

## EDUCATION IN PHOTOGRAMMETRY

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### FOREWORD

Photogrammetry is still in its development stage and is far from being used to its best advantage by many Hydrographic Offices of the States Members and non-Members of the Bureau. The degree of its use varies greatly between Offices and even an agreement as to the best means of solving the problem of providing accurately instructed and trained personnel to make greatest use of photogrammetry is not yet settled.

The following two short articles were submitted by representatives of the U. S. Hydrographic Office and the U. S. Coast and Geodetic Survey in response to the following questionnaire forwarded by the Publications Committee of the magazine *Photogrammetric Engineering* :—

1° What is your recommendation as to the amount and content of courses in photogrammetry that should be given in colleges to better fit graduates for photogrammetric work in your organization ?

2° In your opinion, should the colleges stress the fundamental theories of photogrammetry, leaving the practical applications to the organizations employing the students after their graduation, or should the college attempt to do both ?

3° Would you prefer to employ a college trained man having specific photogrammetric work, say in the operation of the multiplex or other stereophotogrammetric instruments, or one with considerable general knowledge of photogrammetry and allied surveying subjects ?

Those articles, two of the many received in response to the above questionnaire indicate in general the train of thought of these two important Hydrographic Offices who consider photogrammetry as an indispensable aid in the execution of Hydrographic Surveys.

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### I

#### **TRAINING IN PHOTOGRAMMETRY BY THE U. S. NAVY HYDROGRAPHIC OFFICE**

by Sidney SHERMAN, Photogrammetric Engineer.

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During the period from July 1946 to July 1947, approximately 75 persons were given instruction in photogrammetry at the Hydrographic Office. The extent of this training to individuals or groups varied from one week to twelve weeks' duration. Since the Photogrammetry Section with its small staff was constantly being called upon to give this instruction, often on short notice, it was recently found necessary to design a course in Photogrammetry, consisting of a series of lectures and exercises, primarily for the training of U. S. Navy and civil personnel connected with the Hydrographic Office. The course stresses the requirements and methods of mapping from aerial photographs as used by the Navy for the preparation of hydrographic charts.

The type of instruction given and the emphasis placed upon the various phases of the subject differ according to which of the following groups the trainee belongs: 1. Hydrographic survey officers; 2. Aircraft pilots and photographers; 3. Visitors from foreign countries;

4. Civilian employees. During the period July 1946 to July 1947 approximately 20 survey officers were given two to four weeks of instruction in photogrammetry with emphasis upon control requirements. One week courses were given to more than 30 Navy pilots and aerial photographers, stressing photography and flight specifications. Seven South American Naval officers were given complete instruction in photogrammetric mapping methods. Of these officers, four are from Argentina, two from Peru and one from Colombia. In addition to these officers, six Chinese Army officers were given training specifically in the operation of the K.E.K. Stereoscopic Plotter. Several civilian employees were also trained in the operation of stereoplotting instruments during this period.

It is not necessary for every person connected with aerial photography, surveying or map compilation to be an expert in all of the technical phases of the subject of photogrammetry. All of these persons, however, should have an understanding of the basic principles of the subject and of the particular rôle which he plays in obtaining the final map. In view of this an attempt is made to stress the relationship of aerial photography to surveying, and the importance of both in the process of map compilation.

Photogrammetry is primarily a study for application. The theoretical basis of the subject lies in the fields of physics and mathematics. Its recognition as a separate field of study is due to the numerous valuable practical uses which have been found for it in many fields including art, archeology, astronomy, agriculture, crime detection, surgery, census surveys, electronics, engineering, forestry, geography, geology, hydrography, photo intelligence, surveying and mapping. With a wider knowledge of the subject, undoubtedly more applications will be found in these and other fields. By far, the widest application of photogrammetry so far has been in the field of surveying and mapping, and it is with this application that this office is, at the present time, primarily concerned.

The rapid development of the airplane in recent decades has brought about a revolution in the science of surveying and mapping from photographs, but it also brought about many new problems to be solved. Better cameras, more sensitive photo materials, new instruments and procedures had to be invented and developed. Many of these developments have already come about. Many problems, however, remain to be solved and many of the solutions to these problems are now in the experimental stage; as, for example, the development of airborne equipment to obtain horizontal and vertical control on each mapping negative, the development of accurate camera stabilizing equipment, or, for example, the development of airborne means of determining underwater depths in shallow waters. Research on the part of the government, industry and colleges can make valuable contributions towards the solution of these problems.

The following is an outline of the material covered in the course in Photogrammetry given at the Hydrographic Office. If four weeks or less are available for instructions, only the material in Part I is covered. If more time is available, the subjects listed in Part II are also taken up. This course in general is meant for persons new to photogrammetry; however, from time to time more detailed training is given, for example, in the operation of a stereoplotting instrument, to persons already familiar with the basic principles of the subject.

## AN INTRODUCTORY COURSE IN PHOTOGRAMMETRY FOR MAPPING COURSE OUTLINE

### PART I. — LECTURES A-M

#### A. *Introduction and Scope of Course.*

B. *Maps and Charts.*—1. Definitions; 2. Types and Purposes; 3. Characteristics; 4. Scale; 5. Map Projections and Coordinate Systems; 6. Accuracy; 7. Conventional Signs and Symbols. Reading Material. Exercise 1 : Quiz.

C. *Topography. Elevation and Relief.*—1. Topography; 2. Elevation; 3. Relief; 4. Methods of Representing Relief : (a) Contours; (b) Hachures; (c) Shading; (d) Colour Gradients; (e) Form Lines; 5. Contours : (a) Definition; (b) Contour Interval; (c) Contours and Slope; (d) Characteristics of Contours; 6. Summary. Reading Material. Exercise 2a : Quiz. Exercise 2b : Problems in Contouring.

D. *Standards for Photogrammetric Compilation of Maps.*—1. The Development of Aerial Mapping; 2. The Status of the Topographic Mapping of the World; 3. Map Making Agencies; 4. Scales of Military Maps; 5. Source Material; 6. Theatre Areas; 7. Operational Index; 8. Sheet Numbering System; 9. Standard Specifications and a Sample 1 : 25 000 Manuscript Sheet. Reading Material. Exercise 3 : Quiz.

- E. *The Place of Aerial Photos in Surveying*.—1. Aerial Photos vs. the Planetable; 2. The Principles of Surveying; 3. Aerial Photos vs. The Topographic Map. Reading Material. Exercise 4 : Quiz.
- F. *Aerial Cameras and Accessories*.—1. Principle; 2. Types; 3. Aerial Camera Lenses; 4. Shutters; 5. Strip Camera; 6. Focal Plane; 7. Fiducial Marks; 8. Film Magazine; 9. Cameras in present-day Use; 10. Accessories: (a) Bubble Level; (b) View Finder; (c) Intervalometer; (d) Colour Filters; (e) Stop Watch; 11. Aircraft Camera Mounts. Reading Material. Exercise 5 : Quiz.
- G. *Aerial Photographs : Types, Filters, Film and Paper*.—1. Types : (a) Obliques; (b) Verticals; (c) Composite; (d) Trimetrogon; 2. Filters; 3. Characteristics of Photo Materials. General; 4. Film; 5. Paper. Reading Material. Exercise 6 : Quiz.
- H. *Aerial Photographs: Characteristics, Scale and Relief*.—1. General; 2. Scale; 3. Displacement due to Relief. Reading Material. Exercise 7 : Problems.
- I. *Aerial Photographs : Tilt Displacement*.—1. General; 2. The Effect of Tilt; 3. Methods of Tilt Determination. Reading Material. Exercise 8 : Problem in Tilt Determination.
- J. *Aerial Photographs : Specifications, Indexing and Inspection*.—1. Specifications; 2. Indexing : (a) Purpose; (b) Identification; (c) Methods; 3. Inspection. Reading Material. Exercise 9 : Problem in Indexing.
- K. *Stereovision*.—1. General; 2. The Human Eye; 3. Binocular Vision; 4. Stereoscopic Parallax; 5. Stereoscopic Fusion; 6. Observing Relief in Aerial Photographs; 7. Stereoscopes; 8. Exercises in Stereovision; 9. Correct Use of Stereoscope. Reading Material. Exercise 10 : Practice Stereovision.
- L. *Aerial Photographs : Mapping Methods and Control Requirements*.—1. The Mapping Problem; 2. Solutions to the Mapping Problem: (a) Mathematical Solution; (b) Graphical Solution; (c) Optical Solution; 3. Stereoscopic Plotting Instruments : (a) The Stereocomparagraph; (b) The K.E.K.; (c) The Multiplex; (d) The Stereoplanigraph; 4. Control Requirements; (a) Importance; (b) Control Density; (c) Basic Requirements; (d) Identification; (e) Control Planning; (f) H. O. Control Requirements. Reading Material. Exercise 11 : Problem in Control Planning.
- M. *Radial Line Methods of Mapping*.—1. General; 2. Purpose; 3. Theory : (a) Radial Line Principle; (b) Relief and Tilt; 4. Requirements : (a) Photography and Compilation; (b) Horizontal Control; 5. Methods of Radial Line Triangulation; 6. Procedure : (a) Preparation of Base Sheet; (b) Preparation of Photographs; (c) Establishing "Photo Control"; (d) Plotting the Planimetry. Reading Material. Exercise 12 : Compile a Planimetric Map.
- Appendix A*. — Outline and Reading Material for Part II. Lectures N-W.
- Appendix B*. — Bibliography.
- Appendix C*. — Required Equipment.
- Appendix D*. — Examination Questions.

## PART. II. — LECTURES N-W

- N. Photo-Interpretation.
- O. Stereo Plotting Methods : Parallax and Elevations.
- P. — — — The Stereocomparagraph.
- Q. — — — The K.E.K. Stereoscopic Plotter.
- R. — — — The Multiplex and Stereoplanigraph.
- S. Supplementary Control with the Camera Transit and Photo Transit.
- T. Mosaic Mapping.
- U. Oblique Mapping.
- V. Tri-Metrogon Mapping.
- W. Planning a Photo Mapping Project.

This course in Photogrammetry is but one example of what some of the Federal Agencies are doing in the way of training the personnel needed to carry out their own

programs. In view of the wide application of the subject, however, colleges and engineering schools throughout the country can perform a valuable service by making such instruction more readily available.

As far as the college student is concerned, the possibility of job opportunities in the field is an important consideration in determining whether or not to select a specialized course such as photogrammetry. It should be the task of the American Society of Photogrammetry to survey and publicize the job opportunities in the field. A survey might possibly be attempted to cover commercial companies and government agencies, federal, state and local to find the answers to questions such as the following :—

1. The total number of companies and Government agencies employing photogrammetrists ?
2. The total number of photogrammetrists employed by each company or agency in 1940 ?
3. The total number of photogrammetrists employed by each company or agency in 1947 ?
4. The expected number to be employed in the future ?
5. Increase or decrease ?

Some conclusions concerning the value of having a few colleges in the country offer courses toward a degree in Photogrammetric Engineering may be drawn from such a survey.

There are many jobs requiring some training in photogrammetry, other than those as full time photogrammetrists. Specialists such as pilots, navigators, photographers, field surveyors, geologists, foresters, agriculturists, astronomers, hydrographers, and civil engineers, all would benefit from a knowledge of the principles of photogrammetry. Such basic information should be readily available at all colleges.

It would be of great benefit to the profession of photogrammetry as well as to the engineering profession in general if photogrammetry would be included as an integral part of every college course in surveying and if in addition at least one special course in photogrammetry were to be offered at every engineering College. If this were done there would certainly be less chance of having surveyors or civil engineers making the error of taking measurements on mosaics as if they were maps. Furthermore, there would be considerable saving in both time and money if all engineers knew exactly when and how aerial surveys could be advantageously substituted for, or used to supplement, ground surveys. Both the advantages and limitations of aerial photos for surveying purposes should be general knowledge among engineers.

The value of photogrammetry to the studies of geology, soils and forestry is of considerable importance and the subject should certainly be included as a recommended course for a student seeking a degree majoring in one of those sciences.

As to the content of college courses in photogrammetry, this will of course vary in emphasis and in detail depending upon whether it is an advanced course or an elementary one and whether it is stressing surveying, mapping, mosaics, photo-intelligence, geology, forestry, soil studies or some other aspect of the subject.

All courses pertaining to photogrammetry, should include as a minimum, information concerning :—

- 1° Basic characteristics of photographs, perspective qualities, relief and tilt displacements ;
- 2° Elements of stereoscopy ;
- 3° A simple graphical method of mapping.

Where more time is available, the other material as listed in the outline above can be included, and of course, advanced courses in the subject could concentrate more on theory, equipment and procedures.

Photogrammetry is still in a youthful stage of development and is not yet being used to a maximum possible advantage either by private industries or by local, state or federal governments. It has not yet received sufficient recognition by colleges, possibly due to inertia or lack of information concerning the valuable applications of the science, or of limited information regarding job opportunities in the field. Perhaps informing more people as to what it is, will stimulate the greater application of such knowledge and thereby bring about a better understanding of the geographic basis of the world in which we live.