MERRILL R. BROWN*
PAUL E. NORMAN
U. S. Army Inter American Geodetic Survey
Fort Clayton, Canal Zone

IAGS College-Level Training

. . . keep abreast of new methods and evaluate them relative to their applicability to Latin America.

ABSTRACT: *For many years students from the Latin American countries have been attending college photogrammetry programs in the U. S. and Europe. These programs are invariably taught in a language other than Spanish. The mapping agencies of Latin America requested that IAGS establish and present a college photogrammetry program in Spanish. Implemented by IAGS, the program was conceived and designed with the cooperation of the Directors of the Latin American Mapping Agencies and the Canal Zone College.*

THE NEED FOR UNIVERSITY-LEVEL training in Photogrammetry is an established fact throughout the world and has become of paramount importance in Latin America. The tremendous strides being made in technological, economic, and social development in Latin America have mushroomed the requirements for cartographic data. The production of these data can only be accomplished by employing the most modern photogrammetric techniques; a fact which accentuates the need for high level training.

Until recently university level training in Photogrammetry was available only outside of Latin America; i.e., United States, Canada, and Europe. This training has invariably required the student have a proficiency in a language other than Spanish. Thus it became apparent that a need existed for a facility where intensive university level training in Photogrammetry could be obtained in the Spanish language.

At a conference of the Directors of the mapping agencies of Central America in December 1962, the Director, Inter American Geodetic Survey, was requested to consider the establishment and presentation by IAGS of a college level Photogrammetry program in Spanish. The program was to encompass a curriculum designed to cope with the complex cartographic situation and would be that of a major in Photogrammetry at the bachelor's degree level.

A STUDY WAS CONDUCTED by IAGS to ascertain the best procedure to follow in fulfilling the requirement of providing such photogrammetric training. Considerations in the study over and above the academic need for this program were: where it should be given, instruments available, classroom space, and most important how to organize a qualified faculty. It was decided to integrate this program into the already existing IAGS Cartographic School. This School was organized in 1952 to present technician type training in the Spanish language to personnel of the mapping agencies of Latin America. The success of the training given to date by the Cartographic School is evident when we note the quantity and quality of cartographic data now being achieved by the mapping agencies of Latin America. To date 1,886 students have completed courses in Geodesy, Astronomy, Supplemental Map Control, Field Classification, Basic Photogrammetry, Aerial Triangulation, Cartography, Map Editing, and Map Reproduction. 511 of the students attended courses in subjects related to photogrammetry.

The task of establishing this new program was turned over to the photogrammetric staff of IAGS. Mr. Paul E. Norman was given the responsibility for the actual organization and presentation of the program. Mr. Norman had previously received a degree in education from a U. S. college and a degree in photogrammetric engineering from the International Training Center for Aerial Survey, Delft, Netherlands. Mr. Norman was

* Presented at the Annual Convention of the American Society of Photogrammetry, Washington, D. C., March 1966.

awarded a Department of the Army Research Fellowship to continue his studies at the ITC and to work on the program organization. He was awarded a master's degree in photogrammetric engineering as a result of his studies and work. The balance of the permanent instruction staff was chosen later and includes Mr. Philip Scudieri who has a master's degree in civil engineering and Mr. Robert Rountree who possesses a degree in mathematics. The permanent instruction staff is supplemented by guest instructors selected from qualified Latin American photogrammetric engineers. This arrangement not only assures an adequate and well-qualified staff of instructors but provides an excellent opportunity for an interchange of ideas.

EACH OF THE DIRECTORS of the Latin American mapping agencies was contacted as to his specific needs in Photogrammetry and was requested to provide suggestions. Letters explaining the objectives and scope of the program were sent to the leading universities in the world who teach Photogrammetry, to manufacturers of photogrammetric instruments, and to a number of commercial mapping companies. The response to our inquiries was most gratifying. We received many constructive suggestions and a number of offers of assistance. Several universities supplied copies of their photogrammetric course outlines.

Next we reviewed our inventory of photogrammetric instruments available in the Cartographic School. For teaching Basic Photogrammetry and Aerial Triangulation courses we had at that time: Multiplex, Balplex, Kelsh and M-2 Plotters, a Wild A-7 Autograph, a Wild B-8 Aviograph, a Bausch-and-Lomb Rectifier and appropriate Reduction Printers. In order to present practical exercises on photogrammetric instruments currently available in Latin America we obtained: a Wild A-9 Autograph, two Wild A-8 Stereo Plotting Machines, two additional Wild B-8 Aviographs, a Jerie Analogue Computer, a Zeiss Radial Secator, one Wild PUG III Point Transfer Device, a Zeiss Stereotope (on loan from Colombia), a Kern PG-2 Plotter (on loan from Kern), a Wild B-9 Aviograph (on loan from Wild), and a Wild RC-9 Aerial Camera with Statoscope RS-1 (on loan from Wild). Arrangements were consummated to utilize an IBM 1620 at the University of Panama.

ANOTHER STEP IN ORGANIZING the program was to obtain suitable college accreditation. Through the cooperation of the Governor of the Canal Zone, an affiliation was established with the Canal Zone College. The college provides assistance in evaluating student qualifications, maintaining transcripts, and furnishing general consultation services. Upon the successful completion of the program the Canal Zone College grants thirty semester hours of college credit to the students.

Students for the program are nominated by the Directors of the mapping agencies of Latin America. The men proposed for the program normally are employees of the mapping agencies and possess potential supervisory qualities. The entrance requirements are a minimum of two years of engineering study at the university level and successful completion of an entrance examination; practical photogrammetric experience is also considered essential. The caliber of students who have enrolled in the program, to date, has been very high. Many of the students have degrees in engineering. Thus far, we have had students from: Guatemala, Nicaragua, Costa Rica, Panama, Colombia, Peru, Bolivia, Brazil, Paraguay and Uruguay.

Scholarship and subsistence assistance in many cases is furnished for civilian personnel by the U. S. Agency for International Development and for military personnel by the U. S. Military Assistance Program.

THE PROGRAM RUNS for 41 weeks. There are 520 lecture hours and a minimum of 455 laboratory hours. The students are in class approximately 40 hours per week. The program consists of twelve credit courses for a total of thirty semester-hours. The courses are: Mathematics Review (non credit), Introduction to the Use of Electronic Computers, Mathematics as Applied to Photogrammetry, Introduction to Photogrammetry, Elementary Photogrammetric Optics, Fundamentals of Photogrammetry, Production of Air Photographs, Photogrammetric Determination of Control Points, Photogrammetric Adjustments, Photogrammetric Instruments, Production of Surveys and Maps, Photogrammetry and the Cadastral Surveys, and Seminar on Mapping Problems. Analytical Photogrammetry is currently being covered in several of the courses. We are now considering the establishment of a separate course for this very important subject or presenting it more fully as a postgraduate course.

The practical aspects of the uses of Photogrammetry are dealt with by a series of

eighteen laboratory exercises. In addition to teaching the basic skills involved in the use of Photogrammetry in the cartographic field, the exercises are also designed to further clarify the theoretical subject matter. The exercises cover such operations as relative and absolute orientation, aerial triangulation, radial triangulation, stereo-compilation, preparation of mosaics, checking and calibration of instruments, etc. A brief description of the content of each course and practical exercise is included as Appendices A and B.

During the first presentation of the program we were fortunate to have a number of guest lecturers and instructors. Among those who gave us their valuable time and assistance are:

Mr. J. Klaver, Representative, Kern Company, Aarau, Switzerland.
Mr. T. J. Blachut, Chief, Photogrammetric Research, National Research Council, Ottawa, Canada.
Mr. Heinz Gruner, Senior Scientist, Bausch and Lomb, Inc., Rochester, New York.
Mr. Daniel Gut, Representative, Wild Heerbrugg Limited, Heerbrugg, Switzerland.
Mr. Pedro Molina, Photogrammetric Division, Direccion de Cartografia Nacional, Caracas, Venezuela.
Dr. Alfredo Diaz, Chief of Photogrammetry, Instituto Geografico "Agustin Codazzi," Bogota, Colombia.
Mr. Robert Troester, Electronic Data Processing Unit, University of Panama.

Also participating with guest lecturers were several engineers of the IAGS staff.

One of our initial problems was the lack of suitable textbooks on Photogrammetry in the Spanish language. This has been overcome by the compilation of a complete set of lecture notes. The notes total approximately 800 pages and in effect constitute a textbook on Photogrammetry. The notes are considered provisional at the present time; however, we anticipate that they will be released after being revised and edited.

WE BELIEVE THAT the IAGS program may be unique for several reasons:

- This is the only presentation in Spanish at this time that endeavors to cover as much as thirty semester-hours of Photogrammetry.
- Differing from most universities, IAGS covers normal academic requirements for the photogrammetric major in one year. This allows us to commence with an introductory course. This course, in fact, represents a synopsis of the entire program. This means we present the overall picture and then expand the sections of the introductory course into the twelve courses.
- As IAGS is somewhat isolated, we tend to have a greater-than-average need for contacts with leading cartographic officials. The contacts are accomplished by personal visits, correspondence, and attendance at technical meetings.
- We endeavor to keep abreast of new methods and evaluate them in light of their applicability to Latin American conditions.

An agreement has recently been concluded with the International Training Center for Aerial Survey which will provide more active participation by the ITC in the IAGS program. We are certainly looking forward to future visits to the Canal Zone by senior staff members of ITC.

One idea for the future that has been broached to us is the possibility of transferring this program to a university in one of the Latin American countries. There are a number of advantages to this idea and we are exploring these prior to reaching a conclusion.

Although IAGS is only in the second presentation of this program, many encouraging comments have been received from leading cartographic officials of Latin America as well as from the guest lecturers and the students. At the present time we plan to continue this program as it is currently operating with the exception of improving technical content and scope to include new developments.

APPENDIX A. DESCRIPTION OF COURSES

CARTOGRAPHY 030.—Mathematics Review (60-0-0)*

A general review of mathematics designed for the photogrammetrist including topics on algebra, trigonometry, analytical geometry and differential calculus.

CARTOGRAPHY 329.—Introduction to the Use of Electronic Computers (20-10-1)

An introduction to electronic data processing covering computer classification, computer language, preparation of flow charts and computer programming including a laboratory exercise in the writing and processing of computer programs applicable to Photogrammetry.

CARTOGRAPHY 330.—Mathematics as Applied to Photogrammetry (70-0-4)

Provides photogrammetrist with the basic principles and photogrammetric applications of statistics, the theory of least squares adjustments, the theory of errors, the Gauss algorithm, matrices, and solid analytic geometry.

* Hours of Lecture—Hours of Laboratory—Credit-Hours

CARTOGRAPHY 331.—Introduction to Photogrammetry (20-10-1)

Provides an overall picture of the applications of Photogrammetry in the cartographic and noncartographic fields with major emphasis on the cartographic field covering briefly the following subjects: aerial photography, orientations, rectification, photogrammetric instruments, aerial triangulation, and map production.

CARTOGRAPHY 332.—Elementary Photogrammetric Optics (20-0-1)

Geometrical and physical optics, reflection and refraction, mirrors, prisms, image formation by lenses, types of lenses, lens distortion, simple optical systems, projection systems, projectors, compensation of lens distortion.

CARTOGRAPHY 333.—Fundamentals of Photogrammetry (60-60-4)

Relative and absolute orientation, geometry of orientations, parallax formula, development and solutions of the elements of orientations, empirical and numerical orientations, graphic orientations, rectification, mosaics.

CARTOGRAPHY 334.—Production of Air Photographs (35-0-2)

Aerial cameras, design and construction characteristics, inner orientation of photogrammetric cameras, camera calibration, photographic operations, photographic materials and processing, orientation elements in flight, survey aircraft, special types of photography.

CARTOGRAPHY 335.—Photogrammetric Determination of Control Points (45-70-4)

Plan and design of ground control requirements, instrumentation procedures, planimetric or radial triangulation, execution of spatial aerial triangulation, analytical or digital aerial triangulation, etc.

CARTOGRAPHY 336.—Photogrammetric Adjustments (40-200-4)

Aerial triangulation adjustments, computation of strip coordinates, propagation and effect of errors, single strip adjustment (graphical methods and computational methods); block adjustments.

CARTOGRAPHY 337.—Photogrammetric Instruments (60–55-4)

Binocular vision and stereoscopes, stereoscopic restitution instruments with a correct reconstruction of the bundle of rays, instruments with direct optical projection, instruments using direction projection and observation by telescope, optical-mechanical, instruments with mechanical projections, miscellaneous instruments and accessories, adjustment of plotting instruments, approximate plotting instruments.

CARTOGRAPHY 338.—Production of Surveys and Maps (50-60-4)

Cartography, types of maps, geometrical aspects, map projections, topography and relief cartographic drafting, reproduction, precision of maps, medium and small scale maps, topographic maps, large scale maps, photomaps, checking of maps, organization of aerial survey agencies, cost of maps, project planning.

CARTOGRAPHY 339.—Photogrammetry and the Cadastral Survey (20-0-1)

The detailed study of accomplishing cadaster using Photogrammetry as a tool.

CARTOGRAPHY 340.—Seminar on Mapping Problems (20-0-1)

To consist of discussions, guest lectures, visits, etc., which will embody various cartographic and photogrammetric problems.

This constitutes a total of 520 Lecture Hours, 455† Hours of Laboratory, and 30 Credit-Hours.

APPENDIX B. PRACTICAL EXERCISES

1. Empirical orientations
2. Numerical relative orientation
3. Graphical determination of omega
4. Absolute orientation of irregular models
5. Aerial mosaic preparation
6. Stereo template layout
7. Aerial triangulation preparation
8. Aerial triangulation with universal plotter
9. Strip adjustment by IAGS graphical method
10. Strip adjustment by Zarzycki method
11. Strip adjustment using an electronic computer
12. Block adjustment using the ITC-Jerie Analogue Computer
13. Determination of height from parallax measurements
14. Instrument checking and adjustment
15. Operation of approximate instrument
16. Instrument familiarization
17. Stereo-compilation
18. Special problems

† These are the minimum number of hours necessary to meet the requirement for the college credit; the average student may spend 600 hours.