing aerial photography and a technological improvement in photographic emulsions have led to the introduction of improved aerial panchromatic negative films. The characteristics of these new films are indicated.

WORK on sensitized materials and equipment for aerial photography was started at the Eastman Kodak Company before World War I. During that war, improvements in the sensitivity of photographic materials were made so that, at the time of the Armistice, orthochromatic and panchromatic films, 9½ inches by 75 feet, were being manufactured (1). The most sensitive of these films, Eastman Panchromatic Aero Film, Hypersensitized, could be exposed at about 1/100 second, *f*/5.6, through a Kodak Wratten Filter No. 25. The K-1 camera was also designed at that time to use this film and is the granddaddy of the large-format automatic aerial cameras of today (2).

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Between the two World Wars, much progress was made in photographic science and technology so that, when the United States entered World War II, what is now called Kodak Super-XX Aerographic Film was available for both reconnaissance and mapping purposes. Also, Kodak Tri-X Aerographic Film, having twice the sensitivity of Super-XX, was made available for use in night photography or at other times of reduced illumination. Just prior to the war, advances made in cellulose chemistry provided a material of improved dimensional stability so that a safety

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