

## XIXTH INTERNATIONAL CONGRESS OF PHOTOGRAMMETRY AND REMOTE SENSING

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### *Abstract*

*The XIXth International Congress of Photogrammetry and Remote Sensing was held at the Amsterdam RAI International Exhibition and Congress Centre, the Netherlands, from 16th to 23rd July 2000. Reports are given on the Congress as a whole, including the General Assembly, some Technical Commission activities and the Congress Exhibition. Papers from the Congress are published in the International Archives of Photogrammetry and Remote Sensing, 33.*

KEYWORDS: geoinformation, ISPRS Congress, photogrammetry,  
remote sensing

### CONGRESS OVERVIEW

THE XIXth International Congress of Photogrammetry and Remote Sensing was held at the Amsterdam RAI International Exhibition and Congress Centre, the Netherlands, from 16th to 23rd July 2000. It was attended by 2120 participants from 93 countries. The commercial exhibition attracted 89 companies and there were 20 displays in the national members' and scientific exhibition. Six pre-Congress tutorials attracted 130 participants and 410 people went on the five technical tours, including one tour to ITC at Enschede which celebrated its 50th anniversary in the year 2000. ISPRS previously held a Congress in the Netherlands in 1948, at The Hague.

The attendance statistics were similar to those for the 1996 Congress in Vienna but an organisational change saw the shortening of the Congress from two weeks to eight days (Sunday to Sunday) and the exhibition to five days (Monday to Friday). This concentration of activity led to high attendances at the technical sessions and the exhibition throughout the Congress. The exhibitors appreciated the compact one-week programme and the quality of the visitor interaction.

#### *Opening Ceremony and Plenary Session*

The Congress theme was “Geoinformation for all”, chosen to emphasise the service that the spatial information sciences can provide to society generally. In July 2000 ISPRS published its Strategic Plan for the 21st Century, written by the outgoing President, Lawrence W. Fritz. This plan carries the mission statement that ISPRS should be “devoted to the development of international cooperation for the advancement of *knowledge, research, development and education in the photogrammetry and remote sensing and spatial information sciences, their integration and applications, to contribute to the well being of humanity and the sustainability of the environment*”. (*Italics indicate new wording compared with previous mission statements.*) The new part of the mission statement, giving as much emphasis to spatial information sciences as to photogrammetry and remote sensing, represents a move by ISPRS to broaden the scope of its operations. This was also reflected in the structuring of the scientific technical programme of the Congress and in the choices of the keynote speaker for the opening ceremony and of the three invited speakers in the plenary session that followed.

The invited keynote speaker was Ismael Serageldin, recently Vice President of the World Bank, who presented his audience with numbing illustrations of some of the resource and environmental problems facing certain parts of the world. The three invited speakers are all very qualified in the geoinformation field to comment on the Congress theme. Each stressed the need for a new visualisation of geoinformation. Firstly, Krishnaswamy Kasturirangan, the Director of the Indian Space Research Organisation, illustrated the need for information and reminded his audience of such structural issues as database standards, interoperability, access and GIS clearing houses. Jack Dangermond, the President of ESRI, continued this theme by stressing the need for integrating the presently focused but fragmented information systems. He foresaw a GIS/Geography network channel on the Internet. Finally, He Changchui, Chief of the Environmental and Natural Resource Service of the Food and Agriculture Organization of the United Nations (FAO), described FAO’s strategy and efforts in international cooperation and participation. He asked for more research and development and technology transfer, but saw the 21st century as knowledge based, not technology based. His mantra for FAO and message for the Congress was “to think globally, plan practically and act locally”.

#### *The Scientific Technical Programme*

Reflecting the theme of “Geoinformation for all”, with its implication of wide technical range and global relevance, the scientific technical programme was developed well beyond the seven separate Technical Commissions (TCs). Following receipt of abstracts in 1998, the programme was organised by themes into six

different types of scientific technical sessions, only two of which were based on the TCs.

- (1) 44 TC sessions, organised by the seven TC Presidents.
- (2) 30 Interactive Poster sessions, a procedure developed in Vienna with 2-minute lecture room introductions for each of about 20 poster papers per session, followed by interactive discussions at the poster booths. A total of 625 posters were listed for presentation.
- (3) 35 Inter-TC sessions, comprising subjects of a broader content than those in individual TCs.
- (4) 6 Special sessions to enhance the dialogue between scientists, industry, policy-makers and users. Organised by Council members, these sessions included such topics as the availability of spatial data, business opportunities with spatial data, and GIS for sustainable development.
- (5) 16 Exhibitors' Showcase sessions for presentations by commercial firms engaged in any technology. These were considered a great success.
- (6) 8 Add-on sessions as a forum for various international organisations. The mixed bag included sessions for OEEPE, ICOMOS, CATCON 2, and ISO Standards.

All accepted papers have been included in the *International Archives of Photogrammetry and Remote Sensing*, Volume XXXIII, and are available for purchase. In addition, as an innovation at this Congress, the papers from the seven Technical Commissions, on two CD-ROMs, and the 959 abstracts of all papers, in a separate abstract book, were presented to all participants. A third supplementary CD-ROM was to be distributed after the Congress. In addition, the book *Global Environmental Databases—Present Situations; Future Directions* (edited by R. Tateishi and D. Hastings), published by ISPRS Working Group IV/6 (1996–2000), was officially released at the Congress and distributed to each member delegate.

#### *General Assembly Issues*

The General Assembly convened on four occasions for delegates to deal with lengthy agendas. Six organisations were admitted to ISPRS as new Ordinary Members, representing Botswana, Eritrea, El Salvador, Bangladesh, Benin and Cameroon, which brings the total Ordinary Membership to 103. A further seven organisations were admitted as Associate Members and two as Regional Members. With respect to members in default, the General Assembly voted to expel members who do not, with reasonable cause, request a delay in payment within six months of Council's communication.

ISPRS has reached a new agreement with Elsevier Science for the publication of the *ISPRS Journal of Photogrammetry & Remote Sensing*. ISPRS has regained ownership of the title name and plans to call for more outreach to developing countries. The quarterly bulletin, *ISPRS Highlights*, which commenced with the post-Vienna Congress edition in 1996, is now being published by GITC. A financial



The UK delegation to the ISPRS General Assembly, July 2000: Delegate Dr R. P. Kirby, flanked by Advisers Mr P. R. T. Newby and Mr I. D. Downey, with Professor I. J. Dowman (ISPRS Secretary General elect) behind.

consultant has been hired to assist the elected ISPRS Treasurer in managing the complex bank and investment accounts.

The ISPRS Strategic Plan for the 21st Century, already referred to, was presented by the President with details of activity goals and objectives, and was endorsed by the General Assembly. Two new ISPRS committees with international memberships have been set up: the International Policy Advisory Committee (IPAC) in 1998, chaired by Ray Harris, and the International Science Advisory Committee (ISAC) in 1999, chaired by Shunji Murai.

The General Assembly discussed and accepted 57 resolutions collectively proposed by Council, delegates and TCs. General recommendations included new guidelines for Commission correspondents, further inter-TC activities, and the need to establish an International Industry Forum.

To host the next Congress in 2004, there was competition between China, Spain and Turkey. Spain was eliminated on the first ballot and, on the second ballot, Turkey won by 113 votes to 69. Therefore the 2004 Congress will be held in Istanbul with Professor Dr Orhan Altan as the new Congress Director.

The Technical Commissions for the period 2000–2004 were elected as follows:

<i>Commission and Name</i>	<i>Host</i>	<i>President</i>
I Sensors, platforms and imagery	USA	Stanley A. Morain
II Systems for data processing, analysis and representation	China	Jun Chen
III Theory and algorithms	Austria	Franz Leberl
IV Mapping and geographic information systems	Canada	Costas Armenakis
V Close-range techniques and machine vision	Greece	Petros Patias
VI Education and communications	Brazil	Tania Maria Sausen
VII Resource and environmental monitoring	India	Rangnath R. Navalgund

The Technical Commissions will each hold a symposium during 2002 with dates and venues provisionally fixed as follows:

<i>Commission</i>	<i>Symposium dates in 2002</i>	<i>Venue</i>
I	11th to 15th November	Denver
II	20th to 23rd August	Xian
III	9th to 13th September	Graz
IV	6th to 10th May	Ottawa
V	3rd to 6th September	Corfu
VI	10th to 12th September	Rio de Janeiro
VII	4th to 6th December	Hyderabad

The ISPRS officers elected to serve for the period 2000–2004 are:

*ISPRS Council*

President	John C. Trinder (Australia)
Secretary General	Ian J. Dowman (United Kingdom)
1st Vice President	Lawrence W. Fritz (USA)
2nd Vice President	Gérard Bégni (France)
Treasurer	Ammatzia Peled (Israel)
Congress Director	M. Orhan Altan (Turkey)

*Financial Commission*

Chairman	Heinz Rüther (South Africa)
Members	Marcio Barbosa (Brazil) and Iffat Huque (Bangladesh)

*Awards*

At the Congress opening ceremony, honorary membership was awarded to Professor Shunji Murai (Japan), whose international contribution to the fields of remote sensing, photogrammetry and surveying, especially in Asia, has been truly enormous. Honorary membership of ISPRS is limited to seven persons at any time. The Brock Gold Medal was awarded to J. Dangermond (USA), and the Otto von

Gruber Award was presented to H. Mayer (Germany) and G. Vosselman (the Netherlands). The U. V. Helava Award, a new award to authors of the best paper published in the *ISPRS Journal* in the previous four years, was made to M. Meister (Germany), A. Gruen (Switzerland) and H. Dan (Switzerland).

In the plenary session, the Willem Schermerhorn award was presented to T. Woldai (the Netherlands). Young author awards were made to B. Ameri, S. Priya, G. Zalmanson, J. Schiewe, A. Brunn, Jun Li and M. Honikel. At a subsequent General Assembly, Samuel Gamble Awards were made to A. A. Abiodun (Nigeria) and B. Forster (Australia), and Doležal Awards to I. Katzarsky (Bulgaria), U. R. Rao (India) and P. Tarikhi (Iran), as well as U. V. Helava certificates for best papers in 1997, 1998 and 1999 to other persons too numerous to list. Schwidefsky Medals were presented to G. Ducher (France) and L. R. A. Narayan (India).

### *Social Programme*

The Congress was underpinned by a very efficient administration (except in respect of hotel bookings, which were sub-contracted). The seven issues of the daily newspaper published by GITC were a model of their kind, including programme changes and featuring different IKONOS high resolution images each day. The liberal cultural identity of Amsterdam was evident in the welcoming reception, in the civic reception at the Maritime Museum and, for invited delegates, by a canal tour. The cultural highlight for many participants was the DinnerShow 2000, an extravagant multi-media evening at Studio 21 in the Netherlands' Media Park at Hilversum—a pageant of 2000 years of European social history by means of tableaux, song and dance, slickly performed by a large professional company. Commission V (visualisation) inevitably claimed some of the credit for the spectacular light and sound effects.

### *Conclusions*

This brief summary of a large, successful Congress has concentrated on names and activities. At the closing ceremony, a new ISPRS logo was introduced, reflecting the current dynamism of the Society and prompting a comment on how far the Congress reflected the wider aims of ISPRS. The overall impression is of an international society working hard to support its Ordinary, Associate, Regional and Sustaining Members while also increasing its cooperation with other international organisations. Council's primary achievement since the previous Congress has been the preparation and refinement of the Strategic Plan. While the seven Commissions and their Working Groups remain at the core of the technical programme, the deliberate move to broad themes cutting across Commission boundaries indicates the anticipated future scope of ISPRS operations. Also, the choice of guest speakers in Amsterdam, from the World Bank and other user communities, was presumably designed to reinforce the importance of wider issues. The incoming President, John Trinder, has already stated that implementation of the Strategic Plan is the most

important new task; this includes keeping up with changing technologies, particularly in the field of spatial information sciences. By concentrating on information from imagery, the Society can complement other organisations already operating in the geoinformation field.

The Congress website including the full Congress programme and all abstracts is: [www.itc.nl/~isprs](http://www.itc.nl/~isprs)

The new address of the ISPRS home page is: [www.isprs.org/isprs](http://www.isprs.org/isprs)

The website of the publishers of *ISPRS Highlights* is: [www.gitc.nl](http://www.gitc.nl)

ROGER P. KIRBY

*UK Delegate to General Assembly*

#### COMMISSION I: SENSORS, PLATFORMS AND IMAGERY

SINCE the Vienna Congress, the technology of sensors and platforms has made substantial progress in various areas. Authorisation to own and operate satellites giving 1 m resolution has stimulated a number of companies to develop high resolution earth observation systems. The first of these, IKONOS, has been successfully operating since 1999 and represents the beginning of a new era of satellite imagery which is likely to approach the resolution of aerial data. The interest in high resolution imagery generated in the remote sensing community is well evident from the overwhelming attendance (more than 275) at the session on "high resolution sensor data".

Sensors dedicated to elevation extraction, using fixed fore and aft cameras, and interferometric SAR open up new possibilities for topographic mapping. A number of papers were presented at the congress on various aspects of SAR, including the development of new algorithms to reduce noise and sharpen feature edges. Another area of interest which uses SAR is moving target identification. Multifrequency/multipolarisation SAR is likely to open up new vistas of application. The availability of hyperspectral data and multi-angle sensing have also presented the opportunity for new areas of application, which will enhance the use of remote sensing data.

Platform technology has been improving, resulting in spacecraft with lower weight and less power. The combined use of GPS, star sensor and other devices enables a positional accuracy of a few pixels to be achieved even without resorting to ground control points.

With the new possibilities for data fusion from different sensors, the need for geometric and radiometric calibration has become increasingly important, as demonstrated by a number of papers.

To sum up, numerous innovations are taking place in the field of sensors and platforms, which could make remotely sensed imagery useful for several new tasks. These developments also pose new challenges. With a large number of sensors available, use of the data from them as supplementary and complementary information calls for a uniform code for specifying sensor parameters and their

evaluation methodology, thereby enabling spatial, spectral and radiometric inter-comparison to be meaningful. This rationalisation could be one of the major tasks for the Commission in 2000–2004.

GEORGE JOSEPH  
*President, Commission I, 1996–2000*  
*(Indian Space Research Organisation)*

#### COMMISSION II: SYSTEMS FOR DATA PROCESSING, ANALYSIS AND REPRESENTATION

THE main themes of the Commission II programme were related to the fusion of data to produce useful information by processing within photogrammetric digital systems and integrating into GIS. This process involves several focal points, including algorithms for feature extraction which can be incorporated in systems for automatic registration and data fusion. Papers by Stilla (generation of 3D city models) and Dare (feature-based registration) showed the directions of work in this area and McKeown emphasised the importance of performance evaluation for automatic feature extraction. It was reported by Gülch that semi-automatic systems are now found in commercial systems. There was great interest in the photogrammetric software for the new digital cameras, particularly the systems being developed by LH Systems and Z/I Imaging, as reported by Tempelmann and Doerstel, and it appears that the community is receptive to using this new technology. On the integration of photogrammetric systems with GIS, Estes and Ehlers gave an overview and a number of speakers, including Woodsford from Laser-Scan, gave specific examples.

Integration in another sense was highlighted in the sessions on real-time mapping and use of sensors on airborne and other platforms. Mobile mapping system components, including GPS, INS and mapping sensors are integrated and modularised for commercialisation. Papers by Li (recognition of civil infrastructure objects), Ellum (backpack mobile mapping system) and Murai (integration of three-line scanner with INS and GPS) indicated that the utilisation of such modules was successful.

The successful development of image transfer standards in collaboration with ISO and OGC was demonstrated in a session with papers from Fadaie on ISO, Di from NASA and Thorpe representing the commercial users. ISPRS is playing an important role in this work and Kresse reported on the current status.

The goal of the commission to promote SAR data was achieved by conducting a tutorial before the congress and by devoting several sessions to SAR throughout the congress. The topic of interferometric SAR was covered by a number of papers, for example Mercer presented a poster on airborne InSAR; stereo SAR (Chen) was also shown to be an important complementary method.

The session on “Systems for new data products” was a panel-led discussion on the challenges facing remote sensing systems. These were seen to be the variability of formats and the consequent difficulties of accessing remote sensing data, the price of remote sensing data, particularly from operational programming, and the lack of calibration and orientation data provided by operators.

The issues facing systems on a global scale were discussed, with Williams from EUMETSAT and Churchill (JRC) presenting papers on IGOS and CEOS. Sustainable earth observation requires a greater coordination of both user



information requirements and supplier offerings and both IGOS and CEOS are significantly assisting this process.

Overall, the Commission II programme highlighted the increasing importance both of viewing systems in totality and of incorporating appropriate data to solve user requirements. The issues of transfer standards, evaluation and global initiatives are all related to achieving these aims.

IAN J. DOWMAN

*President, Commission II, 1996–2000*  
*(University College London)*

### COMMISSION III: THEORY AND ALGORITHMS

COMMISSION III has had the most encompassing title “Theory and algorithms” and has been one of the most heavily subscribed commissions for a long period; this congress was no exception. Many papers which could have been in Commission III have been allocated to other commissions to make the workload among commissions more balanced and more manageable. This dispersal has, however, made it difficult for this report to be comprehensive. A summary is given, following set themes from about 35 papers presented in 7 oral sessions and 80 papers in 4 poster sessions. Including those presented in the relevant Inter-TC sessions, altogether about 150 papers have been collected in the Commission III volumes of the Archives.

#### *Calibration, Orientation and Adjustment*

For the fundamental orientation problems, new formulae using the fundamental matrix and the trifocal tensor were introduced and their adoption was advocated to facilitate communication with sister societies involved in computer vision and computer graphics (Ressl, Theiss and Förstner, Niini). Lidar data filtering, adjustment and systematic error correction were investigated to reveal greater achievable accuracy (Crombaghs, Cage, Burman, Maas, Weisensee). Rational functions were given renewed attention and considered to be viable models for the IKONOS 1 m image sensor and other uncalibrated non-frame image sensors (Dowman, Tao). The 2D affine projection model has been shown to be effective with experiments using SPOT and MOMS-2P images (Hattori, Ono). A number of experiments were reported which assessed the accuracy and benefits of GPS/INS direct orientation as opposed to, or as combined with, aerial triangulation (Cramer, Colomina, Heipke, Jacobsen, Wicherson). With regard to automatic absolute orientation, interesting results have been described in the use of network features and surfaces (Jaw, Oda, Shan, M. Smith).

#### *Algorithms for Surface Reconstruction*

Stereo matching and surface reconstruction were still the key words for numerous papers and the theme of two oral sessions and a poster session. The first oral session was started by Jahn who presented a parallel stereo matching method

suitable for exploiting neural network and real-time implementation. McIntosh then reported how airborne laser scanning data could improve automatic digital surface model generation in urban areas. An overview on the joint advantages of laser and stereo imagery for surface extraction, given by Toth, followed. Vosselman then presented an erosion based filter for cleaning laser scan data. H. J. Park described a matching strategy that combines point matching and line matching based on comparison of line shapes, flanking region colour, and point-line positional relationship and connectivity. In the second oral session, Lohmann started with approaches to the filtering of laser scanner data. Scholze followed by describing how colour could be exploited for edge extraction and line segment stereo matching. Heitzinger presented knowledge-based 3D surface reconstruction. Piechullek reported on simulation studies and tests using multi-image shape from shading. Kubik presented a robust estimation method for matching for DEM generation. Overall, the trend in matching and surface reconstruction is to combine laser data, to interact with object recognition and to increase robustness with statistical and knowledge constraints. Presentations were also made on registration and integration of images with GIS (Filin, Forghani), surface matching (Xu, Kager, Zhao) and line matching (Shao, Zhou, Y. Chen).

#### *Image Understanding and Object Recognition*

Presentations on these subjects were strongly focused on road and building extraction. Although no breakthrough was reported, steady progress was shown. The approaches, though diverse, were grouped on the use of multi-images, knowledge and detailed models that incorporate contextual information (Baumgartner, Bibitchev, Boichis, Growe, Heuel, Hinz, Wallace, Wiedemann, C. Zhang) and also on the use of multi-sensor data, particularly laser scanning data (Hazarika, Geibel, Z. Wang, Vögtle). Both automatic and semi-automatic systems were covered. Presentations were also given on field extraction and land use classification, using a region competition algorithm (Torre), data mining technique (Li) or SAR data combined with optical imagery (Hellwich). The topics in the poster session and some Inter-TC sessions under object recognition were even more diverse, extending to recognition of trees (Bacher), road surface textures (Paquis) and language characters. Techniques adopted included neural networks (Hu, Bellman), Bayesian networks (Brito), fuzzy logic (Abramovich, Samadzadegan), self-organisation (Doucette), simulated annealing (Trinder), Markov random fields (Brunn) and so on. More comprehensive accounts of urban modelling and visualisation can be found in papers by Mikhail, Z. Zhang, Uehara and Coppola. Many problems in object recognition are difficult and will remain so for years to come; Michaelsen explained a list of them.

YI DONG HUANG  
*UK Correspondent to Commission III*  
*(University of East London)*

#### COMMISSION IV: MAPPING AND GEOGRAPHIC INFORMATION SYSTEMS

THE PROGRAMME for Commission IV was vast, with the printed version of the 185 papers taking up 1264 pages and occupying three large volumes of

the *International Archives of Photogrammetry and Remote Sensing*. Since the programme of oral and poster presentations often did not follow the established Working Groups of the Commission, it was not easy to follow the order or the themes under which these papers were presented. Of the various groups of papers presented in the Technical Commission (TC) sessions, three of these each had five presented papers given within the 90 minutes allocated to each session, while two groups each had ten presented papers given over two of these 90 minute sessions. Thus 35 papers were fully presented in the seven TC-IV sessions. However, it also emerged that five of the so-called Inter-technical Commission (IC) sessions (IC-14 to IC-18) were essentially Commission IV sessions. Again three of them had five papers given in a single 90 minute session, with the other two each having ten papers that were given over two sessions. Of these 35 additional papers, 31 were printed in the Commission IV volumes. Thus, in total, 66 of the papers submitted to Commission IV—roughly one third—were presented orally. The remaining papers were allocated to Technical Poster (TP) sessions. There were six of these poster sessions, each containing approximately 20 papers. With these arrangements, it was not possible, in many cases, to attend a single session on a particular theme (for example, the papers on a specific subject such as mapping from satellite imagery or from airborne scanner imagery were spread over several different IC, TC and TP sessions). Thus your contributor will attempt to review the papers under what he considers to be the main subjects concerned with photogrammetry and remote sensing covered by Commission IV at the Amsterdam Congress. There were plenty of other papers wholly or mainly concerned with GIS, computer science, cartography and so forth that were given within the Commission IV programme; these will not be considered in this account.

Since one of the main highlights of the Congress was the introduction or advent of several new airborne and spaceborne imagers, it would seem appropriate to review first the papers that were related to these devices and the imagery produced by them. This will be followed by a review of mapping from satellite imagery and finally the numerous papers on mapping from aerial photography will be discussed.

#### *Mapping from Airborne Scanner Imagery*

Given the excitement generated by the introduction of the LH Systems ADS40 airborne pushbroom scanner, developed in collaboration with DLR, and the recent use of the latter agency's own HRSC-A scanner for the mapping of urban areas in Western and Central Europe, this was a subject of intense interest to many participants. Unfortunately it suffered from the fragmentation of the six contributions, which were to be found spread over four different sessions. These were IC-15 (with one paper); TC-IV-06 (three papers); TP-IV-01 (one paper) and TP-IV-02 (one paper). The first of these papers by Haala, Fritsch and others from IfP, Stuttgart, was absolutely first-class, giving the results of comparative tests of the imagery from the DPA scanner (from DASA) and the HRSC-A and WAAC scanners (from DLR) over a test field near Stuttgart. Comparisons were made with the results obtained from comparable metric film camera photography of the area. The paper also spelt out the procedures and some of the difficulties that can be experienced with the processing of this type of pushbroom scanner imagery. Many

of the same remarks can be made regarding the three TC-IV-06 papers. Albertz of TU Berlin and his collaborators from DLR described the software and the procedures used for the digital cartographic production of maps of the active Vulcano island in Italy from HRSC-A imagery. The second of these three papers was given by Moeller of Vechta University and dealt with the generation of DEMs and building height information from HRSC-A imagery for the city of Osnabrück. The third, by Hofmann (of Delphi2) and Reinhardt (of the University of the Federal Armed Forces, Munich), dealt with the use of the Delphi2 company's new eCognition object-oriented image analysis software for the extraction of features from DPA imagery of the Buckeburg test area.

The two poster papers were of a similar high quality and interest. Scholten of DLR (who is an excellent speaker, but was relegated to a poster in session TP-IV-01) covered the data acquisition, processing and geometric validation of the HRSC-A system over a test field near Cologne and various applications of the resulting HRSC-A imagery over different sites in Europe. The final paper by Reulke et al. from LH Systems and DLR gave the results obtained using the engineering model of the ADS40 imager over a test field near Berlin. Taken together, these six highly informative papers would have made a really outstanding single session. Why this was not done for such a hot topic was quite incomprehensible to your reviewer. But these six papers in the *Archives* do deserve to be read: they are highly relevant to the photogrammetric future and there is much to be learned from them by all photogrammetrists who are venturing into this new area for the first time.

#### *Mapping Potential of the DMC*

Also concerned with the new generation of digitally-based imagers—in this case, the Z/I Imaging Digital Modular Camera (DMC)—was the excellent paper by Tang, Dorstel, Jacobsen, Heipke and Hinz from Z/I and the University of Hanover. Curiously, this very important contribution was only included as a poster paper in Session TP-IV-02. As one would expect, this high-powered group had made a very thorough photogrammetric analysis of the imager, including its geometric characteristics, the requirements for the transformation and processing of the imagery, and its geometric accuracy potential. Again, in your reviewer's opinion, this paper is a "must read" item in the *Archives*.

#### *Mapping and DEMs from InSAR Imagery*

This was one of the subjects that did have a reasonably coherent session (IC-15a). The first paper by Tighe of Intermap Technologies described the ongoing project of undertaking the topographic mapping of Puerto Rico at 1:20 000 scale from airborne interferometric SAR (InSAR) imagery acquired by the company's STAR-3i system mounted in a Learjet aircraft. This reflects the intense current interest in this type of imagery in North America, the use of this SAR imagery being especially suitable to overcome the difficulties of acquiring usable optical imagery over this cloudy subtropical area. The other four papers in this session all dealt with the generation of DEMs from InSAR imagery acquired by the ERS-1/-2 Tandem mission. The first, given by Morley et al. (mainly from University College London (UCL)), concerned the production of a DEM of the British Isles using

the 80 pairs of ERS SAR interferometric images required to cover the area. The raw SAR dataset amounts to 53 gigabytes. Thus much of the processing has been carried out on the high-performance MIMAS computer (equipped with 23 Sparc processors) at the University of Manchester using the PulSAR software and InSAR toolkit provided by Phoenix Systems. The resulting DEM will be used as the basis for the generation of Landmap, an integrated set of ortho-rectified and mosaicked Landsat and SPOT imagery intended mainly for educational and academic research purposes. Slob et al. from the Royal Museum of Central Africa near Brussels reported on their experiences with DEM generation from ERS-1/-2 Tandem data for part of NE Uganda carried out on behalf of the Ugandan Geological Survey. While the flat areas were covered in a reasonable manner, many of the images of the vegetated mountain areas displayed a lack of coherence, so the interferometric fringes (and therefore the DEM) could not be generated for these areas. Tokunaga (Japan) attempted to measure the deformation of the volcanic cone and the area and depth of the lava flows from the active volcano of Mount Mayon in the Philippines. He also experienced difficulties with lack of coherence in parts of the InSAR imagery. The final paper in Session IC-15a by Shiping (China) covered all the theory and equations behind his PC-based InSAR processing package and provided some test results for the Mount Etna area in Italy.

It was a great pity that the very interesting paper by Siebe and Kaufmann on their use of both airborne InSAR data from the STAR-3i system and digital photogrammetric methods using the ERDAS OrthoMAX package to generate height data in urban areas in Germany for radio planning purposes could not have been included in this session instead of being relegated to the TP-IV-01 poster session. Another interesting poster paper was that given in the TP-IV-05 session by Sharov et al. from the Joanneum Research Centre in Graz. They reported on the mapping of the Western Arctic coast of Russia and the detection of movement in the glaciers and sea ice of Franz Josef Land using ERS InSAR data. In summary, the various contributions to the topic of mapping from both airborne and spaceborne InSAR data were really interesting and, in total, quite significant as pointers to their future use.

#### *Mapping and DEMs from Airborne Laser Scanning*

This highly topical subject was covered by relatively few papers: only two fully presented papers given in Session IC-15b and a poster paper in Session TP-IV-01. Axelsson (Sweden) described a filtering method to recover the ground surface from the airborne scanner data using an adaptive TIN model that can handle terrain discontinuities. The procedure starts with a sparse TIN model which is then densified in an iterative procedure. The algorithm has been implemented with the Terrasolid software and results from its use were given using data from the Swedish-built TopEye scanner. The other very detailed paper from IC-15b was that given by Favey et al. from the ETH in Zurich. This described the use of data acquired by an airborne laser scanner (the ScaLars II of the University of Stuttgart) over the Unteraar and Lauteraar glaciers in Switzerland in comparison with the elevation data extracted from metric aerial photography. Overall the laser-derived data was less accurate but had fewer large errors than those encountered with the digital photogrammetric method based on automatic image matching. The study also

contained an interesting comparison of three DPWs: the Inpho Match-T, LH Systems 770 and VirtuoZo systems. The poster paper was by Akiyama of the Aero Asahi Corporation in Japan and gave a straightforward account of his company's experiences with an Optech laser scanner mounted in a helicopter.

#### *Mapping and DEMs from Satellite Imagery*

This was another well-defined area of high current interest where unfortunately the papers were scattered over many different sessions, in spite of the fact that the Commission had established a specific Working Group (IV/4) entitled "Mapping Potential of High Resolution Satellite Imagery". Once again, one really had to search around and then attend parts of seven different sessions to find the relevant papers, instead of having them concentrated in a session (or two!) devoted to WG IV/4. In fact, only three out of 17 or 18 papers on this important topic were presented orally. One of these was an interesting paper by Armenakis of the Canadian Centre for Topographic Information (CTI) given in Session TC-IV-06. He reported on the continuing efforts of this national mapping organisation to use satellite imagery for map revision at 1:50 000 and 1:250 000 scales and the updating of the corresponding databases. On this occasion, ortho-rectified IRS-1C Pan stereopairs and LISS multi-spectral imagery were used for change detection employing a semi-automated procedure and automated classification methods based on PCI software, and the use of LH Systems DPWs for the generation of the orthoimages and of CARIS for the cartographic production operations. In the same session, Ohlof et al. reported on a comprehensive series of tests to carry out revision of the military V-Map series for the German Federal Armed Forces at 1:250 000 (Level 1) and 1:50 000 (Level 2) scales over test areas near Cologne and Minsk (for Level 1) and Buckeburg and Sarajevo (for Level 2). This employed a wide variety of satellite images acquired by optical (TM, SPOT, IRS) and microwave (ERS, JERS, Radarsat) imagers together with aerial images used for comparative purposes. As with previous tests of this kind, there still was a fairly large shortfall in the completeness of the revision data that could be extracted from the satellite imagery. In the third fully presented paper (given in Session IC-17), Walter of IfP, Stuttgart, also discussed the results achieved with software developed at the Institute for automatic change detection in the German ATKIS data using both spaceborne (IRS and MOMS) and airborne data. For this approach to be successful, high resolution imagery from airborne or spaceborne imagers is required.

Turning next to the many poster papers, another study on map revision from satellite imagery was contributed by de Freitas from Brazil in Session TP-IV-05. This concerned the revision of 1:50 000 scale mapping from SPOT Pan and XS imagery. Again, because of the shortfall in the extracted data, a substantial field completion and verification procedure using aerial photographs was needed to complete the revision task. Yet another paper, by Özbalmumcu of the General Command of Mapping (GCM), Turkey's national mapping agency, compared the suitability of aerial photos and SPOT Pan images for mapping and map revision at 1:50 000 scale. Once again, the SPOT-derived maps lacked many of the features required for this scale of mapping. Further contributions to this important subject of map revision were given in Session TP-IV-01 by Fiani and Vatore for a test area in Italy that had been affected by recent landslides, and by Diomande and Bahintche

in Session TP-IV-03 for the revision and build up of the cartographic database of the Ivory Coast at 1:200 000 and 1:50 000 scales. Both of these projects had also employed SPOT imagery for these purposes. Finally Raachapudi of the Survey of India in his paper given in TP-IV-06 mentioned the difficulties encountered using IRS-1C stereopairs resulting from its cross-track operation and the changes in the overall appearance of the landscape and in the sun angle and shadows arising from the time interval (sometimes months) between the acquisition of the individual images making up the stereopair.

Also of much interest was the use of high-resolution Russian space photography for mapping, all presented in poster papers. These included a most interesting account by Sibiriyakov (in Session TP-IV-01) of the extraction of DEMs from stereo photographs from the Russian TK-350 large-format camera using the locally-developed PC-based Z-Space DPW. The height accuracy of the TK-350 DEM data is given as  $\pm 10$  m. Another more general Russian contribution was that given by Tchekaline and Fomchenko. A further paper concerned with mapping from Russian space photography was that given in TP-IV-05 by Drachel and Kaczynski of the IGiK in Warsaw. They have used KVR-1000 and KFA-1000 photography as the basis for a new approach to the cartographic processing of space imagery by which the important features are enhanced and the unwanted features are diminished. This method has been used for the production of image maps of the Warsaw area, principally at 1:50 000 scale.

Other relatively straightforward accounts included the production of maps at 1:100 000 scale from Landsat TM images for an area near Bahia Blanca in Argentina given by Malinverni and Tonelli in Session TP-IV-02 and another similar project for the São Sebastião area near São Paulo in Brazil using the locally developed SPRING software and AutoCAD which was described by Pereira in her paper given in Session TP-IV-05. Then the results of accuracy tests of MOMS stereo-imagery over test areas in Bavaria and Bolivia using different specialised modules supplied by Zeiss, Intergraph and DLR were presented by Kresse et al. in Session TP-IV-05. Their results were in line with the previous tests of MOMS-02 and MOMS-2P stereo-imagery.

Returning to the matter of generating DEMs from space imagery, three more poster papers reported on the use of non-standard methods of DEM extraction from SPOT stereopairs. As described in their paper in TP-IV-01, Papapanagiotu and Hatzopoulos (Greece) ignored the usual rigorous photogrammetric procedures and used polynomials only in conjunction with an image matching procedure to generate a DEM of the island of Levros in the Aegean Sea. Also Takeuchi et al. in a paper given in Session TP-IV-02 reported on the use of simple parallax methods to update DEMs of urban areas in Japan. The reported accuracy of  $\pm 27$  m lies far below the  $\pm 10$  m achieved using regular photogrammetric methods with SPOT stereopairs. Finally Lee, Yeu et al. from Korea in Session TP-IV-03 described the refinement of DEMs using iteratively produced orthoimages to generate parallaxes to correct elevation values in areas where matching errors had occurred.

It would have been useful to have heard and read reports on tests and experiences with the high-resolution imagery acquired from the IKONOS satellite that was launched in September 1999. The very long lead time needed to submit both the abstracts and the finished papers for inclusion in the Congress programme and the *Archives* precluded this. However, actual test results have since appeared in

various monthly magazines, for example those by Cheng and Toutin published in the July 2000 issue of *EOM* that was issued to Congress participants. Instead R. Li from Ohio State University and his collaborators reported (in Session TP-IV-05) on a study of the attainable accuracy of IKONOS imagery using simulated data. The results of another simulation of IKONOS imagery based on the use of aerial photography having a similar ground resolution also formed part of the paper by Drachel and Kaczynski mentioned earlier. However the results from the work by Cheng and Toutin on actual IKONOS imagery were being presented to small groups in sessions conducted on the PCI stand in the Technical Exhibition.

#### *Mapping and Map Revision from Aerial Photography*

Needless to say, there were numerous (mostly interesting) papers that also dealt with mapping and map revision from conventional aerial photography. However only one or two were presented in the TC or IC sessions; most were posters scattered throughout the TP sessions. One important and distinctive group comprised the government mapping agencies concerned with mapping and database construction and updating on a national or regional scale. These included the contribution in TP-IV-03 by Arrighi of IGM, who described the build up of the new digital mapping of Italy at 1:25 000 scale and its associated databases (DB25) from 1:30 000 scale aerial photography. The first part of this project has been completed for the city of Rome and its surrounding area. A fascinating insight into Russian topographic and map revision techniques was given by Nekhin and Zotov in Session TP-IV-05. This included discussion of the different roles played by analytical plotters (APs) and DPWs in current practice and some most interesting details about Russian-built APs, film scanners and DPWs that had not been disclosed previously. The work of producing and updating maps at 1:10 000 and 1:25 000 scales and of managing and maintaining the corresponding databases (DTK10 and DTK25) in Germany was also covered by Muller and Seyfert of the Brandenburg State survey organisation with particular reference to the ATKIS database, in a paper given in Session TP-IV-03. Similarly there was a Dutch contribution (given in TP-IV-02) by Simonse et al. about the maintenance of the TOP10 (1:10 000 scale) planimetric map series and its integration with the national AHN height database for the Netherlands. Airborne laser scanning data is being used to help populate this database and to provide information for the adjustment of the positions of viaducts and bridges appearing on the photographs. Also covering a mapping programme with nationwide coverage, but being undertaken by a non-government (commercial) mapping group was the paper by Jamieson of Simmons Mapping given as a poster in Session TP-IV-02. He described his company's part in the MAPS (Millennium Aerial Photography Survey) project to produce high-resolution (0.25 m ground pixel) digital colour orthophotography under the UK Perspectives banner.

With the ever-increasing production of digital orthophotos, the matter of achieving a seamless merging of the individual images to produce orthophoto mosaics was a matter of considerable interest and importance. This matter was investigated and the results of using different approaches and solutions with real images were given in a series of papers by Zu and Yang (China) and Kerschner (TU Vienna) in TP-IV-02, and by Wang et al. (China) in TP-IV-04. The last of



these was also concerned with the integration of the orthophotos into spatial databases.

From Latin America came a number of poster papers on low-cost methods of mapping using digital rectification of scanned aerial photographs and simple mono-plotting techniques. These included the contributions of Mitishita and Kirchner concerned with rural planimetric mapping in Brazil (Session TP-IV-02) and that by Jaramillo for a cadastral mapping project in Bolivia (TP-IV-05). In a similar context, also in TP-IV-05, was a paper by Jauregui et al. from Venezuela on digital orthophoto production.

#### *Environmental Mapping and Monitoring from Aerial Photography*

The area of topographic and thematic mapping for environmental monitoring purposes is another area of considerable current interest to photogrammetrists. In Session IC-15, Welch et al. from the University of Georgia (USA) outlined the procedures used to construct topographic and vegetation maps and databases and provide digital orthophoto mosaics from colour infrared photography for the huge area of the Great Smoky Mountains National Park. The mapping and monitoring of glaciers as they retreat due to climatic warming is another very active photogrammetric activity. Besides the DEMs generated from airborne laser scanning mentioned earlier, other groups in the European alpine countries continue to use aerial photographs for this purpose. Thus Eder et al. from TU Munich and the Bavarian Academy of Sciences reported in Session TP-IV-02 on a large project concerned with the mapping of no less than 166 glaciers in one part of Austria using both APs and DPWs. This will help to establish a new glacier inventory, which, when completed, will cover the 925 glaciers that exist in the country. Kaufmann and Ploetsch from Graz in their poster paper in TP-IV-05 also described the mapping of the retreat of cirque glaciers in the Central Alps of Austria, again using both APs and DPWs to measure six sets of photos taken between 1957 and 1997.

Another closely related matter is the mapping and monitoring of areas hit by natural disasters. Following the series of disastrous earthquakes in the region lying on the east side of the Sea of Marmara, an intensive effort was made to produce very large numbers (1300) of orthophotomaps rapidly for the affected areas both for relief and reconstruction purposes. These were described in two separate poster papers in Session TP-IV-01 by Akdeniz et al. and by Özbalmumcu of GCM. Another Turkish contribution by Kulur and Divan of ITU given in the TP-IV-02 poster session gave the results of testing the accuracy of digital orthophotos produced by different methods with and without a DEM. Still in the natural disaster area, Fiani et al. in the TP-IV-01 poster session described the mapping of areas hit by large landslides and mud flows in Italy using a variety of methods, including conventional aerial photogrammetry and ground-based laser scanning. In poster session TP-IV-02, de Laporte from the Swiss Federal Institute for Forest, Snow and Landscape Research also provided an account of production of DEMs of the area of a large bog slide over 15 years covering the period before and after the slide. Based on the evidence of the Amsterdam papers and given the present high degree of scientific and public interest, undoubtedly many more photogrammetrists will become involved in these environmental and disaster monitoring activities.

*Aerial Triangulation and DEM Accuracy*

As might be expected, there were numerous papers concerned with the accuracies that are attainable with aerial triangulation and DEMs generated from aerial photography. The former group included two papers from Eastern Europe. The first of these (given in TP-IV-02) by Drobzhynski from the Ukraine discussed the influence of in-flight GPS data on aerial triangulation and gave the results obtained using different control point arrangements. The second (given in Session TP-IV-06) by Ruzgiene and Vainauskas from Lithuania discussed the error distribution for a block of aerial triangulation using numerous different configurations and combinations: with and without transverse strips, with different GPS arrangements and so on. From the USA came a third paper (given in TP-IV-05) by Appleton of Caltrans and his two collaborators (Hussain and Munjy) from CalState University in Fresno who had devised the ISBBA triangulation package. They discussed the impact of the use of INS and GPS data using both simulated and real data in the specific context of highway corridor mapping.

On the DEM front, besides the papers on DEM generation from satellite stereo-imagery, InSAR data and airborne laser scanning already discussed, there was a substantial number of additional papers dealing with the generation and accuracy of DEMs from aerial photography. On the more theoretical side, in a presented paper given in IC-15b, Schenk et al. outlined a comparative study of surface-matching algorithms with particular reference to the relationship between different surfaces and the need for suitable transformations between them. In a poster session (TP-IV-02), Wang, Trinder and others from UNSW in Australia described the use of 2D Kalman filtering to reduce errors and remove outliers in elevation models, while Burshtynska et al. (in Session TP-IV-05) discussed the accuracy of DEMs with respect to sampling interval using spectral analysis, and Tagaki from Japan (in TP-IV-06) discussed the relationship between spatial resolution and terrain features within the specific context of the resulting DEM accuracy.

Besides the more theoretical contributions, experimental assessments of DEM accuracy were forthcoming from two poster papers given in Session TP-IV-06. The first from Hasegawa et al. from GSI in Japan gave the results of a systematic investigation into the effects of changing base-to-height ratios on the accuracy of DEMs produced by automatic image matching in DPWs. This made use of over 1000 ground points measured by GPS that were available for verification purposes. The second paper by Forlani and Pinto (Italy) again involved tests of DEMs produced in DPWs, on this occasion, for the monitoring and measurement of the volumes of marble being excavated from open-cast quarries in comparison with surveys produced by ground-based laser scanning.

*Global Mapping and Change Monitoring from Satellite Imagery*

As interest in and commitment to the concept of the Global Map with its worldwide topographic, land cover, land use and vegetation datasets steadily increases, this was reflected in the Commission IV programme which had two sessions (IC-18a and b) of orally presented papers, supplemented by various poster papers. Given the global scale of the coverage, the main emphasis in most of these

papers was on the use of NOAA's AVHRR scanner imagery, especially for land cover and vegetation mapping, with widespread use of the Normalised Difference Vegetation Index (NDVI) derived from the AVHRR data. Thus the projects reported in the papers from Tateishi et al., Park and Tateishi (Japan), Jakubauskas and Legates (USA), Semovski et al. (Russia), Múcher et al. (Europe) and Cavalli et al. (Brazil) had all made use of this data in different ways for different applications. Of course, the AVHRR data with its 1 km ground pixel size has distinct limitations in terms of ground resolution, but it is readily available at low cost, hence its widespread use. It does seem however that the global mapping community is looking forward to the availability of the MODIS data from NASA's recently launched Terra satellite to give higher resolution (250 m ground pixel) data, but still with a wide swath (2330 km) as needed for global coverage. In this context, it is interesting to note that much of the leadership and drive behind the Global Map concept comes from the Japanese (GSI) and American (USGS) national mapping agencies. Furthermore the space agencies of the two countries—NASDA and ERSDAC on the one hand and NASA and NOAA on the other—are also heavily involved with this global mapping and monitoring effort and are cooperating on it. For the specific matter of achieving the required global topographic dataset, not only will the InSAR elevation data derived from the Shuttle Radar Topographic Mission (SRTM) be used for the purpose, but NASA's new Terra satellite also has the Japanese-built ASTER instrument providing optical along-track stereo data for DEM generation. In addition, two papers on the mapping capabilities of the forthcoming Japanese ALOS satellite with its PRISM three-line pushbroom scanner were presented by Shibasaki et al. in Session IC-18b and by Osawa Hamazaki in Session TP-IV-05.

#### *Extraterrestrial Mapping*

This is the area of activity of the Commission's WG IV/5 under its chairman, Peter Muller of UCL. In contrast to some of the other Working Groups, it had a small, coherent and well-structured programme of papers given in Session TC-IV-02. The actual contributions were quite fascinating. Kirk et al. from the well-established USGS Planetary Mapping Group in Flagstaff, Arizona gave an excellent and very detailed account of their mapping activities over the Moon, Mars, Venus and the asteroid Eros, employing digital photogrammetric techniques with many different types of imagery and supplemented by laser altimetric data. Much ingenuity has been needed to overcome the problems of handling very large numbers of small-format images, often with poor image overlap, the variable scale and quality of the coverage, and the lack of ground control. Muller and his collaborators (Kim and Morley) discussed the potential of using the Mars Orbiter Laser Altimeter (MOLA) profiles for the creation of a 3D control point network for the surface of Mars and the need to register these profiles with the features that are visible on the Mars Orbiter Camera (MOC) and Viking images. An automatic registration technique has been devised for the purpose. Hauber et al. from DLR Berlin also discussed the use of Viking images and the MOLA data for the construction of topographic image maps for selected areas on Mars. Then Zeitler from Z/I Imaging and his collaborators described the various photogrammetric procedures used to measure a network of control points for part of the asteroid Ida

using digital images acquired by NASA's Galileo spacecraft en route to the planet Jupiter. Finally R. Li and his colleagues from Ohio State University and collaborators from JPL gave an account of their experimental work designed to carry out large-scale mapping of Mars landing sites and the surrounding areas that can be traversed by a rover vehicle. Their preliminary earth-bound trials were carried out over a test site in California using imagery acquired during the lander's descent in conjunction with stereo-imagery taken from the rover. In summary, this really was a most interesting and satisfying session.

GORDON PETRIE

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#### COMMISSION V: CLOSE RANGE TECHNIQUES AND MACHINE VISION

FROM 1996 to 2000, Commission V has been very well supported and organised from Japan, under the Presidency of Professor Hirofumi Chikatsu of Tokyo Denki University. This very active TC was divided into five working groups, an Inter-TC working group and a special interest working group. Commission V has always covered an extremely wide range of topics and the past four years have been no exception, with broadening of the remit to include visualisation and animation. The titles of the Working Groups and their Chairpersons were:

- V/1 Close Range Imaging and Metrology, Professor Clive S. Fraser (Australia)
- V/2 Integration of Photogrammetric Systems with CAD/CAM, Professor Jürgen Peipe (Germany)
- V/3 Scene Modelling for Visualisation and Virtual Reality, Dr Sabry F. El-Hakim (Canada)
- V/4 Human Motion and Medical Image Analysis, Dr Felix Margadant (Switzerland)
- V/5 World Cultural Heritage, Professor Petros Patias (Greece)
- IC WG V/III Image Sequence Analysis, Professor Hans-Gerd Maas (Germany)
- Special Interest Working Group on Animation, Professor Armin Grün (Switzerland)

The representation from Commission V at the Amsterdam Congress was strong, with 160 published papers. Of these, 53 were presented in 11 technical sessions of an hour and a half each, with the remaining 107 being given in five poster sessions. As far as the UK contingent was concerned, seven papers were authored, or part authored, by photogrammetrists based in the United Kingdom. This represents a slight decrease with respect to the previous Congress in Vienna, where there were eight authors from the UK.

#### *The Technical Programme*

The Commission V technical programme was spread over the seven days of the Congress. Commission V had no parallel sessions so it was possible to attend

the complete technical programme; however there were many items of interest in other Commissions which meant that it was necessary to select carefully and to transfer between sessions where necessary. Your reporter attended about two thirds of the Commission V events, some of which are summarised below.

*Vision Metrology and VR/VE Generation. Chair: Hirofumi Chikatsu (Japan).* This first session included presentations that reflected some of the variety that is characteristic of Commission V. Papers covered the following topics: forensic videogrammetry and the exploits of the “big nose gang” (Fryer); the creation of detailed 3D models from multiple views (El-Hakim); a review of photogrammetric CAD/CAM in culture and industry (Patias); the use of edge segments in the interactive modelling of robot environments (Even); and how image based dominant regions could be used to quantify teamwork in ball games (Taki). This session provided an enjoyable introduction to the technical sessions, with enough diversity to contain something for everyone interested in close range issues.

*Automation in Vision Metrology. Chair: Clive S. Fraser (Australia).* This session reflected a number of key elements that are having an increasing influence on the acceptance of digital photogrammetry by the engineering community. In particular, these elements include real-time processing, sensor and system calibration, the use of intelligent cameras and the increasing importance of traceability and quality control. The session contained five papers: the calibration of a stripe projection system (Guehring); online 3D measurement (Schneider); laser scanner accuracy evaluation (Radovanovic); automatic surface reconstruction using feature-based matching and multiview geometry (Kirsten); and coded target and automated measurement procedures in industrial vision metrology (Harutaka).

*Integration of Photogrammetry with CAD/CAM. Chair: Jürgen Peipe (Germany).* This session consisted of five papers which covered image analysis and object-oriented information systems necessary to support industrial design and manufacturing quality control. Applications investigated included the following: sheet metal forming (Bösemann); linear super-elastic wires in orthodontics (Suthau); and range imaging for the automated recognition of industrial parts (Boehm). Van den Heuvel provided a very complete analysis of trends in CAD-based photogrammetric measurement. The last paper in the session was concerned with the design of PC-based software for an object-oriented stereo system using OpenGL (Boochs).

*Image Sequence Analysis. Chair: Hans-Gerd Maas (Germany).* This technical session contained presentations associated with inter-commission working group V/III focusing on the following topics: model-based processing; image understanding; performance of time-constrained algorithms; optical flow analysis; and dynamic data compression. As such, this working group represents one of the most direct areas of integration between machine vision and photogrammetric research. Four papers were presented: a method for automatically generating 3D models from image sequences, such as those taken from an off-the-shelf video camera (Pollefeys); automatic stereo matching using optical flow (Kunii); analysis of dynamic scenes (Handmann); and a high accuracy positioning system for urban areas using multiple sensors and image sequence analysis (Chen). The quality of

the presentations was high and demonstrated the future potential of combined photogrammetric and machine vision research.

*Visualisation and Virtual Reality. Chair: Sabry El-Hakim (Canada).* The provision of data for virtual reality is a recent and logical addition to the range of topics included in Commission V that reflects the increasing ability of systems for immersive environments, such as VR caves, to make use of images and 3D spatial data. Accordingly, this session aimed to include the creation and modelling of virtual reality systems and to document new applications of VR technology in science and engineering. Five papers were given: low-cost VR systems (Samoylov); a historical multimedia reconstruction of the Schloss Herborn (Pomaska); VR in open pit mine monitoring (Boulanger); remote sensing data and 3D visualisation of leisure and tourism information (Almer); and sensor integration for spatial data acquisition and database development (Yoshimura).

*Motion Capture, Animation and 3D Medical Image Processing. Chair: Armin Grün (Switzerland).* This session combined some of the ideas behind the formation of the special interest working group on animation with the human motion and medical image analysis working group that has been a long-standing feature of Commission V. Five papers were presented covering the full gamut of human body modelling, motion recording and analysis. The following papers were presented: human shape and motion recovery using animation models (Fua); a tracking algorithm suited to human body modelling based on least squares matching (D'Apuzzo); a system for human motion analysis (Yoshida); the measurement of trajectory-invariant gait signatures (Carter); and a high speed 3D measurement system based upon intensity ratios (Miyasaka).

*CAD Based Architectural and Archaeological Photogrammetry. Chair: Petros Patias (Greece).* This session was the first of several that dominated Commission V in terms of the number of papers submitted and of community interest. Techniques in this area are continually evolving, with parallel technological advances in the representation of data and in the ability of digital photogrammetry to provide data of appropriate quality and with an increasing level of automation. Five papers were presented in this session: the estimation of 2D–3D motion of surfaces using frequency domain techniques (Guarnieri); the “Zurich city hall” architectural photogrammetric data set (Streilein); 3D archaeological modelling surveys (Tokmakidis); 3D-vector scenegraphs of ancient buildings (Yixuan); and the application of spectral and textural classifications in the recognition of material types and damage on historic building façades (Lerma).

*Site Recording and Modelling. Chair: Sabry El-Hakim (Canada).* This session was the second dealing with virtual reality and covered recording and modelling in architectural, archaeological and engineering applications. The following papers were delivered: a stereo vision system for 3D object modelling (Kakiuchi); semi-automated approaches to site recording and modelling (Grün); low-cost web-based documentation of Brazilian historical towns (Renuncio); short-baseline active triangulation for CAD reconstruction of room-sized industrial environments (Chapman); and panoramic image measurements (Heikkinen).

*Quantitative 3D Medical Image Acquisitions and Processing. Chair: Felix Margadant (Switzerland/Australia).* This session encompassed topics drawn from the field of medical image measurement and analysis. The following papers were presented: anatomical morphometry from 3D image data sets (Greenshields); automated extraction of 3D human back surfaces (Sechidis); dynamic analysis of human motion using a hybrid video theodolite system (Tetsuji); wound measurement (Boersma); and simulation of postoperative 3D facial morphology using a head model (Aoki).

*World Cultural Heritage and Information Systems. Chair: Petros Patias (Greece).* This session was concerned with the recording and documentation of historic monuments, an area that is rapidly growing as low-cost computer systems become increasingly capable of storing and manipulating large quantities of image, model and archival data. Papers included: 3D recording and visualisation of the Nasca geoglyphs (Grün); a hybrid video theodolite and panoramic 3D modelling (Chikatsu); the combination of aerial and architectural photogrammetry in the modelling of historic sites (Nour el Din); an image-based information system for restoration of cultural heritage (Hongo); and the suitability of desktop image measurement software for architectural recording (Mills).

*Performance of Close Range Imaging Systems. Chair: Horst Beyer (Switzerland).* The use of close range photogrammetry as an online positioning, measurement and quality control tool by industry is becoming increasingly common. The first paper in this session (Luhmann) detailed key acceptance and verification tests that should be taken into account if optical 3D measurement systems are to be accepted. Subsequent papers covered some of the broad range of industrial application: a four-headed camera system for use in microgravity research (Willneff); the control of a robot end-effector using photogrammetry (Clarke); the photogrammetric determination of friction surfaces (Hemmler); and measurement of granite joint surfaces (Mushairry).

*Image Sequence Applications. Chair: Hans-Gerd Maas (Germany).* The final technical session again drew from the Inter-TC working group on image sequence analysis. In this case papers were diverse, covering applications in robotics and navigation, 3D measurement in dynamic processes and remote sensing. The following papers were presented: a technique for vehicle tracking on the assumption of stratospheric platforms (Fuse); robust object tracking for robot manipulation and navigation (Zillich); geo-spatial grasping of pavement with mobile mapping (Takagi); and the creation of temporal images from sequences of remotely sensed images (McCloy).

#### *Poster Sessions*

There were five Commission V poster sessions, allowing the presentation of over a hundred papers. All poster sessions took the form of a brief oral summary presentation, in which the author had enough time to outline briefly the pertinent points in his or her paper, before the conventional poster viewing took place. Titles of the poster sessions were as follows: Close range imaging systems and vision metrology; Vision metrology and integration with CAD; Site modelling and cultural heritage recording; and Image sequence analysis and medical applications. As can be expected, the range of content was vast and it is impossible in the space available

to detail all the papers presented as posters. However the variety of subject matter and content throughout Commission V attests to the measurement and analysis possibilities enabled by today's sensing systems.

*Summary*

In your reporter's opinion, Commission V presented a logical progression from the four years since the previous Congress. It drew upon the best of the inter-congress meetings, in which there were few blinding insights but many interesting solutions and adaptations to overcome specific data acquisition and measurement problems. This is not surprising because, in general, digital close range photogrammetry is a mature technique which has been explored to the extent that research interest now usually lies in understanding, communicating and delivering optimal solutions that promote the value of the delivered spatial data, and in evolutionary advances in sensors and data processing.

There are some exceptions to this scenario. For example, it is evident for some archaeological work that digital systems cannot yet deliver sufficient image quality at an appropriate cost; hence film-based systems must still be used, in association with scanners. Whilst being gradually eroded, this limitation is likely to remain for some time because it is unlikely that there will be any "off-the-shelf" large-area sensors at affordable cost on the market in the near future. A second important exception is where rapid processing, industrial measurement and task automation are required. Here novel photogrammetric measurement solutions that make best use of the advantages of rapid data access and processing will always be needed. In this area it is also significant that laser scanning systems are maturing to the extent that they are able to provide a viable solution to many measurement problems. Commission V has embraced laser scanning systems and integrated them, together with other optical measurement techniques, within its remit.

The key area of note lay in the increased predominance and effectiveness of traditional photogrammetric techniques used in combination with image analysis methodologies drawn from machine vision and laser scanning. The most important of these developments are the inroads being made through the integration of the geometric imaging understanding of photogrammetry with the automation and capability of extracting information from images offered by machine vision techniques to provide effective solutions to problems in all Commission V application areas. It should be noted that within the UK the increasing overlap and integration between photogrammetric and machine vision approaches is not well organised and the newly formed Remote Sensing and Photogrammetry Society should promote this coordination if it wishes properly to encompass the full scope of photogrammetry.

Following the Congress, the presidency of ISPRS Commission V was awarded to Professor Petros Patias of the University of Thessaloniki (patias@topo.auth.gr). The number and make-up of the technical working groups is currently being revised and those interested are advised to look at the ISPRS web site ([www.isprs.org](http://www.isprs.org)) for notification of future areas of focus.

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COMMISSION VI: EDUCATION AND COMMUNICATIONS

THE ACTIVITIES of Commission VI exemplify the theme for the XIXth Congress of “Geoinformation for all” which could be interpreted as geoinformation for the benefit of all; available for all; accessible for all; useful for all; producible by all; and understandable by all. In total, 109 sessions were held at the Congress and of these, six were dedicated to education. About 305 delegates attended the sessions concerning education, which consisted of one Special session, one Inter-TC session, three TC sessions and one Interactive Poster session.

*Special Session IV*

Special sessions at the Congress were organised by the ISPRS Council members; these sessions included invited speakers from a wider circle of organisations with strategic significance for the future activities of the ISPRS scientific community. In Special Session IV, “Education and the profession. Expected new developments”, invited speakers from Japan, Germany, Brazil, the Netherlands and Denmark presented papers on distance learning and on geo-information and environmental geology education in developing countries. These papers focused on the current situation with regard to education and training opportunities in these countries and on new educational proposals.

*Inter-TC Session 20*

The themes for Inter-TC sessions were organised in collaboration with at least two ISPRS TCs, and the session theme had to be focused on a specific subject related to these commissions. Inter-TC 20, on “Computer-assisted and distance learning”, identifies a theme that is important for ISPRS Commissions II (Systems for Data Processing, Analysis and Representation), III (Theory and Algorithms) and VI (Education and Communications); in particular, this theme is the main concern of TC VI WG VI/3. The latest methodologies, datasets and software on education, including distance teaching using the Internet, were presented and discussed in the Inter-TC 20 session. For example, papers were given on teaching architectural photogrammetry on the Web with ARPENTEUR, the use of CAT/CAL programs for image processing and remote sensing in distance learning, and advanced learning space in geo-information science at Wageningen University, the Netherlands. The first two papers took part in the CATCON 2 contest.

*CATCON 2 Contest*

The Computer Assisted Teaching Contest (CATCON 2) is a software contest organised by ISPRS WG VI/2, “Computer assisted teaching”, and sponsored by the Central Computer Service Company of Japan. The main objective of the contest is to promote the development and dissemination of good, user-friendly software packages, WWW sites and data sets for computer-assisted teaching in remote sensing, photogrammetry and GIS. In general, the submissions to the contest are preferred to be non-commercial and preferably to be provided to the users free of charge. Total prize money of US\$4200 was awarded to the winners. Nine candidates presented their software and material to an audience. During the contest anyone

could try all the software and some free software packages were provided. The ARPEUR software, presented by P. Grussenmeyer and P. Drap (France), received the Gold Award (US\$2000). This is a photogrammetric software package available on the Internet, with applications mainly dedicated to architectural photogrammetry, education and research using small-format images. Several examples are available for educational use and personal projects can be stored on the servers' database. Joint runners-up were Q. Zhou (Hong Kong, China) and J. Høhle (Denmark).

#### *Technical Commission Sessions*

Session VI-1, "International cooperation and technology transfer" was held under the auspices of the working group with the same title, TC VI/WG 3. This session included education in the international field, cooperation, cogeneration for correct technology transfer, communication and networking. Papers were presented on international standardisation and management of GIS activities; production flowcharting for mapping organisations; networking and technology transfer in Africa; Polish–Belgian co-operation; development of educational software for digital photogrammetry; and regional cooperation on space applications for sustainable development in Asia and the Pacific.

Session VI-2, "Multimedia approach for education", was organised by TC VI/WG 4 (Internet resources and spatial data sharing). The latest multimedia approaches for education, including the use of PC, Internet, CG and CD-ROM, were discussed. Papers given in this session included ISPRS on the Internet—presence and prospects; the design concept and features of Chinese National Geospatial Data Transfer Format; the situation and progress of Internet for ISPRS; interactive education on the Web—experiences in development and application of a computer assisted training course for remote sensing; the MiraMon Map Reader, a new tool for the distribution and exploration of geographical information through the Internet or on CD.

Session VI-3, "Restructuring education in photogrammetry, remote sensing and GIS" was the responsibility of TC VI/WG 1 (Education). New approaches in education and training opportunities, integration of communication technology, curriculum development and financial aspects were considered. Papers were presented concerning ORS and its activities in Syria; modernising and strengthening the educational programme of the Federal School of Surveying in Nigeria, in partnership with ITC; and new paradigm, new approaches: restructuring geospatial information education and training in a traditional research university setting, in the USA.

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#### COMMISSION VII: RESOURCE AND ENVIRONMENTAL MONITORING

COMMISSION VII was renamed and reorganised for the 1996–2000 inter-Congress period under the Presidency of Gabor Remetey-Fülöpp (Hungary). The Working Groups (WGs) were cut from ten to seven and operated as follows:

- VII/1 Fundamental Physics and Modelling
- VII/2 Application of Remote Sensing and GIS for Sustainable Development
- VII/3 Thematic Applications of High Spatial Resolution Satellite Imagery
- VII/4 Computer Assisted Image Interpretation and Analysis
- VII/5 Global Monitoring (in collaboration with WG IV/6 – Global Databases)
- VII/6 Radar Applications
- VII/7 Non-renewable Resources and Geotechnical Applications

Since the events at Amsterdam in many cases hinged directly on activities during the four-year session this report is introduced with a brief account of the highlights of those activities.

#### *Inter-Congress Period*

During the 1996–2000 inter-Congress period, Commission VII and its working groups have been active to varying degrees. A notable input was as part of the ISPRS contribution to UNISPACE III in 1999. Members of WG VII/2 made presentations on sustainable development, resource mapping and crop production monitoring. Similarly, papers presented at the ISPRS–EARSeL workshop on natural disasters and at the ISPRS–NASA seminar on sustainable development are included in the special UNISPACE III volume of the ISPRS *Archives*.

In the same year, WG VII/5 focused on the potential of remote sensing in the context of the 1997 Kyoto protocol to the UN Framework Convention on Climate Change. A review of available and future technology for monitoring treaty compliance was a joint activity of WG VII/5 and WG VII/6 in 1999. Although this activity was comparatively under-represented at the 2000 Congress, one of the recommendations of that review was for ISPRS Commission VII to establish a Kyoto Task Force with the aim of promoting and stimulating more research and development in this area. The successful cooperation between WG VII/5 and WG VII/6 yielded a special Congress session on Global Remote Sensing and GIS and the Kyoto Protocol.

Numerous Commission VII workshops were held during 1996–2000 and participation at other significant meetings was widespread.

*WG VII/1* continued to help to maintain the long-running series of spectral signature symposia in 1997 and again in 2001 at Courchevel. This WG also organised two sessions, on improved geometry and radiometry of remotely sensed data, and on experimental methods and procedures in remote sensing, at the Commission VII mid-term symposium “ECO-BP’98” in Budapest. ISPRS is a CEOS affiliate and there was a recommendation that WG VII/1 be involved in a special calibration and validation (cal/val) session at Congress 2000.

*WG VII/2* (the best represented by far at Congress 2000 in terms of presented and published papers) organised important international workshops on remote sensing and sustainable development in each of the four years of the inter-Congress period 1996–2000. This no doubt accounts for the preponderance of papers on this topic at the Congress. WG VII/2 also made important contributions at ECO-BP’98 and at UNISPACE III.

*WG VII/3* is a new working group of the Commission and was inhibited due to the delays in launching many of the anticipated high resolution satellite systems.

Nonetheless, participation at major meetings was achieved and two important papers on the topic were published in *ISPRS Highlights* in June and September 1999.

*WG VII/4* was also active in many international forums and especially at the Congress in 2000 but there is significant overlap with *WG III/5* and *WG IV/3.2*, and space does not permit a more thorough review.

*WG VII/5* activities in relation to UNISPACE III and Kyoto were mentioned earlier. Other important activities included collaboration with IGBP and the Global Rain Forest Mapping initiatives (<http://southport.jpl.nasa.gov/GRFM> and <http://www.eorc.nasda.go.jp/JERS-1>). The Kyoto theme was continued at the Congress through two joint sessions (with *WGs IV/6* and *VII/6*) on global environment and biomass monitoring.

*WG VII/6* has contributed during 1996–2000 by supporting many of these *WG VII/5* and Inter-Commission initiatives, as well as organising PACRIM and GRFM meetings on its own account.

*WG VII/7* provided plenty of impetus at meetings already mentioned and also through a special conference of the NATO Advanced Studies series. Other than Congress 2000, most of the *WG VII/7* activities were focused on events outside Europe, with a particular emphasis on Africa.

### *Congress Papers*

For the Amsterdam Congress, a total of 241 papers were submitted to Commission VII (a number broadly similar to that of the previous Congress in Vienna in 1996). Of these only 35 were eventually listed for presentation orally in technical sessions and 206 were listed for poster sessions. The *ISPRS Archives* (33(B7)) contain 247 papers from technical and poster sessions. An analysis of the large quantity of published material confirms the wide range of subject matter being submitted from many different countries, characteristic of Commission VII from previous Congress technical programmes.

Of the 55 countries with papers published (an increase in geographical coverage of about 60% on the previous Congress), the Netherlands (29 papers), Brazil (20) and Germany (19) lead, followed by India (16), Japan (15) and the USA (13), while some 17 countries are represented by only one paper. Three papers from the UK, all presented as posters, were published in the *Archives*. Green and King presented the need for increased integration of coastal zone management information; Chandler, Lane and Ashmore demonstrated the utility of digital cameras in analysing fluvial geomorphology, and Smith and Hoffman demonstrated classification methodologies for fine resolution image data.

Nonetheless, the representation of the seven Working Groups shows a distinct emphasis on *WG VII/2*, *VII/3* and *VII/7*. These three represent respectively 38%, 24% and 16% of the published papers, virtually four fifths of the entire Congress output for Commission VII. *WG VII/1* follows with 12% with *WGs VII/3*, *VII/5* and *VII/6* making relatively little contribution. This is perhaps not so surprising given the strong natural resources mandate of the Commission. However it is somewhat surprising to find that fundamental physics (*VII/1*) and image interpretation techniques (*VII/4*) feature so prominently, in what should be a Commission

typified by applied research in the world at large. The small number of papers in WG VII/3 no doubt reflects the recent establishment of this Working Group and also indicates the difficulties in getting high spatial resolution (spaceborne) imagery operational.

The majority of the published papers, irrespective of working group, were devoted to remote sensing using optical (mostly) or microwave satellite imagery, different technologies normally being used in combination. A smaller number of papers involved a combination of photogrammetry and remote sensing or remote sensing and GIS, although the latter combination is clearly a growing area of synergy within the field. Indeed an extra session was arranged at the very last minute featuring “the synergy of GIS and RS”. Few papers involved the use of photogrammetry or remote sensing alone. Resource management issues and regional case studies far outnumbered the papers devoted to algorithm development, as would be expected given the title of Commission VII and the breadth of its terms of reference.

Apart from the pre-Congress tutorials, the wide ranging activity of Commission VII was reflected also by the numerous Inter-technical Commission sessions during the Congress. These included IC-21, Hyperspectral Sensing Applications; IC-23, Sustainable Resource Management; and IC-24, Disaster Management. Efforts to support work on global climate change are noted above but Commission VII also took part in the discussion forum on Monitoring and Change Detection for Preservation and Development of Cultural and Natural Heritage Landscapes.

#### *Recommendations for Future Activity*

An open business meeting of Commission VII was held at the Congress, with participation by approximately 20 delegates, representatives and experts, to discuss the Commission’s activities for the 2000–2004 session. Proposals were made for the seven working groups to be increased to nine and renamed as follows:

- VII/1 Spectral signature research
- VII/2 Standardisation of methodology of computer-aided interpretation
- VII/3 Crop monitoring, yield estimation and policy issues
- VII/4 Integrated monitoring systems
- VII/5 Disaster management
- VII/6 Generation and use of global databases
- VII/7 Supporting implementing (*sic*) of international policies and treaties
- VII/8 Urban management
- VII/9 Imaging segment of information infrastructure

These proposals are encapsulated in considerably greater detail in the nine Congress resolutions of Commission VII (published in *ISPRS Highlights*, September 2000). Whilst no doubt worthwhile and important in their own right, these proposed Working Groups (and the tendency to overlap the remit of others) would arguably only serve to perpetuate the wide-ranging and overly diffuse activities and terms of reference of Commission VII. In practice, at the time of writing,

the future shape and focus of this important ISPRS Commission has yet to emerge although a structure comprising only six Working Groups appears more probable.

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#### CONGRESS EXHIBITION

EVEN as your reporters write, accounts of the exhibition are appearing in some of the lighter weight periodicals with shorter publishing cycles. They concur with your reporters' observation in Amsterdam that the well-organised, vibrant and busy exhibition hall was witnessing nothing less than a photogrammetric "paradigm shift", to risk an overused buzz term. The principal feature or theme was the advent of digital imagers, which many prefer to call airborne digital sensors, in the context of photogrammetric mapping. Finally an electronically based alternative to the film camera was displayed. At last the transition had begun from a technology of superb achievement and refinement that had its origins in the 1920s, the metric film camera. This latest event may prove to be of equal significance to our science and livelihood as the rich crop of analytical stereoplotters seen with similar excitement at Helsinki in 1976. Revolutionary though the new sensors are, however, they did not eclipse other aspects of an exhibition that reflected an industry as active, innovative and competitive as ever, entering the new millennium with rightly earned scientific aplomb.

#### *Airborne Digital Sensors (Imagers)*

The new sensors were not difficult to find. Visitors entering the exhibition hall were faced immediately with the gigantic booth of Z/I Imaging, square metres of floor space as far as the eye could see celebrating the arrival of the Intergraph/Zeiss joint venture. At the front were attractive exhibits depicting the DMC 2001 Digital Modular Camera in its glass and metal form. The multiple frame camera approach had been well publicised in advance of the Congress and, as the modular name in the title suggests, the DMC will be available to acquire pan imagery, either using a single camera or as an integrated assembly of two or four of these frame cameras, which operate synchronously and are tilted to give contiguous images to provide greater ground coverage. The idea is that a user can start with a single module at a relatively low price and gradually build up the capabilities of the system by purchasing additional modules. Each DMC camera module utilises a  $7000 \times 4000 = 28$  megapixel areal array supplied by Philips, together with a lens of 120 mm focal length, having a maximum aperture of f4. Thus the twin-camera configuration provides a  $7000 \times 7500 = 52.5$  megapixel image with a  $39^\circ \times 42^\circ$  field of view (FOV); while the four-coupled arrangement provides a  $13\,500 \times 8000 = 108$  megapixel image giving a  $74^\circ \times 44^\circ$  FOV. As the name suggests, first deliveries of this camera system are scheduled for 2001.

For the acquisition of colour (RGB) and false-colour (RGB+NIR) frame imagery, Z/I Imaging's solution again uses multiple (three or four) cameras. Each of these is equipped with a much smaller ( $2000 \times 3000$ ) areal array than those utilised in the panchromatic cameras and they are used with much shorter focal length (25 mm) lenses. Furthermore, the cameras are mounted and operated with

parallel optical axes, each lens having a different filter. While this configuration provides a comparable angular coverage of  $72^\circ \times 50^\circ$  to that of the four-coupled panchromatic camera assembly, inevitably it sacrifices considerable ground resolution ( $f = 25$  mm versus  $f = 120$  mm) from the same flying height. Changing the photographic film (from pan to colour or colour infrared) with an analogue film camera contrasts with the need to provide a separate camera and filter for each of the component bands or colours to achieve a composite colour or false-colour digital image.

Located beside Leica Geosystems, and glorying in the crowds drawn by its own display as well as by its Swiss parent's laser light show, LH Systems advertised the birth of its ADS40 Airborne Digital Sensor with a dirigible, a giant inflatable model of the new sensor hung high in the roofspace of the exhibition hall. On the booth floor were display cases, one containing the outer housing of the ADS40 and the other showing the electronic components and lens. A further display used moving miniature terrain and a prototype model of the ADS40 to explain the three-line scanner pushbroom principle. LH Systems, with its partner DLR, has gone for a different solution to Z/I and has based the ADS40 on the three-line scanner principle with forward, nadir and backward pointing linear arrays imaging through a single new, specially designed, telecentric lens with a focal length of 63 mm; a cross-track angular coverage of  $64^\circ$ ; and a maximum aperture of f4. Each of the linear arrays comprises two 12 000 pixel lines of CCDs, each of which is offset horizontally with respect to the other by half a pixel ( $3.25 \mu\text{m}$ ). This arrangement appears to be quite similar to that of the so called Supermode sensor developed and demonstrated by the French organisation CNES, for use with the forthcoming SPOT-5 HRG (High Resolution Geometric) sensor. The read-out rate of the ADS40, which largely governs the data acquisition rate of the scanner, is 800 Hz. The ADS40 incorporates a specially designed GPS/IMU unit from Applanix. It will be intriguing to see how production photogrammetrists, previously accustomed to aerial frame photography, will accept the very different geometric processing of the ADS40 imagery, although LH Systems is attempting to ease the learning curve by exploiting variants of its familiar ORIMA and SOCET SET products and has announced the availability of a development kit to enable other software suppliers to add modules for use with ADS40 imagery. LH Systems intimated at the Congress that it has already secured an order for two ADS40 units from the Japanese Pasco aerial mapping company to be delivered in 2001.

In addition to the pan sensors, the ADS40 has four other 12 000 pixel linear arrays covering the red, green, blue (RGB) and near-infrared (NIR) spectral bands respectively, all mounted side-by-side in a forward-pointing (RGB) or near nadir-pointing (NIR) orientation. After passing through the lens, the incident light from the ground is split into its three RGB components using "trichroid" beam splitters before being passed on to the appropriate linear arrays. In this way, the possibility of colour fringing occurring within the visible spectrum has been removed. Of course, as with Landsat TM satellite imagery, purely monoscopic (non-stereo) multispectral scanner imagery results from the pointing arrangements; there is no possibility of colour or false-colour stereopairs being produced, other than by creating them artificially rather in the manner of stereomates.

With all the razzmatazz surrounding the Z/I and LH Systems booths at the front of the hall, it took a few moments' further investigation to discover that there

was a lot more happening on the airborne digital sensor side. Inpho, from Stuttgart, unveiled a remarkable transformation in Amsterdam. Under a new GeoToolBox Team brand it revealed several new strategic partnerships (see below). However, perhaps most intriguing on its well designed booth was its inCAM SF digital modular camera, developed over quite a short time period in cooperation with another German company, SensorVision. Like the DMC, it offers multiple camera modules, either mounted on suitably tilted plates to give increased ground coverage or used with parallel optical axes to provide a multispectral capability. The main difference compared with the Z/I Imaging DMC is the use of much smaller sized ( $2000 \times 3000 = 6$  megapixel) areal arrays in the individual inCAM SF modules, which are available in both panchromatic and colour forms. Each module uses a Zeiss Biogon lens with a focal length of 28.5 mm and a maximum aperture of f2.8; alternative lenses, for example with  $f = 50$  mm, to provide greater ground resolution but smaller angular coverage, are available if required. Of course the ground footprint resulting from this smaller array will be substantially less than that of the DMC panchromatic camera, but so will the price. It will be most interesting to see if users adopt this compact small-format metric camera for economical use in small aircraft, as has occurred with the Kodak DCS 460/560.

LH Systems' development partner for the ADS40, the Institute of Space Sensor Technology of DLR in Berlin, developed its own HRSC-A (High Resolution Stereo Camera—Airborne) imager some years ago from its space programmes. Over the past three years, this device has been used by DLR and the French ISTAR company to acquire imagery over 50 European cities. The Dutch company Geodan has separately collaborated with DLR in the development of automated techniques for the interpretation and use of the resulting imagery. Currently the HRSC-A scanner is being flown in a similar manner over cities in the USA, in a joint programme between ISTAR and ORBIMAGE. In view of DLR's involvement in the development of the ADS40, it came as a considerable surprise to most people to learn from the presentations and literature available on the ISTAR and Geodan booths that DLR has also constructed and is bringing into operation two new models of its own scanner this summer. These are the HRSC-AX, with a narrow-angle ( $f = 150$  mm) lens, and the HRSC-AXW, with a wide-angle ( $f = 47$  mm) lens. Both models use 12000 pixel linear CCD arrays (double the length of those in the HRSC-A) operating at a maximum frequency of 1640 Hz, together with an Applanix POS/DG. So it appears that DLR will continue to offer an extensive data acquisition service in conjunction with its partners.

To confirm the impressive German contribution to airborne digital sensors, Rollei showed its d-Metric series of digital SLR cameras, complete with a tiny integral monitor and using an areal array of  $1280 \times 1024$  pixels as its sensor. The obvious application would seem to be close range photogrammetry, supplementing the company's Rollei 35 and 6008 metric film cameras. The Swiss company PMS Photo-Mess-Systeme, however, was promoting an Olympus calibrated digital camera alongside Elcovision 10, the latest version of its well-known software for close range photogrammetry.

Both LH Systems and Z/I Imaging were at pains to clarify, of course, that their new sensors were not superseding their well established and continuing film camera lines. Both the RMK TOP and RC30 were on display. For the RMK TOP, the IGI CCNS-4 and AeroControl-IIId for flight planning, navigation and IMU



were offered under a cooperation agreement. ASCOT and Applanix (on an adjoining booth) were available for the RC30. The HIEI SE-IIa five-inch format film camera manufactured in collaboration by Osaka Optical Ltd. and the Tomtecs A.G. Corporation was on show too, a handful having been sold, mainly in Japan. Both Agfa and Kodak featured new aerial films and FoMos from Russia displayed several photographic materials.

#### *Scanners and Photogrammetric Workstations*

The scanner world had become simpler, with Vexcel Imaging having left the market earlier in the year. LH Systems' DSW500 and Z/I Imaging's PhotoScan 2000 were the units that visitors encountered first, but at the lower cost end of the market there was encouraging competitive activity, with the familiar Vexcel Imaging Austria UltraScan 5000 and Wehrli RasterMaster joined by two products from further east: the Delta scanning workstation from the Ukrainian company GeoSystem and the China Swei Imatizer-2302. The high-end units offer greater speed, but the gap in spatial resolution and radiometric performance is less emphatic. All of these units, except the DSW500, run with PC hosts only, and all except the RasterMaster offer some form of roll film capability. These are two trends worth noting from Amsterdam. There is widespread acceptance of scanning roll film, often the original negative medium, so organisations without analytical or analogue plotters need no longer produce diapositives. Also, Unix has been clearly eclipsed by Windows, especially NT and 2000. In Vienna, in 1996, these norms had not yet become clear. Nevertheless, Autometric and LH Systems continue their Unix and NT lines in parallel and ERDAS and Z/I Imaging both offer some support for Unix, albeit overshadowed by their PC activities.

The Inpho booth included the MATCH (-AT, -T and -I), PAT (-B and -M), SCOP and SKIP software products that have been sold both directly and through DPW suppliers, especially Intergraph, Zeiss, Z/I Imaging and DAT/EM. But Inpho's remarkable broadening of its range, both through its own efforts and its GeoToolBox Team partnerships, was a major feature of this exhibition. Your reporters infer that this strategic departure for this previously rather conservative and stable company is prompted not only by a desire for growth but also by a wish to avoid overdependency on one component of its distribution channel, Z/I Imaging. The Team partners include Vexcel Imaging Austria with its UltraScan 5000 high-precision film scanner and DAT/EM with its Summit PC DPW. Rather more unexpectedly, another player in the GeoToolBox Team is the small firm from Finland, X-Position, previously best known for its specialist geodetic packages. Out of this has come a new package, OrthoWarp, for orthophoto generation. This software includes a variant called OrthoWarp ER that has been developed specifically as an add-on module to the well-known image processing software from ER Mapper, whose ImageWebServer is also being offered by Inpho. These products join the OrthoVista digital orthophoto mosaicking package from the Stellacore Corporation. Inpho had already added this package to its product line after it had been dropped by Zeiss following the formation of Z/I Imaging. Inpho even has a product for semi-automated feature extraction called inJECT.

Besides X-Position, two other Finnish companies showed digital photogrammetric products. Stora Enso Forest Consulting group, which has been involved for

some time in forestry mapping and GIS activities both in Finland and abroad, offers its own aerial imaging and processing system under the title of EnsoMOSAIC. This package includes modules for GPS-controlled flight planning and navigation and data acquisition using either small-format digital or video cameras, together with modules for block triangulation and adjustment and the production of rectified images and mosaics. Applications appear to be primarily directed towards thematic mapping of land use, agriculture and forestry. ESPA Systems has produced quite a wide range of digital photogrammetric software products called Espa Kernel, Espa Block and Espa Bundle (for aerial triangulation), Espa Ortho (for orthophoto generation), Espa City (for 3D data acquisition) and Espa Gate (for the exchange of 3D data with MicroStation and the Smallworld GIS environment). The Espa software seems more oriented towards photogrammetric mainstream activities than that of Stora Enso. The GIS connections reflected on the one hand the predominance of MicroStation and on the other a resurgence of direct linkages between photogrammetric workstations and GIS software, an approach that has been repressed since the demise of System 9. LH Systems announced a 3D, bi-directional link between SOCET SET and ESRI's ArcSDE, and Laser-Scan, now under its new owners, Yeoman Group, had a SOCET SET workstation on its booth showing the link to LAMPS2.

Yet another Finnish company, Novosat Oy, owned jointly by the National Land Survey of Finland and the Novo IT Group, used the Congress to launch the China Sweit JX-4 DPW on the European market in collaboration with the Chinese State Academy of Surveying and Mapping. Thus it joins the already established VirtuoZo DPW produced originally by a group from the Wuhan University of Surveying and Mapping and now being developed by its spin-off company, Supresoft. At the exhibition, VirtuoZo was demonstrated by Survey and Development Services from the UK, the representative for Europe, the Middle East and Africa. GeoSystem's Delta DPW, like its other products, was shown in a more developed form in Amsterdam at what are, by Western standards, amazingly low prices. As a result, the company is beginning to sell these products in Western Europe, Asia and Africa. If the quality control and support of the GeoSystem products is adequate, then they must become serious competitors in certain markets. Another vendor at the Amsterdam show was the Czech company, TopoL Software, which, besides its TopoL GIS software, showed its ATLAS PhoTopoL DPW which appears to be directed towards DEM and orthophoto generation, but also provides stereo-compilation and updating capabilities.

Despite these new or unfamiliar DPWs (mainly from Europe), the well-established DPW companies from North America that appear regularly at ASPRS and ISPRS meetings were in Amsterdam in force. Most had well-staffed and busy stands that reflect their current domination of the market. A review of their numerous offerings has recently been given (Petrie and Walker, 2000). Nearly all of these DPWs feature small but worthwhile improvements. Some of these will have been new to the European and Asian photogrammetric communities, but virtually all had been shown at the ASPRS Annual Meeting in Washington, DC, at the end of May and have been summarised elsewhere (Petrie, 2000). They included the Stereo Analyst from ERDAS (whose close relationship with ESRI was reflected in their abutting booths), a feature collection product based on ArcView and part of the same product line as OrthoBASE; DAT/EM's Summit PC (now a member of

Inpho's GeoToolBox Team); and the PC/NT-based version of Autometric's SoftPlotter, continuing to be featured with the KDMS software for feature collection. Others were DVP's Stereo Index and online MicroStation products; the latest version of ISM's DiAP; and the Z/I Imaging ImageStation 2000. Then there was the latest version of SO CET SET from LH Systems (complete with its new TopoMouse for 3D stereo measurement); and KLT's ATLAS DPW and the Amsatek/ABC DPW (both of which also had a new mouse—3D Puck).

The dividing line between photogrammetric and remote sensing software products grows ever thinner as time goes by, as the latter include photogrammetric functionality such as orthophotos and mosaicking, and their everyday uses are based as much on aerial photography as satellite imagery. In addition to ER Mapper (in the Inpho booth), ERDAS IMAGINE and a range of PCI products, including the new Geomatica offering, were much in evidence. The younger player in this league, Virginia-based Sensor Systems, showed its RemoteView package, with strengths that clearly reveal its origins in the defence world. Research Systems' European distributor, Creaso, exhibited the ENVI and IDL products.

Many observers might have expected that this would be the first ISPRS exhibition since the 1960s not to include an analytical plotter; LH Systems and Z/I Imaging continue to sell their SD2000/3000 and P3/33 lines but no longer see any need to exhibit such well-known workhorses, and Adam Technology had no booth this time. However, GeoSystem showed its very neat Stereogram and the ABC booth advertised the company's analytical plotter upgrades.

#### *Image Archiving*

As digital sensors enter the production line, with no film in the can as a last resort if digital data is destroyed, and most photogrammetric organisations accumulate huge volumes of image, vector and project data, the need for an efficient archiving system becomes obvious and unavoidable. Whilst few of these have entered the photogrammetric industry from suppliers of photogrammetric systems, as opposed to photogrammetric firms exploiting solutions from computer hardware and software vendors, Amsterdam witnessed the beginnings of competition between such product lines. Most strongly marketed was Z/I Imaging's TerraShare, but the huge US defence conglomerate Lockheed Martin promoted its Intelligent Library System (ILS), scalable up to 5000 terabytes and 10 million files. It is certain that these offerings will be joined in Istanbul in 2004 by a host of contenders. A series of products from the Israeli company NESS Technology reflected the trend; indeed, a joint announcement with Z/I Imaging of the Military Photography Intelligence System emphasised the mainstream position that these product families will soon occupy. Not new but also on show were Autometric's DataMaster and Spatial Query Server (SQS) products; the future of these lines will be interesting under their new owner, Boeing.

#### *Other Exhibits*

There was much more at the exhibition to capture attention. There were booths from service companies, publishers, universities, government organisations and learned societies. The Photogrammetric Society will not be seen again at ISPRS (it

will be RSPSoc in Istanbul) and it was good to see ASPRS entering into the spirit of the European venue. A large Dutch pavilion hosted several Dutch organisations. Perhaps the biggest draws amongst the other booths, however, were those featuring other forms of data acquisition. For example, the Optech and FLI-MAP lidar systems were shown directly and/or on booths of their users. Airborne radar drew a steady stream of visitors, on the impressive booth of Aero-Sensing Radarsysteme and that of its rival, Intermap Technologies. Of course satellite data is in everyone's mind, with Space Imaging's imaginative booth featuring real imagery at last. Sovinformputnik showed Russian space images, some with 1 m resolution. SPOT Image and INPE (with the CBERS satellite) generated interest too. Kodak's booth featured its space technology capabilities as well as its better known expertise in the air, another instance of space imagery being perceived as one of the tools at everyone's disposal. The many service companies promoting their wares included Aerodata, Arcadis/KLM Aerocarto, Compagnia Generale Ripreseaeree, Fugro-Inpark, Geodan Geodesie, GEODIS and NRSC (National Remote Sensing Centre), whereas Hansa Luftbild had a section of the Z/I Imaging booth.

### *Conclusions*

Almost every ISPRS exhibition in the past has been epochal in photogrammetry's evolution, as manufacturers have preferred this event to any other on the calendar as the launch pad for new products. The XIXth Congress will be remembered as the one where airborne digital sensors capable of performance akin to their film counterparts were first seen. Scanners and digital photogrammetric workstations confirmed their status as mature products, but there were other technologies, such as lidar and image archiving, that had barely featured in Vienna. On the commercial side, the two joint ventures, LH Systems and Z/I Imaging, had been formed since Vienna. The Inpho GeoToolBox Team was further evidence of consolidation in the industry and the trend towards photogrammetric suppliers behaving like any other global players in an industrial goods market, as opposed to the rather charismatic, idiosyncratic companies that one might argue they had been in the past. The high-resolution satellites have begun to fly and spaceborne platforms promise just as exciting developments as airborne in the period until Istanbul in 2004. Yes, this was indeed an exhibition to savour. Lastly, a word of acknowledgement is due to the exhibition organisers for creating an attractive, humming space that was a pleasure to tour.

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*Editor's note: On this occasion it has proved impossible to secure reports from the UK correspondents for some Commissions; the contributions of several Commission Presidents and other authors are gratefully acknowledged.*

*Résumé*

*Le XIXème Congrès international de Photogrammétrie et Télédétection s'est déroulé du 16 au 23 juillet 2000 aux Pays-Bas, au Centre des Congrès et des Expositions internationales RAI d'Amsterdam. On trouve dans cet article des comptes rendus de l'Assemblée Générale, des activités de quelques Commissions Techniques et des Expositions de ce Congrès. Les différentes communications émanant du Congrès sont publiées dans le volume 33 des Archives Internationales de Photogrammétrie et de Télédétection.*

*Zusammenfassung*

*Der XIX. Internationale Kongress für Photogrammetrie und Fernerkundung fand im Internationalen Ausstellungs- und Kongresszentrum RAI, Amsterdam, Niederlande, vom 16. bis 23. Juli 2000 statt. Es wird über die Hauptversammlung, einige Aktivitäten der Technischen Kommissionen und die Ausstellung berichtet. Die Kongressbeiträge wurden im Internationalen Archiv für Photogrammetrie und Fernerkundung, Bd. 33, veröffentlicht.*