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Commission V
Report of Working Group V/2

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Photogrammetric Potentials of Non-Metric Cameras

IN THE FALL of 1972 Working Group V/2 was formed with the task to address itself to Resolution 2 of Commission V passed at the XIIth ISP Congress, which shall be quoted for reference:

"...to undertake the following additional studies:

2.1 Photogrammetric potentials of non-metric cameras

2.2 Basic concepts of application of photogrammetry in quality control in industry."

As there appeared to be a considerable overlap with Working Group V/1 (Chairman: Prof. Dr. Ing. K. Linkwitz), it was decided to concentrate on non-metric cameras, often referred to as off-the-shelf cameras. With this in mind, the following areas of interest were defined within the overall theme of the working group:

(1) Definition and Classification of Non-Metric Cameras
(2) Calibration of Non-Metric Cameras
—Methods and Parameters, Comparison of Approaches
—Accuracy and Tolerances
—Repeatability and Recalibration
(3) Object Space Control Requirements and the Actual Determination of Control
(4) Comparision of Metric and Non-Metric Photogrammetry in terms of feasibility, economy, and simplicity
(5) Evaluation of Non-Metric Photography and Instrumentation Used
(6) Practical and Experimental Experiences, especially in the area of quality control in industry.

Discussions and correspondence with the members of the working group led to the design of a rather comprehensive questionnaire on the use of non-metric cameras which was distributed to the ten full and contributing members of the working group, eleven other colleagues who have been involved in photogrammetric applications of non-metric cameras, and 31 additional national correspondents of ISP Commission V. A follow-up reminder increased the response from 40 percent to 60 percent (31 out of 52 coming from 23 countries!), of which 18 indicated present involvement with non-metric cameras, which represents 35 percent of the total mail-out.

Prior to drawing any conclusions from this representative sample, I shall summarize the main responses, considering the actual users of non-metric cameras only. The following major areas were identified:

(1) User environment: university 50 percent; research institute 25 percent; private company 25 percent.
(2) Cameras utilized: a large variety resembling the display of a well stocked photographer's store was named with the exception of Hasselblad products for which 20 percent of the users have opted.
(3) Knowledge of Interior Orientation: 22 percent claim to know the interior orientation sufficiently well. Most of the remaining 78 percent perform some kind of a calibration, while a few resort to remedial steps or do not require accurate results.
(4) Calibration: 53 percent perform a laboratory calibration while 47 percent calibrate on the job. In addition to the basic parameters (principal point and principal distance) 87 percent include radial lens distortion parameters, while 25 percent also include decentering lens distortion, and 19 percent add affinity parameters.
(5) Frequency of Calibration: 50 percent

calibrate before each new project, 25 percent once a year, 12 percent once after purchase of equipment, and the remaining ones have no fixed pattern.

(6) Stability of Calibration: As this is an individual characteristic for each camera, the answers vary from "insignificant changes" to changes of up to 0.1 mm between calibrations.

(7) Stereo Coverage: Only 13 percent do not require stereo coverage, while 32 percent use two cameras, 26 percent move the camera, 23 percent move the object, and 6 percent use mirrors.

(8) Control Requirements and Accuracy: This question was rarely answered, with the figures ranging from 4 to 20 points per model, and the accuracy (depending on the project) from 0.01 mm to 1 cm in object space.

(9) Evaluation: Here a 50-50 split between graphical and numerical evaluation is reported.

(10) Compilation Instrument: 50 percent use an analogue plotter, some solely for numerical purposes; 40 percent a comparator; and 10 percent other devices such as rectifiers, projectors, or analytical plotters.

Finally, it should be noted that in each reply one or more specific applications were quoted which cover a variety of fields, such as plant growth and human forms, recording and movement studies in architecture and art, mining tunnels, quarries, moving objects and model experiments, structural and machine part deformation, forest inventory, water resource and ocean wave studies, accident investigation, vehicle speed control, wearing of road surfaces, and electron microscopy in chemistry and metallurgy.

These data, my own research experiences, additional literature, and numerous discussions with colleagues at national and international meetings, especially the ISP Commission V Symposia in the U.S.A. (Washington, D.C. and Urbana, Ill.) provided the information, with which I now shall try to respond to the program of the working group as outlined before. Obviously a certain personal bias may be apparent, but this might serve to initiate a discussion. As some of the topics will be discussed in detail during the Congress through invited papers and a panel discussion, I shall not interfere by reporting on them here. Following the individual program points, I would like to make these comments:

To No. 1)

A non-metric camera is a camera whose interior orientation is completely or partially unknown and frequently unstable. All "off-the-shelf" or "amateur" cameras belong to this category and are perhaps rather easily classified by the lack of fiducial marks. Contrary to common opinions, the term non-metric does not imply any quality statement and has as such nothing to do with accuracy, information content, or other such characteristics. Interior orientation in this context encompasses the basic parameters principal point and principal distance or calibrated focal length (camera constant) as well as radial (symmetric) lens distortion, decentering (frequently considered in form of its components asymmetric and tangential) lens distortion, film deformation, and affinity.

Classification of non-metric cameras appears to be impractical, as shortcomings can be counteracted by more sophisticated computer usage. Perhaps the stability of interior orientation might act as a means of classification.

To No. 2)

The invited paper by Dr. O. Kölbl, Switzerland, entitled "Accuracy Aspects Concerning the Interior Orientation of Non-Metric Cameras", which follows this report will form a solid base for further discussions on this problem area.

To No. 3)

The questions concerning object space control are very much project and equipment oriented. It is, therefore, extremely difficult to provide a general answer. Since users of metric cameras are also faced with similar problems, an answer may arise from the various discussions in all Commission V sessions.

Items 4 to 6 will be covered in detail during the 2nd session of the working group at the Congress, where the invited paper by Mr. VanWijk and Dr. Ziemann (Canada) entitled "The Use of Non-Metric Cameras in Monitoring High Speed Processes" will be followed by a panel discussion on the "Actual Use of Non-Metric Cameras in Photogrammetric Practice". Of the seven experts, two are associated with photogrammetric instrument manufacturing companies in order to insure the representation of metric cameras and provide a basis for comparisions between them and non-metric ones.

Concluding, I would like to state that the use of non-metric cameras has expanded within the past four years and has made an impact in a large number of areas where measurements are required. The non-metric camera/computer evaluation combination has reached its fullest potential, and accuracies reaching the photogrammetric noise level have been achieved. It often depends on the

individual project, whether the low cost camera/expensive evaluation system or the metric approach is more suitable or financially advantageous, which leaves the decision to the user. Often project arrangements require versatility and light weight which can only be met by non-metric cameras, and with the progress that has been made in the evaluation phase this option now can be a high precision approach. The photogrammetric potentials of non-metric cameras are indeed very high.

In closing, I wish to express sincere appreciation and gratitude to all the members of the working group for their interest, contributions, and cooperation: Dr. J. Badekas (Greece), Dr. I.A. Harley (Australia), Dr. O. Jacobi (Denmark), Dr. O. Kölbl (Switzerland), Dr. T. Oshima (Japan), Dr. Z. Sitek (Poland), and Dr. K. Torlegård (Sweden) and also to the contributing members: Dr. M. Döhler (W. Germany), Dr. G. Ladouceur (Canada), and Mr. M.C. VanWijk (Canada).

In particular, I am grateful to Dr. H.M. Karara, President of Commission V, ISP for his continued support and excellent cooperation.

1976 Alaska Surveying and Mapping Convention

The 1976 Alaska Surveying and Mapping Convention, sponsored by the Alaska Society of Professional Land Surveyors, The Alaska Region of the American Society of Photogrammetry, and the Alaska Section of the American Congress on Surveying and Mapping, will be held in Anchorage again this year at the Anchorage Westward Hotel, January 30 and 31.

This will be the 11th Annual Convention sponsored by the three societies. The theme for the convention will be "Alaska—Many Voices, Many Directions" and will include topics covering Alaska's resources, transportation, surveying and mapping programs, and the development of state lands by private firms as well as state and federal agencies.

The convention format is somewhat different this year, with the formal convention running Friday and Saturday. This should allow greater attendance by field personnel at the technical conferences with less inconvenience to themselves and employers.

Many people have found maps readily available because the surveying and mapping professions have done their jobs well, but the job is far from done and the task demands technical ability. A short course, put on in conjunction with the convention, is designed to improve the technical ability to make and use map products. The short course will last four days, beginning Monday, January 26 in the Kenai Aleutian Room of the Anchorage Westward Hotel. The course is devoted to draftsmen and interested people to help them become more aware of map products available in Alaska. The course will expose draftsmen to new techniques used in the drafting and reproduction fields today. Representatives from K & E, DuPont, and Eastman Kodak will present seminars on their latest techniques.

Exhibits will be shown in the Alaska Room this year, beginning at 1 P.M. Thursday, January 29. The display of the latest surveying, mapping, and computing equipment will last for the duration of the formal convention. This year promises more and better exhibits than ever before.

For a copy of the convention program or additional information please direct your correspondence to Ms. Dorothy Olmsted, Convention Coordinator, P.O. Box 2164, Anchorage, Alaska 99510.