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Education for Users of Photogrammetry

The role of and education for the users of photogrammetry, as opposed to researchers in photogrammetry, are described.

Abstract: *The differences between active and passive photogrammetrists, as well as the differences between education for practitioners and researchers, are discussed. A detailed table of content for lectures and appropriate exercises for the education of passive photogrammetrists is put forward as a basis for discussion and criticism. It is anticipated that this proposal for education is very well suited for countries in Africa, Asia, and Latin America.*

Photogrammetry and photo interpretation require a relatively small number of personel for doing the work, but both methods can be of considerable help for quite a number of disciplines. As a consequence, there are two requirements regarding the structure of personnel:

- Just a small number of engineers and technicians carry out the work; they will be called *active* photogrammetrists; and
- many specialists can apply photogrammetry successfully in their fields; they will be called *passive* photogrammetrists.

For example, about 34000 engineers and technicians are working in surveying and mapping in West Germany. However, just 400, i.e., about 1 per cent, are active photogrammetrists.

These facts result in one demand for all German universities: the curricula have to be based on the necessities of passive photogrammetrists. This requirement probably holds for most other countries, even if there are really few chances for training of active photogrammetrists (e.g., ITC-Netherlands and SSPO-Switzerland).

In West Germany there are two modes of education at the university level: Scientific education at universities, and practitioners education at Fachhochschulen (comparable to institutes of technology). The curricula are different inasmuch as the theoretical fundamentals must be treated adequately at universities, whereas Fachhochschulen have to concentrate on dealing with the bases for practical applications.

Practitioners education of passive photogrammetrists should be guided by the following facts:

The forthcoming engineer must—

- know the methods and measuring capabilities (and limitations) of both photogrammetry and photo interpretation;
- be able to judge whether a certain task can be handled most suitably by photogrammetry and, for this aim, be able to estimate the required time as well as the costs involved;
- precisely state the technical part of a contract to be placed with the active photogrammetrist; and
- be able to judge whether the active photogrammetrist did carry out the work properly and according to specifications.

A detailed curriculum, established to fulfill these conditions for practitioners education, is given in Appendix A. It might be mentioned that we have available at our Fachhochschule 110 hours for lectures and exercises. For successful education in photogrammetry it is felt necessary to supply the students with such a detailed table of content for two reasons: (1) It enables the student to judge what is necessary for a practitioner and to classify the various items systematically; and (2) it is a well accepted help to prepare for examinations.

PHOTOGRAMMETRY CURRICULUM AT THE FACHHOSCHULE RHEINLAND-PFALZ

1. INTRODUCTION
  - 1.1 Definition and characteristics
  - 1.2 Historical development
  - 1.3 Possibilities of application
  - 1.4 Literature

2. STEREOSCOPY
  - 2.1 Normal stereoscopic vision
  - 2.2 Artificial stereoscopic vision
    - 2.2.1 Conditions
    - 2.2.2 Separation of images
      - 2.2.2.1 Spatial separation
      - 2.2.2.2 Time separation
      - 2.2.2.3 Physical separation
        - 2.2.2.3.1 Anaglyphs
        - 2.2.2.3.2 Polarization
    - 2.2.3 Observation in epipolar planes
    - 2.2.4 Pseudoscopic effect
    - 2.2.4 Floating mark

3. DATA ACQUISITION
  - 3.1 Photography
    - 3.1.1 Photographic process (chemical properties)
    - 3.1.2 Physical properties of photography and remote sensing
    - 3.1.3 Photographic materials
      - 3.1.3.1 Emulsions
        - 3.1.3.1.1 Different spectral sensitivities
        - 3.1.3.1.2 Resolution
      - 3.1.3.2 Bases for emulsions
      - 3.1.3.3 Laboratory equipment
    - 3.1.4 Filters
      - 3.1.4.1 Spectral absorption (colour filters)
      - 3.1.4.2 Antivignetting Filters
  - 3.2 Equipment for data acquisition
    - 3.2.1 Instruments for remote sensing
      - 3.2.1.1 Review
      - 3.2.1.2 Cameras with measurement capabilities
        - 3.2.1.2.1 Definition and purpose
        - 3.2.1.2.2 Terrestrial cameras
        - 3.2.1.2.3 Aerial survey cameras
        - 3.2.1.2.4 Ballistic cameras
      - 3.2.1.3 Multispectral cameras
      - 3.2.1.4 Aero magnetometer
      - 3.2.1.5 Equipment for space vehicles
    - 3.2.2 Calibration
      - 3.2.2.1 Image quality
      - 3.2.2.2 Measurement properties
  - 3.3 Carrier of equipment for data acquisition
    - 3.3.1 Surveying aircraft
      - 3.3.1.1 Requirements
      - 3.3.1.2 Types of aircraft in use
    - 3.3.2 Space vehicles
  - 3.4 Techniques for data acquisition
    - 3.4.1 Definitions
    - 3.4.2 Flight planning
      - 3.4.2.1 Using aircraft
      - 3.4.2.2 Using space vehicles
    - 3.4.3 Contributing factors to the quality of aerial photographs
      - 3.4.3.1 Reflectance and emission of terrain
      - 3.4.3.2 Haze, air light, contrast
      - 3.4.3.3 Unsharpness due to image motion
      - 3.4.3.4 Development, drying
    - 3.4.4 Inspection, index map
    - 3.4.5 Terrestrial photography
    - 3.4.6 Time and season for undertaking photography
  - 3.5 Procurement of photographs
    - 3.5.1 Germany
    - 3.5.2 Abroad

4. PLOTTING FROM SINGLE PHOTOGRAPHS
  - 4.1 Principles
  - 4.2 Rectification
    - 4.2.1 Computational
    - 4.2.2 Graphical
    - 4.2.3 Optical
      - 4.2.3.1 Geometric conditions
      - 4.2.3.2 Subjective rectifiers
      - 4.2.3.3 Objective rectifiers
        - 4.2.3.3.1 Optical conditions
        - 4.2.3.3.2 Equipment
      - 4.2.3.4 Operational procedures
    - 4.2.4 Errors limiting the application

5. FUNDAMENTALS OF DIGITAL PHOTOGRAMMETRY
  - 5.1 Mathematical relations
    - 5.1.1 Normal case
    - 5.1.2 General case
  - 5.2 Measuring equipment
    - 5.2.1 Stereocomparator
    - 5.2.2 Monocomparator
    - 5.2.3 Other instruments

6. STEREO-PLOTTING INSTRUMENTS
  - 6.1 Principles
  - 6.2 Analog instruments
    - 6.2.1 Common characteristics
      - 6.2.1.1 Parallelogram of Zeiss
      - 6.2.1.2 Compensation of distortion
    - 6.2.2 Different principles of construction
      - 6.2.2.1 Optical
      - 6.2.2.2 Optical-mechanical
      - 6.2.2.3 Mechanical
      - 6.2.2.4 Approximate solutions
  - 6.3 Analytical plotter
  - 6.4 Hybrid plotters
  - 6.5 Output possibilities of plotters
    - 6.5.1 Graphical
    - 6.5.2 Digital
    - 6.5.3 Photographic
      - 6.5.3.1 Principle of orthoprojector

6.5.3.2 Instruments for different modes of operation
6.5.3.2.1 On-line
6.5.3.2.2 Off-line
6.6 Correlator
6.7 Review of operational procedures
6.7.1 Orientation
6.7.2 Restitution
6.7.2.1 Technique of measurement
6.7.2.2 Representation of map content

7. ORIENTATION
7.1 Task
7.2 Interior orientation
7.3 Exterior orientation
7.3.1 Relative orientation
7.3.1.1 y-Parallax equation
7.3.1.2 Operational procedures
7.3.1.2.1 Principles
7.3.1.2.2 Optical-mechanical procedure
7.3.1.2.2.1 Successive models
7.3.1.2.2.2 Independent models
7.3.2 Absolute orientation
7.3.2.1 Principles
7.3.2.2 Scaling
7.3.2.3 Levelling
7.3.2.4 Operational procedures
7.4 Accuracy of plotting as affected by residual errors of orientation
7.4.1 Distortion
7.4.2 Relative orientation

8. CONTROL POINTS
8.1 Definitions
8.2 Measurement of exterior orientation while undertaking photography
8.2.1 Aerial photography
8.2.1.1 Horizontal
8.2.1.2 Vertical
8.2.1.3 Inclination
8.2.2 Terrestrial photography
8.3 Field surveys
8.3.1 Targeting prior to photography
8.3.2 Methods and instruments
8.3.2.1 Review
8.3.2.2 Geoceiver
8.4 Aerotriangulation
8.4.1 Introduction
8.4.1.1 Purpose
8.4.1.2 Methods
8.4.1.2.1 Plane phototriangulation
8.4.1.2.2 Spatial phototriangulation
8.4.1.3 Propagation of errors
8.4.2 Preparation
8.4.3 Measurement
8.4.3.1 Stereocomparator
8.4.3.2 Independent models
8.4.3.3 Successive models
8.4.4 Computation
8.4.4.1 Review
8.4.4.2 Strip adjustment
8.4.4.3 Block adjustment
8.4.4.3.1 Successive transformation of strips
8.4.4.3.2 All data simultaneously
8.5 Control points from existing maps

9. PLANNING OF AERIAL SURVEYS
9.1 Planning and executing organizations
9.1.1 Germany
9.1.2 Abroad
9.2 Accuracy
9.2.1 Plotting
9.2.1.1 Vertical accuracy
9.2.1.2 Horizontal accuracy
9.2.1.3 Drawing accuracy
9.2.2 Required accuracy of control points
9.3 Choice of photo scale and camera
9.3.1 Basic Considerations
9.3.2 Photo scale resp. flying height
9.3.2.1 General
9.3.2.2 With conditions
9.3.2.2.1 Vertical accuracy
9.3.2.2.2 Horizontal accuracy
9.3.2.2.3 Safe interpretation
9.3.2.2.4 Other factors
9.3.3 Camera resp. field angle
9.3.3.1 Comparison of typical lenses
9.3.3.2 Capabilities regarding interpretation
9.4 Examples
9.4.1 German base map 1:5000
9.4.2 Topographic map 1:25000
9.4.3 Topographic map 1:100000
9.4.4 Restitution for cadastre
9.5 Time estimation
9.5.1 Control points
9.5.1.1 Ground control
9.5.1.2 Aerotriangulation
9.5.2 Restitution
9.5.2.1 Air photo map
9.5.2.1.1 Rectification
9.5.2.1.2 Orthophotos
9.5.2.2 Conventional map
9.5.2.2.1 Large scale
9.5.2.2.2 Medium scale
9.5.2.2.3 Small scale
9.6 Time flow of a project
9.7 Cost estimation
9.7.1 Computation of unit costs
9.7.1.1 Personnel
9.7.1.2 Plotting instrument
9.7.1.3 Aircraft
9.7.1.4 Ground survey
9.7.1.5 Editing
9.7.2 Cost of a project

10. APPLICATION OF PHOTOGRAMMETRY
10.1 Review of methods
10.2 Advantages and disadvantages
10.3 Fields of application
10.3.1 Mapping and cadastral surveying
10.3.2 Earth sciences
10.3.2.1 Geology
10.3.2.2 Soil and agriculture
10.3.2.3 Forestry
10.3.2.4 Meteorology, glacier surveying
10.3.2.5 Archeology
10.3.2.6 Geography
10.3.3 Engineering sciences
10.3.3.1 Planning and pollution
10.3.3.1.1 Introduction
10.3.3.1.2 Scale considerations
10.3.3.1.3 Examples for detail solutions

10.3.3.2 Architecture
10.3.3.2.1 Survey of buildings
10.3.3.2.2 Registration of monuments
10.3.3.3 Hydraulic engineering
10.3.3.4 Civil engineering
10.3.3.4.1 Roads
10.3.3.4.2 Tunnels
10.3.3.4.3 Dams
10.3.3.4.4 Bridges
10.3.3.4.5 Traffic evaluation
10.3.3.5 Mining
10.3.3.6 Mechanical engineering
10.3.3.6.1 Cars
10.3.3.6.2 Shipbuilding
10.3.4 Accidents (land, sea)
10.3.5 Medicine, zoology

11. EXERCISES

11.1 Use of stereoscopes; measurement of parallax difference in stereocomparator or Stereopret and computation of local height differences
11.2 Relative orientation (successive and independent models) and absolute orientation with pattern plates in Multiplex and relative orientation of aerial photos in Balplex
11.3 Plotting exercises in a model, followed by thorough plotting of a map portion, about 10cm by 10cm, in either Kern PG 1, Wild B8, or Zeiss Planimat; measurement of control points and judgement of given absolute orientation

12. EXCURSION

One to be selected from:

12.1 Active photogrammetric organizations
12.1.1 Aerial survey company
12.1.2 State survey office
12.1.3 Reallotment office
12.1.4 Federal Office for Geo Sciences and Raw Materials, Hannover
12.1.5 Military aerial survey unit
12.2 Planning organizations
12.2.1 Regional Planning Institution, Frankfurt
12.2.2 Ruhrsiedlungsverband, Essen
12.3 Research institutions
12.3.1 Institute for Applied Geodesy, Frankfurt
12.3.2 International Institute for Aerial Survey and Earth Sciences, Enschede-Netherlands
12.3.3 Photogrammetric institute of a university
12.3.4 Forest Research Institute, Freiburg
12.3.5 Geologic Research Institute, Munich
12.3.6 Institute for Regional Geography and National Planning, Bad Godesberg
12.4 Education of active photogrammetrists
12.4.1 International Institute for Aerial Survey and Earth Sciences, Enschede-Netherlands
12.4.2 Swiss School for Photogrammetry Operators, St. Gallen

Obituary

Professor E. H. Thompson

It is with the deepest regret that I inform you, on behalf of the I.S.P. President and Council, of Professor E. H. Thompson's passing away. He died suddenly and unexpectedly in the evening of April 9, 1976.

Professor Thompson was one of the leading scientists in all the fields of photogrammetry: he discovered and improved theories and methods, he designed new instruments, he taught a number of students, he edited a very high-quality review.

Professor Thompson was an honorary member of the International Society for Photogrammetry. He was the President of the British Photogrammetric Society, a member of the ninth I.S.P. Congress board (London, 1960), and the Chairman of Commission III (Aerial Triangulation) for the period 1968-1972, ending with the twelfth I.S.P. Congress (Ottawa, 1972).

We were close friends for nearly thirty years. He particularly loved France, with whose history and arts he was so familiar. But I am sure that every one who knew him will suffer the same feeling of sadness as I do.

His loss is a very heavy one for the science of photogrammetry, as it is for his many friends.

Yours sincerely,

Jean Cruset
Secretary General
International Society for Photogrammetry