

REPORT ON THE ACTIVITIES OF COMMISSION III 1984-1988

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Commission III

1. Area of Commission III

The area of Commission III "Mathematical Analysis of Data" consists of the following sub-areas:

1. Mathematical modelling of photographic and other remote sensing systems.
2. Computation of object data from photographic and other remote sensor records.
3. Theory of adjustments of observations, and measures of precision and accuracy of results.
4. Theory of digital processing of sensor data for geometric, radiometric, and visual enhancement.

2. Resolutions for 1984 - 1988

The resolutions made in the Rio Congress for the activities of Commission III for the period 1984 - 1988 refer to the following detailed subjects:

- stochastic behavior of photographs,
- on-line photogrammetric triangulation,
- digital terrain models,
- combined point determination, and
- image analysis and pattern recognition.

3. Organization of Commission III

Commission III was assigned by the General Assembly of the Society at the Rio Congress to the Finnish Society of Photogrammetry again for the period 1984 - 1988. Four Working Groups with their respective terms of reference were approved by the ISPRS Council in Washington D.C. in March 1985. In addition an intercommission Working Group III/IV was established. The President and the Secretary of the Commission and the Chairmen of the five Working Groups have comprised the Board of the Commission.

President: Dr. Einari Kilpelä, Helsinki University of Technology
Secretary: Mrs. Aino Savolainen, as above

WG 1: Accuracy Aspects of Combined Point Determination

Chairmen:	Dr. H. Ebner	Dr. M. Molenaar
	TU München	Agricultural University
	München, FRGermany	Wageningen, The Netherlands

OLT procedure.

- Study and access the feasibility of standardization of some components of software complex for OLT systems.
- Incorporation of modern ergonomic principles into system design (effective man/machine interfaces).
- Use of digital image processing techniques (e.g. image matching) to support and further automate the process of OLT.

WG 3

- Reviewing the state of art in accuracy and assessment of digital terrain models from national data banks covering large land areas and from systems being commercially available.
- Investigating the influence of sampling methods, terrain types and geomorphology on the accuracy of the digital terrain model.
- Experiments with data acquisition including automatic correlation techniques, photogrammetric sampling, manual automatic digitizing of contour maps leading to digital terrain models.

WG 4

- Image processing and its effects on subsequent tasks.
- Image models, feature extraction and image representation.
- Matching techniques for registration/rectification, feature recognition and image analysis.
- Use of knowledge in image analysis and pattern recognition (expert systems, quality control).
- Image analysis with non-image data (maps, radar).

WG III/IV

- Interface between photogrammetry/remote sensing and digital image processing/computer graphics technology.
- Geocoded data bases, land information systems and geographic information systems.
- Integration of photogrammetric/remote sensing data with land information systems (LIS) and geographic information system (GIS) data bases.
- Merging of digital and analog data (e.g. images, photographs, maps).
- Interactive processing and display of photogrammetric and remote sensing data.
- Algorithms for the rectification, registration and integration of data sets.
- Computer graphics for the display of integrated data sets.

5. Joint Activities of Commission III

5.1 Business Meetings and other activities of the Commission Board

The Commission Board had five business and other meetings during 1984-1988:

- October 2, 1985, Stuttgart, FRGermany: The programs of the Working Groups until 1988 were discussed. The plans for the Rovaniemi Symposium were made.
- August 18, 1986, Rovaniemi, Finland: The program of the Symposium and the procedures of the technical sessions were discussed.
- August 22, 1986, Rovaniemi, Finland: The Programs of the Working Groups until 1988 were discussed. The plans for the Kyoto Congress were made.

- September 15, 1987, Stuttgart, FRGermany: The program for the Seminar to be held in Helsinki, January 25 - 31, 1988, was worked out.
- January 25 - 31, 1988, Helsinki, Finland: the Seminar "Trends of Automation in Photogrammetry". It included 10 lectures given by the President, Secretary General, the C III WG chairmen and some Finnish experts. The Seminar had appr. 50 participants mainly from Finland. The C III Business Meeting was held on three afternoons. The detailed program for the Kyoto Congress was prepared. Further, the future of Commission III was under lively discussion.
- There will again be a meeting of the WG Chairmen in Kyoto at the beginning of the Congress.

5.2 Tutorial on "Statistical Concepts for Quality Control"

Commission III organized a one-day Tutorial on "Statistical Concepts for Quality Control" in Rovaniemi, Finland, on Monday, August 18, 1986, just before its Symposium in the same city. Its aim was to explain the notions of geodetic and photogrammetric network design and analysis. Thus the participants of the Tutorial had the opportunity to brush up on the theoretical bases of the subjects to be dealt with in the sessions of the coming Symposium.

The lectures of the Tutorial were given by two Commission III WG chairmen Dr. W. Förstner and Prof. Dr. M. Molenaar.

The program of the Tutorial consisted of the following theme areas:

1. Statistical fundamentals and estimation theory, hypotheses testing and decision theory.
2. Reliability, error detection and self calibration.
3. Criterion matrices, S-system and precision evaluation.
4. Design strategies and examples.

There were altogether 29 participants from 9 member countries in the Tutorial. The response to the Tutorial from them was very positive. The lectures (appr. 200 pages) are reproduced in W. Förstner and M. Molenaar.

5.3. Symposium "From Analytical to Digital"

The Symposium of Commission III "From Analytical to Digital" was held in the City of Rovaniemi, Finland, August 19 - 22, 1986. There were 122 participants from 21 member countries. The number of registered accompanying persons was 15. The Symposium was dedicated to the Memory of Dr. K.G. Löffström who passed away in 1984. Prof. Dr. F. Ackermann gave the first K.G. Löffström Memorial Lecture on the topic "Camera Orientation Data for Aerial Triangulation".

As to the papers of the Symposium over 80 abstracts were received and of those about 75% complete papers with appr. 700 pages were submitted in time for printing. The late papers as well as e.g. the discussions of the technical sessions and the procedures of the Opening and Closing Sessions were published in the third part of the Proceedings.

The program of the Symposium largely corresponded to the structure of the Working Groups. There were only a few lectures discussing other topics.

6. WG activities 1984-1988

6.1 Report of Working Group 1

(by H. Ebner, M. Molenaar and G. Strunz)

Photogrammetric information should not be restricted to photographic images but should include digital image data from optoelectronic cameras. The emphasis of the WG 1 has been on aerial triangulation, although the topics mentioned in chapter 4 are also of importance for triangulation in close range photogrammetry.

WG 1 has had 28 active members and 39 corresponding members. WG meetings were held in Stuttgart October 4, 1985 and in Rovaniemi on August 20, 1986.

At the Commission III Symposium in Rovaniemi, August 19-22, 1986 two technical sessions of WG 1 took place in which 10 papers on combined point determination and a Working Group report were presented.

A joint workshop on "Combined Adjustment of Heterogeneous Geodetic and Photogrammetric Data" organized by the Special Study Groups 1.73 and 4.60 of the International Association of Geodesy and Working Group 1 of the ISPRS Commission III was held at the University FAF Munich on September 22-24, 1986. This joint workshop between geodesists and photogrammetrists brought together 69 scientists from 15 countries. Altogether 13 discussion papers were presented during the 7 sessions. The first contributions were given by T. Krarup on the philosophy of integrated and operational approaches in geodesy and photogrammetry and by D.C. Brown on combined adjustment of photogrammetric and ancillary observations in a retrospective view. Then C. Zenger presented an overview on trends in computer and software technology and the impact on combined adjustment with emphasis on methods for the solution of large systems of linear equations. Integrated models and combined adjustment versus sequential single solutions were treated by A. Dermanis followed by a review by R. Schaffrin on recent methods for the combined adjustment of heterogeneous data. D. Li presented the concepts of reliability and multiple hypothesis testing in combined adjustment and K.R. Koch explained the estimation and testing of variance components for heterogeneous data. Reports on experience with the combination of photogrammetric and geodetic data by S.F. El-Hakim and on experience of integrated geodesy by B. Benciolini et al. followed. The procedure of dynamic modelling and applications for INS and GPS observations was outlined by E.W. Grafarend and K.P. Schwarz discussed precise cinematic positioning and its impact on geodetic and photogrammetric positioning. The contributions of F. Ackermann on joint photogrammetric block adjustment with navigation data as additional observations and G.L. Mader on GPS aircraft positioning for photogrammetric surveys without ground control comprised theoretical and practical results. Summarizing this joint

workshop with its extensive discussions has improved the contact between individual disciplines and confirmed the importance of further cooperation within the geodetic and photogrammetric society. The main lines of the workshop, i.e. short summaries, abstracts and copies of the transparencies are printed in H. Ebner, D. Fritsch, G.W. Hein.

On March 30-31, 1987 a workshop on "Quality Description and Quality Control of Integrated Photogrammetric Terrestrial Networks" took place at the Technical University of Delft. The activities of the workshop were divided into the following four items:

1. The general problem of design and quality control for combined networks.
2. The formulation of criteria for the precision of combined networks.
3. The formulation of criteria for the reliability of combined networks.
4. A discussion on how useful theoretical criteria are in certain practical situations.

For each item there were two presentations giving a formulation on the basic problems and a review of the available strategies to tackle these problems; often illustrated by practical examples. W. Baarda as originator of the Delft approach for network design gave a review on the development of these ideas and concepts. A general outline for the planning of combined photogrammetric blocks and terrestrial networks was given by M. Molenaar. The presentations on S-transformation and the datum definition problem (M. Molenaar) and criterion matrices (H. de Heus) dealt with problems mentioned in item 2. Item 3 was examined by W. Förstner, who gave an introduction on error detection techniques and reliability measures for block and network planning. T. Bouloucos showed the interaction between block and network by the results of a simulation study. Problems and solutions in practice (R. Neleman) and quality analysis in topographic mapping (E. Vaessen, D. Boswinkel) were discussed.

6.2 Report of Working Group 2 (by A. Grün)

During the period 1984-1988 altogether 30 persons from 16 countries were registered as members of WG 2.

On-line triangulation is by its very nature instrument and system related. A successful on-line triangulation procedure requires an optimal tuning of the measurement process and data processing capabilities (algorithmic techniques and available computer hardware). The lack of interest in on-line triangulation during the period 1984-1988 must be mainly contributed to the situation of the instrument sector. In research and development we are in a transition phase "from analytical to digital". There has been no further useful development on analog plotters. The potential of analytical plotters to operate as advanced on-line triangulators has never been utilized and will probably never materialize.

All scientists' attention now is with the digital station. Major

features of digital systems are their flexibility and speed in measurement and data processing. Operator actions can be effectively supported by semi-automated and fully automated routines. On-line capabilities, both on the measurement and on the algorithmic side, are crucial for digital systems. It is expected that on-line point positioning aspects are gaining interest as more people get involved with digital systems. Therefore, as far as the future of this working group is concerned, it is suggested that the scope be expanded to the more general "on-line point positioning" and to processing of digital data, and to include those issues into a newly formed working group dealing primarily with the algorithmic aspects of digital stations.

WG 2 held two Business Meetings, one during the ASPRS Convention, Washington D.C., March 12, 1985, and another during the C II Symposium, Rovaniemi, August 20, 1986. In Washington D.C. the WG program was discussed. It was decided to continue as a study group. The idea of conducting a test on the performance of estimation algorithms was rejected, because most members felt they could not contribute much at that time.

In Rovaniemi the activities of WG members and the need to set new goals and to rearrange the concept of the WG were discussed.

An Intercommission Conference on "Fast Processing of Photogrammetric Data" was organized in Interlaken Switzerland, June 2-4, 1987. This was a joint conference with WG 2 of Commission II and WG 6 of Commission V. The meeting was well attended, with high quality papers focusing on the topic of "Digital Photogrammetry". The interdisciplinary discussions were very much appreciated. The papers are published in Proceedings edited by A. Gruen, H. Beyer, Z. Parsic and L. Steinbrückner.

6.3 Report of Working Group 3 (by O. Jacobi)

A Workshop on Digital Terrain Models was held at Ohio State University, Columbus, USA, on March 14 - 15, 1986. There were 15 participants from USA, Canada and Europe. They were asked to give presentations to stimulate discussions on the following subjects.

- DTM and the physical description of the terrain.
- DTM data capture - sampling spacing, specifications and quality control, automatic versus manual capture.
- DTM data storage and compression - updating and editing, problems of storage space and access time.
- DTM interpolation methods - necessity of breaklines and breakline definition, accuracy specification and quality control of interpolation.
- DTM recommendations for work standards, contracting and overall quality control.

Proceedings of the workshop are printed in a 150 page report with appendices of 5 papers.

In the Commission III Symposium in Rovaniemi, August 19 - 22, 1986, Working Group 3 had two of its own technical sessions in which a WG report and eight papers on digital terrain model classification and sampling, and mathematical procedures and

software were presented. In addition there was a joint session with WG 4 on digital surface model generation using image matching techniques.

A panel discussion "Review and Outlook" and a WG meeting were held in connection with the ASPRS/ACSM 1987 convention in Baltimore, USA, on April 3, 1987.

A Colloquium "Progress in Terrain Modelling" was held in Lyngby, Denmark on May, 20 - 22, 1987. Altogether 59 participants from 14 countries in Europe and North America attended. The 25 papers presented in the colloquium covered the following subjects:

- Data capture and control.
- National elevation data bases.
- Interpolation.
- DEM-applications.
- Terrain characteristics and data compression.
- Sea bed modelling.
- DEM program systems.

The Proceedings of the colloquium are published in O. Jacobi, P. Frederiksen.

6.4 Report of the Working Group 4 (by W. Förstner and E.M. Mikhail)

During the period of activity, four WG Circular Letters were published and distributed. As stated in the first CL, the Working Group was set up to deal with problems of pattern recognition and image analysis as far as photogrammetric tasks are concerned, and to continue the combined activities of the two previous working groups 4 and 5 (1980-1984). Consequently, attached to CL 1 there was a response sheet for collecting data from prospective WG members. Altogether 95 responses were received from 180 addressees.

The Working Group dealt with both theoretical as well as experimental research. Theoretical research consists of individual contributions on aspects which are common to the problems of interest.

Parallel to those theoretical analyses, experimental research was also planned. Four experimental tests were proposed: (A) on Image Matching, (B) on Rectification and Registration, (C) on Classification and Image Analysis, and (D) on Road Finding and Tracking. About 60 participants selected Test A, almost half of them are photogrammetrists/geodesists, while Tests B,C,D each received only between 12 and 14 votes. Therefore, Test A was selected which contained 12 digital image stereo pairs, each 260 x 260 pixels. The primary aim of the test was to establish the state-of-the-art of image matching in the fields of computer vision, pattern recognition, and photogrammetry, including different strategies and an indication of the quality of matching. The 60 individuals who received the Test A data came from 16 different countries, which is an indication of the widespread interest in the activities of this Working Group.

There were 18 responses with actual results for Test A data, and additionally three responses but without results. Of the 18 respondents with results, 11 were photogrammetrist/geodesists which is an indicator of notable improvement in the interest of photogrammetrists in the general area of digital image processing and analysis over that shown in the last Congress. In an invited paper to the Kyoto Congress, Mr. E. Gülch gives the details of the collected results and their analyses. He presents an investigation of the versatility and flexibility of different matching procedures used, and compares the matching results to those obtained by manual or computational means leading to precision and reliability studies.

Working Group 4 was one of most active during the period between Congresses. At the Rovaniemi Symposium of Commission III in 1986, there were over 20 papers presented on the topic of this Working Group. For the Kyoto Congress, the Working Group Co-Chairmen received nearly 70 papers for consideration on various WG areas of activity. There was also a very successful Workshop on Image Matching, which was held at Stuttgart University in September 1987. Several prominent researchers, both in photogrammetry and in Computer Vision were invited and gave detailed presentations on such pertinent topics as Phenomena of Human Binocular Vision, High Precision Image Matching, Relational Matching and Region Matching. The main lines of the Workshop are summarized in E. Gülch.

6.5 Report of the Intercommission Working Group III/IV

The report of the Working Group III/IV is presented separately to the Congress by the Working Group Chairman Dr. Roy Welch.

7. Program for the Kyoto Congress

Commission III has in the Kyoto Congress the following Technical Sessions:

- 8 Technical Sessions
- 2 Technical Sessions for WG III/IV
- 1 Technical Session for C II/III/V (joint session)

In addition to the above sessions Commission III has a Business Meeting and a big number of Poster Sessions.

The number of the abstracts of the WGs 1-4 received for the Kyoto Congress is close to 200. In addition WG III/IV has about 70 abstracts. These high numbers naturally correspond to the interest in the topics dealt with in Commission III, and they indicate the correct selection of the research areas for the time being.

8. Publications of the Commission III

Kubik, K., Roy, B.C.(Ed.): Proceedings of the Digital Model Workshop. Columbus, Ohio, U.S.A., March 14-15, 1986.

Kilpelä, E., Savolainen, A., Laiho, A. (Ed.): Proceedings of the Symposium "From Analytical to Digital". International Archives of Photogrammetry and Remote Sensing Vol. 26-3/1-3. 944 p. Rovaniemi, Finland, August 19-22, 1986.

Förstner, W., Molenaar, M.: ISPRS Commission III Tutorial on Statistical Concepts for Quality Control. International Archives of Photogrammetry and Remote Sensing Vol. 26-3/4. Rovaniemi, Finland, August 18, 1986.

Ebner, H., Fritsch D., Hein G.W.(Ed.) : Minutes of the Joint Workshop on Combined Adjustment of Heterogeneous Geodetic and Photogrammetric Data. Munich FRGermany, September 22 - 24, 1986.

Gruen, A., Beyer, H., Parsic, Z., Steinbrückner, L. (Ed.) Proceedings Intercommission Conference on Fast Processing of Photogrammetric Data. Interlaken, Switzerland, June 2 -4. 1987. 437p.

Jacobi, O., Frederiksen, P. (Ed.): Proceedings of the International Colloquium "Progress in Terrain Modelling". Lyngby, Denmark. May 20 - 22, 1987. 298 p.

Gülch, E. (Ed.): Minutes of the Workshop on "Image Matching", Stuttgart, FRGermany, September 9 - 11, 1987.

9. Acknowledgements

As my eight-year presidency of Commission III comes to an end with this Kyoto Congress, I want to cordially thank the Working Group Chairmen for their excellent work during this time. Their role in realizing the interesting programs has been great and decisive. Further, I thank the WG members and all the others, who have contributed to the success of Commission III activities. Naturally I owe special thanks to Commission Secretary Mrs. Aino Savolainen for her indispensable work.

I can only say that I have greatly enjoyed this international cooperation.