was largely due to the large amount of surveying and railroad construction in Canada carried on up to the 1920s."

(34) "Repeated coverage of University land, 5,000 acres, gives opportunity for ground checking any phase of the work. Course has evolved from one called Topographic Surveying given to the 4th year Foresters. It has built up slowly over a 6-7 year period. Emphasis on elements of mapping and interpretation, mainly forest and related.

"The University is in the process of shifting from 4 to 5 years base in Applied Science. Heavy Forestry postwar enrollment forces Engineers out of course temporarily. Plan to resume for Civils in Fall of 1950."

(35) "The photogrammetry option is open only to Civils, and comes in second term of final year. We expect that in any one year we will give EITHER the photogrammetry OR the geodesy and lab. option. We would expect about 10% of the class to elect this option."

(36) "Need for such a course is felt here. A course is being planned but no final choice has been made yet."

Chairman McNair: The next speaker needs no introduction to most of you. Professor Rayner, from the University of Illinois, is famous for his textbooks and for his writings. Many of you, doubtless, have studied surveying out of one of the Davis, Foote and Rayner textbooks or the Rayner texts. You probably also know that Professor Rayner is on the Executive Committee on Surveying and Mapping of the American Society of Civil Engineers.

INSTRUCTION IN PHOTOGRAMMETRY AT THE UNIVERSITY OF ILLINOIS

Professor W. H. Rayner, Civil Engineering Department, University of Illinois

THIS paper describes the courses of instruction in photogrammetry for civil engineers in the University of Illinois. Three courses are given: (1) six two-hour periods in the course in route surveying, required of all civil engineering students; (2) an elective course with three semester hours credit for undergraduate and graduate students; and (3) a graduate course as part of the requirements for the Master's degree in Civil Engineering.

W. H. RAYNER

THE REQUIRED COURSE

The six periods required of all civil engineering students are designed to acquaint them with the basic characteristics of vertical aerial photographs. The topics included are: definitions, perspective principles, scale of a photograph, image displacements caused by ground relief, computation of height of lens, true length of a line, the air base, and the radial-line method of establishing map control by the use of plain templets.

The materials used include con-

tact photographs for four flight strips across a TVA quadrangle map, with horizontal and vertical control data supplied, copies of the published map at a scale of 1/24,000, ordinary lens stereoscopes, and the usual drawing instruments.

The instruction is given in two-hour laboratory periods, and the problems and exercises include the following: (a) problems involving the relations between the scale of map, scale of photograph, focal length and height of lens; (b) determination of the scale of a photograph using images of points of the same elevation, and also points having different elevations; (c) computations of displacements due to ground elevations; (d) determination of the true length of a line between points of different elevation; (e) finding the heights of vertical objects; and (f) plotting the horizontal control for a planimetric map by the radial-line method, using plain templets.

The purpose of this instruction is to acquaint all civil engineering students with a few of the elementary characteristics of aerial photographs and to enable them to use such photographs on engineering projects, with some understanding of the conditions and limitations which apply to them.

THE ELECTIVE COURSE

This is a semester course with three hours credit designed to prepare civil engineering students to use aerial photographs effectively in the design and construction of engineering projects; also it serves as a basic course in photogrammetry for any students who may wish further training in this subject, or who may enter the government services where this method is used.

The text is Church and Quinn and the chapter on photogrammetry in *Advanced Surveying* by the author, supplemented by readings in other sources, especially the Society's MANUAL OF PHOTOGRAMMETRY.

The topics included are those mentioned above and (1) the use of metal templets for map control; (2) the drawing of a planimetric map by the use of a projector; (3) the finding of spot elevations by the use of (a) the engineer's scale, (b) the parallax bar, and (c) the stereocomparagraph or the contour finder; (4) the determination of displacements due to tilt; (5) drawing contours with the stereocomparagraph or contour finder; and (6) airphoto interpretation. Both problems and exercises utilize the materials mentioned, and each student keeps a notebook in which he writes a detailed report of the manner of solution of each exercise.

Readings on the subject of airphoto interpretation are assigned to inform the student of the many possible uses which the qualitative characteristics of aerial photographs may serve on engineering projects: such as the identification of soils and bedrocks, the location of foundation sites and materials for structures, the use of mosaics in route locations and land classification studies. The photographs also have an important use for the land surveyor, especially where the rectangular system of subdivision exists, in identifying obliterated property lines.

The registration in this course is usually 10 or 12 students, and the equipment includes a lens stereoscope for each student, 10 parallax bars, a metal triangulator, four sketchmasters, two stereocomparagraphs, and two contour finders.

The materials include the TVA photographs, mentioned above, which provide each student with photographs for one flight strip, also one copy of the published map. The vertical control provides one or more spot elevations for each photograph and the horizontal control provides coordinates of ground points sufficient for radial-line map control.

THE GRADUATE COURSE

This consists of a special problem selected by the student. For example, the problem chosen this last semester was the application of Mr. Wilson's method of finding the three space coordinates of objects in the overlap area of two oblique views taken at a relatively high altitude. The plane of reference is then taken as the horizontal plane through the lens where one of the photographs was made. The position of this plane is found by means of successive approximations from an assumed horizon line and from the known position of three ground stations. In this case, the student was interested in photography; beginning with a lens and shutter assembly, he designed his own camera, took his own pictures from a plane supplied by the university airport, and developed his own prints from which he was able to draw a topographic map of a portion of the local terrain.

The purpose of the problem was to demonstrate the practicability of the method for supplying, at small cost, valuable information that would be useful in the design of any engineering project.

AN EXPERIMENTAL FIELD

It has been stated that the photographs supplied by the TVA are contact prints from the original negatives, with at least one, and usually more than one elevation for each photograph. The horizontal control consists of state-wide plane coordinates of two or three points on those photographs which are separated about five exposure intervals on each line of flight. In addition, copies of the quadrangle map are provided. These are published at the scale of 1/24,000 and a contour interval of 20 ft., and for some of the exercises it is possible to scale from the map the positions and elevations of control stations. However these data are not sufficiently accurate for many exercises, and it is very desirable that some experimental tract having considerable relief, be established where many control points, both horizontal and vertical, are provided together with an accurate published map of the area. Such an area would be a most valuable aid for instructional use.

SUMMARY

It has been stated that this instruction is designed to prepare civil engineering students to make effective use of aerial photographs in connection with their engineering projects. It is not intended to prepare students for the various governmental agencies, although of course most of the subject matter is applicable to this work. Accordingly, very little attention is given to the elaborate photographic instruments and processes, or to the highly specialized mapping instruments, except to inform the students of the very great usefulness and economy of these methods for such projects as highways, canals, or transmission lines where the work is extensive and executed by professional photogrammetric organizations. This instruction however, should aid the engineer properly to scale dimensions from photographs in his study of such projects as highway and other route locations, bridges, buildings, dams, etc., and to construct fairly accurate planimetric maps of limited areas. He will also be able to construct mosaics, understand the scale characteristics and limitations of these compilations and furthermore he will be able to make proper use of aerial photographs for studies of soil characteristics, foundation conditions, road materials, timber and other resources.

This very briefly describes the modest beginnings we have made at the University of Illinois in our instruction in photogrammetry.

ELECTIVE COURSE IN PHOTOGRAMMETRY

University of Illinois

Texts: Church and Quinn. Elements of Aerial Photogrammetry.
Rayner, W. H. Advanced Surveying.
Assigned Readings.

Three Semester Hours

3-hour Periods	*Subject*
1	Simple scale and height-of-lens problems for flat ground.
1	Image displacement caused by ground relief. Problems—Exercise.
1	Find the scale of a photograph using the distance between points of different elevation. Exercises.
1	Find the true length of a line between points of different elevation. Exercise.
2	Radial-line plot for map control. Plain templets.
2	Radial-line plot for map control. Slotted templets.
2	Transfer details from photographs and draw a planimetric map using a sketchmaster or other projector.
1	Plot principal points of the photographs on the map.
1	Plot detail points on the map from the photographs.
1	Find the height of vertical objects, e.g., trees, towers, chimneys, buildings.
1	Quiz.
1	Derive the space-coordinate parallax equations.
1	Computations to verify the parallax equations.
1	Find elevations by the unit-change method. Problems.
1	Find elevations by the parallax-table method. Problems.
3	Exercises with the unit-change method. Engineer's scale, Parallax-bar, Contour Finder.
2	Exercises with the parallax-tables method. Engineer's scale, Stereocomparagraph.
1	Derivation of tilt formulas. Problems.
2	Find the tilt of assigned photographs.
1	Find the displacement of points due to tilt.
4	Airphoto Interpretation.
	Examination.
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Chairman McNair: Our next speaker is Professor Lawrence Perez from Pennsylvania State College. He has been teaching photogrammetry and photogrammetric techniques for several years. Rather recently Professor Perez compiled some information regarding the equipment necessary for teaching courses in photogrammetry at various levels of instruction. I think you may be a little surprised to learn the cost of some of the equipment and the need for it in this type of instruction.