

EDUCATION & RESEARCH FACILITIES

by

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Commission VI

Working Group VI-1

ABSTRACT

ISPRS WG VI-1 consists of 12 members regionally distributed all over the world (Chairmen of sub-working groups). Information collected for the period 1980-84 confirmed the previous rough figure of about 150,000 for the world's photogrammetry and remote sensing manpower (excluding photo reconnaissance personnel for strictly military purposes). In terms of photogrammetric and remote sensing education facilities further progress can be reported for the period 1980-84. As to photogrammetric and remote sensing research facilities, considerable information has been collected on a global basis and some analyses have been made on the required R&D personnel, equipment and annual expenditures.

ORGANIZATION OF ISPRS WG VI-1 AND TASKS OF THE INDIVIDUAL MEMBERS OR DELEGATES OF ISPRS WG VI-1

The present members (or delegates) of ISPRS WG VI-1 and their tasks are as follows:

1. Prof. Fred Adamec; Dept. of Surveying, Royal Melbourne Institute of Technology, Melbourne, Australia. Responsible for the sub-working group of Oceania.
2. Maj. Gen. G.C. Agarwal; Surveyor general, Survey of India, Dehra Dun, India. Responsible for the sub-working group on Near and Middle East (Asia) countries.
3. Prof. Henri Bonneval; Saint Maur, France. Responsible for the sub-working group on Francophone countries.
4. Prof. Dr. A.J. Brandenberger; Dept. of Photogrammetry, Laval University, Québec, Canada. Chairman ISPRS WG VI-1.
5. Prof. Dr. S.K. Ghosh; Dept. of Photogrammetry, Laval University, Québec, Canada. Responsible for the sub-working group on Canada and the U.S.A.
6. Prof. A Grimm; Fachbereich Bautechnik, Universität Siegen, Siegen, Federal Republic of Germany. Responsible for the sub-working group on German speaking countries.
7. H. Hoschstitzky; Dept. of Photogrammetry, ITC, Enschede, Netherlands. Responsible for the sub-working group on Western Europe.
8. Prof. Dr. Taichi Oshima; College of Engineering, Hosei University, Tokyo, Japan. Responsible for the sub-working group on Far East (Asia) countries.
9. Prof. Dr. Dem. Rokos; Dept. of Geodesy & Surveying, Aristotelion University of Thessaloniki, Thessaloniki, Greece. Responsible for the sub-working group on the Eastern Mediterranean Region.
10. Prof. Dr. Z. Sitek; Faculty of Mining Geodesy, Cracow, Poland. Responsible for the sub-working group Eastern Europe.

11. Ing. J. Alberto Villasana L.; Director general, Dirección General de Geografía del Territorio Nacional, Mexico D.F. Mexico. Responsible for the sub-working group on Central & South American countries.
12. Dr. A.W. Wassef; Cairo, Egypt. Responsible for the sub-working group on non-francophone African countries (in coordination with Chief O. Coker, Nigeria)

ISPRS WG VI-1 ADMINISTRATION, PARTICIPATION AND COMMUNICATION

To establish the necessary contact and communication between the members of ISPRS WG VI-1 and with the Presidency of ISPRS Commission VI, the Board of ISPRS WG VI-1, during the period under review, has sent several Newsletters and Circular Letters to the ISPRS WG VI-1 members as well as to the Presidency of ISPRS Commission VI. In addition, the ISPRS WG VI-1 Chairman had an extensive correspondence with the ISPRS WG VI-1 members, the President of ISPRS Commission VI and the Board of ISPRS.

In the period of 1980/84, members of ISPRS WG VI-1 have participated or have presented papers at the following conferences or symposia which provided valuable information useful for the work of ISPRS WG VI-1:

- A. Regional Conference on Photogrammetric and Remote Sensing Education, Africa; August 15-18, 1982, Regional Centre for Training in Aerial Surveys, Ile-Ife, Nigeria.
This conference was attended by Dr. S.K. Ghosh as co-director of the Conference and Dr. A.J. Brandenberger as Chairman of Sessions and of the Resolution Committee.
- B. International Symposium Commission VI, ISPRS, 22-25 September 1982, Mainz, Federal Republic of Germany.
The Symposium was attended by the following members of ISPRS WG VI-1:
 - Prof. Fred Adamec who presented a paper on "Teaching of Photogrammetry and Remote Sensing at Australian Tertiary Institutions" and acted as Chairman of Sessions 8, 9 and 13.
 - Prof. Dr. A.J. Brandenberger who presented a paper on "International Documentation Center on Surveying and Mapping including Remote Sensing" and acted as Chairman of Session 10.
 - Prof. Dr. S.K. Ghosh who presented a paper on "Activity Report of WG VI-8 on Stimulation of Education", and acted as Chairman of Session 4.
 - Prof. Dr. Taichi Oshima who acted as Rapporteur of Session 15.
 - Prof. Dr. Dem. Rokos who submitted comments on "Standards of Competence", Session 9.
 - Chief O. Coker who acted as Chairman of Session 5.

For more details on the Symposium reference is made to the Proceedings of the Symposium edited by Prof. Dr. J. Hothmer, President Commission VI, and available from H. Kantelhardt, Secretary Com. VI, HLVA, Postfach 3249, D-6200 Wiesbaden, Federal Republic of Germany.

- C. International Symposium "Education in Geodesy", September 27-29, 1982, Graz, Austria.
The Symposium was attended by the following members of ISPRS WG VI-1:
 - Prof. Fred Adamec who presented papers on "Past and Present Trends in Teaching Geodesy at the Royal Melbourne Institute of Technology" and on "Report on Results of the Symposium of Commission VI (Education and Professional Aspects) of ISPRS held in Mainz and Concerning Particularly Standards for Education and Training in Photogrammetry and Remote Sensing". (Co-authors J. Hothmer and C. Paresi).

- Prof. Dr. A.J. Brandenberger who submitted a paper on "Some Statistics and Analyses on the World's Surveying and Mapping Manpower and Training, United Nations Survey, 1977 (UN Survey)" (Paper read by Prof. Fred Adamec).
- Prof. Dr. Taichi Oshima who presented a paper on "Surveying Teaching in Japan, Past and Present".

For more details on the Symposium reference is made to the Proceedings of the Symposium edited by Prof. Dr. K. Rinner and H. Lichtenegger, and available from Prof. Dr. K. Rinner, Geodätisches Institut, Technische Universität, Rechbauerstrasse 12, A-8010 Graz, Austria.

D. South East Asian Regional Conference on Photogrammetry and Remote Sensing Education, 16-19 May, 1983, Kuala Lumpur, Malaysia.

The following members of ISPRS WG VI-1 participated at the Conference or submitted papers:

- Prof. Fred Adamec who submitted a paper on "A proposal for University Standard Courses in Photogrammetry and Remote Sensing".
- Prof. Dr. A.J. Brandenberger who acted as Chairman of Sessions 1 and 9.
- Prof. Dr. S.K. Ghosh who was Co-director of the Conference, presented a paper on "Stimulation of Photogrammetry and Remote Sensing education", and acted as Chairman of Session 5 and of the Committee Meeting (recommendations and resolutions).
- Prof. Dr. Taichi Oshima who acted as Chairman of Session 8.

WORLD-WIDE INVENTORY ON PHOTOGRAMMETRIC & REMOTE SENSING MANPOWER AND EDUCATION & RESEARCH FACILITIES

Work performed in the period 1980-84 by ISPRS WG VI-1 for this project constitutes a continuation of the work done by the former ISP WG-1 during the period 1976-80 and on which it has been reported in:

1. "Activity Report of ISP WG VI-1, Period 1976-80 - World Status of Photogrammetrie, Education and Research", XIV Congress of the International Society of Photogrammetry Hamburg 1980, Commission VI, Poland; Invited Paper by Prof. Dr. A.J. Brandenberger, Laval University, Québec, P.Q. Canada. International Archives of Photogrammetry, Volume XXIII, Part B6, Pages 052-058.

For the continuation of the project extensive use has been made of information available in the Surveying & Mapping Data Bank of Laval University's Dept. of Photogrammetry. Additional useful information sources for the work performed for the project by ISPRS WG VI-1 are the studies undertaken by and for the Cartographic Section of the United Nations in New York. Since nearly 10 years such studies were performed for the Section by Laval University's Dept. of Photogrammetry (Responsible: A.J. Brandenberger and S.K. Ghosh). Some data partially pertinent to the work of ISPRS WG VI-1 were published in:

2. "Study on the World's Surveying and Mapping Manpower and Training Facilities", by A.J. Brandenberger. World Cartography, Volume XVI, United Nations, New York, 1980; ST/ESA/SER L/16; pp 3-72.
and
3. "The World's Surveying and Mapping (S&M) Manpower and Training Facilities", by A.J. Brandenberger. Surveying and Mapping, Vol. 41, No.3, Sept. 1981, pp. 309-314. American Congress on Surveying and Mapping, Falls Church, Va.

In order to receive specific information for the project, the Chairman of ISPRS WG VI-1 mailed to all working group members a questionnaire (Title: 1981-84, Questionnaire on the Status of World Photogrammetry and for Remote Sensing Education and Research). It was expecting that each member responsible for a sub-working group prepare a summary report (including an analysis) on the information received for his region up to about the end of 1983. It was also anticipated that this world-wide survey would provide partial information on the world's total photogrammetric and remote sensing manpower together with additional information contained in the Surveying & Mapping Data Bank of Laval University's Dept. of Photogrammetry.

Up to the present date the Chairman of ISPRS WG VI-1 has received progress reports, the announcement of regional reports or of contributions from the following working group members or specialists:

- Prof. Adamec: Report on Oceania
- Prof. Bonneval: Report on Francophone countries
- Prof. Ghosh: Report on North American countries (Canada, U.S.A.)
- Prof. Rokos: Report on East Mediterranean Zone
- Dr. Winter & Dr. Howard: Report on the professional Education in Digital Remote Sensing with special emphasis on the Federal Republic of Germany.

It is hoped that additional reports will be obtained and papers would be announced up to Spring 1984 from other working group members of ISPRS WG VI-1 members or other specialists. However, due to deadline limits, the information contained in these reports or papers might run the risk of not being included in this general report. Nevertheless, and in spite of this inconvenience it is hoped that additional members of ISPRS WG VI-1 or additional specialists would still submit their reports or papers as Presented Papers.

PROGRAM FOR THE ISPRS WG VI-1 ACTIVITY AT THE 1984 ISPRS CONGRESS IN RIO DE JANEIRO

Tentatively, one 3 hours session within the ISPRS Commission VI sessions at the Rio Congress has been scheduled (1½ hours for summarizing papers and 1½ hours for discussions).

The following Invited and/or Presented Papers have been scheduled for the ISPRS WG VI-1 session:

- Adamec A. & Fraser D: "Photogrammetry and Remote Sensing - A Review of Training in Australia and Oceania".
- Bonneval H.: "Enseignement de la photogrammétrie et de la télédétection en France".
- Brandenberger, A.J.: "Activity Report of ISPRS VI-1, Period 1980-84 - World Status of Manpower and of Education & Research Facilities".
- Ghosh, S.K.: Report on Canada and the U.S.A. to the ISPRS WG VI-1 Program.
- Rokos D.: "Photogrammetric and Remote Sensing Education and Research in the South-Eastern Mediterranean Countries".
- Winter R. & Howard J.: "Professional Education in Digital Remote Sensing in the Federal Republic of Germany".

THE WORLD'S PHOTOGRAMMETRY AND REMOTE SENSING MANPOWER

In the period 1980-84, the figures listed in 1 have been up-dated; Additional information is now being available in the following publication:

4. "The Status of the World Topographic and Cadastral Mapping. Total Surveying & Mapping Manpower, Education, Research & Development. Total Surveying & Mapping Expenditures". World Cartography, Volume XVII, United Nations, New York, 1984 (Draft prepared by A.J. Brandenberger and S.K. Ghosh).

In this publication, total manpower figures for the world's national cartographic agencies (responsible for national geodesy and cartography) are published as follows:

Total manpower (excluding for strictly military Surveying & Mapping operations).....162,000. This manpower consists of the following categories:

-Geodesy & Surveying	25,920	or	16.0%
-Photogrammetry	16,020		9.9%
-Remote Sensing	1,820		1.1%
-Cartography	22,800		14.1%
-Reproduction	14,420		8.9%
-Administration	11,300		7.0%
-Others (in cadastral operations)	69,720		43.0%
	Total		100.0%
	162,000		

Therefore and for the year 1980, the combined photogrammetry and remote sensing manpower is 17,840 or 11.0% of the national cartographic agencies' total manpower. - The latest figure for the world's total surveying & mapping manpower is 1.23 million which figure is 7.6 times larger than that for the national cartographic agencies. On the other hand it was found that the total manpower of the world's national cartographic agencies in recent years and annually increased by about 2.1%. Using this figure would yield for the national cartographic agencies and for 1984 a total photogrammetry and remote sensing manpower of approximately 19,500 or using the above factor of 7.6 a figure for the world's total photogrammetry and remote sensing manpower (excluding strictly military photogrammetry on remote sensing operations) of approximately 150,000. This figure agrees with the figure reported in 1. Nevertheless it should be mentioned that the figure is obtained by extrapolation with a certain error margin. An exact figure could only be produced on the basis of a detailed inventory. Such an inventory is indeed in progress within ISPRS WG VI-1, however, it is still not complete. For this reason, the figure of 150,000 being the only available figure, might be considered as a first and acceptable estimation.

In a similar way and based on statistics published in 2, the various educational level categories can be evaluated for the world's photogrammetry and remote sensing manpower and this again by extrapolation of the world's total surveying & mapping manpower and considering the educational categories ratios (see also 1). This would produce for the entire world 15,000 professional photogrammetrists (University level or equivalent) 75,000 middle-level education personnel (technologists, technicians and equivalent), and 60,000 auxiliary personnel (photographers, auxiliary plotter operators, etc.) or an education level ratio of about U:T:A = 1:5:4: - As indicated in 1, the world's photogrammetry and remote sensing

manpower has to be renewed by an annual intake of about 5% which results in annual education (graduation) or training requirements of:

- 750 professional photogrammetry and remote sensing specialists (1 per 5 million inhabitants)
- 3,750 photogrammetry and remote sensing middle-level personnel (1 per 1 million inhabitants) and
- 3,000 photogrammetry and remote sensing auxiliary personnel (1 per 1.2 million inhabitants).

These figures provide some indicators for the actual or supposed to be number of photogrammetry and remote sensing personnel which are or have to be educated (graduated) or trained each year at various levels and at appropriate institutions or organizations.

INVENTORY ON EDUCATIONAL FACILITIES IN PHOTOGRAMMETRY AND REMOTE SENSING

It is assumed that the information contained in 2 is at present still the most comprehensive one as far as institutions are concerned offering such education and training at least up to about 1978. Since then, some programs have been modified or expanded and new programs have been started. Of particular importance and interest are a number of autonomous photogrammetry and remote sensing educational institutions offering programs at various educational levels. At the present time there are at least 6 such institutions, namely:

- Centro Interamericano de Fotointerpretación; Bogotá, Colombia
- Indian Institute of Remote Sensing, IIRS; Dehra Dun, India
- Internationales Fortbildungszentrum für Photogrammetrie - Operateure, IPO, Stuttgart, Federal Republic of Germany
- International Institute of Aerial Survey & Earth Sciences, ITC; Enschede, Netherlands
- Regional Centre for Training In Aerial Surveys, RECTAS; Ile-Ife, Nigeria
- Schweizerische Schule für Photogrammetrie - Operateure, SSPO; St. Gallen, Switzerland.

During the period 1980-84 and due to the efforts of ISPRS WG VI-1 members, a considerable amount of new information has been obtained on educational facilities in photogrammetry and remote sensing throughout the world. It is felt that it would be of considerable value to a wide range of interested organizations and persons to have this information available in published form, i.e. in form of a directory similar to Publication 2. Considering the importance of such a project it is proposed to discuss this matter furthermore with ISPRS WG VI-1 members at the Rio Congress.

A preliminary inventory of photogrammetry and remote sensing teachers throughout the world has been established by the author of this paper and by distinguishing between the following educational or training institutions:

- U Teachers at higher education institutions (University level; professors, readers, lecturers, instructors).
- T Teachers at middle-level education institutions (technologists and technician schools).
- A Teachers at auxiliary personnel level education institutions (for auxiliary photogrammetric operators and photographers, etc).

Based on the Surveying & Mapping Data Bank of the Dept. of Photogrammetry, Laval University, the number of full-time or part-time Photogrammetry and remote sensing teachers has been identified (and partially estimated) for the various regions of the world and for the U and T levels as shown in Table I. (A-level teaching or training in photogrammetry and remote sensing is nearly exclusively done as on the job training and at this time no comprehensive information is available on the number of teachers involved on this level of teaching or training). - In this table the T figures are probably somewhat too low because of incomplete information. Nevertheless, and in spite of this, it can be concluded that at the present time there is a massive shortage of T-level photogrammetry and remote sensing teachers in the world and this particularly in consideration of the requirement of producing or training annually a multiple of specialists in these fields when compared with the production or graduation of U-level specialists in photogrammetry and remote sensing either in the already existing 30 university level photogrammetry departments (plus 1 remote sensing department) or in other departments.

Table I

Number of Photogrammetry and Remote Sensing Teachers in various Regions of the World.

Region	U-level	appr. per..... inhabitants	T-level	appr. per..... inhabitants
Africa	77	610,000	66	718,000
America North	468	80,000	78	478,000
America South	49	507,000	13	1,906,000
Asia	224	1,210,000	137	1,980,000
Europe (exc. USSR)	384	131,000	160	315,000
Oceania (Ind. Aus- tralia)	41	563,000	17	1,360,000
USSR	206	132,000	60	454,000
World	1,449	322,000	531	878,000

There is not enough information available on the number of teaching or research assistants per teacher, but it can be assumed that as a general rule and in most cases, each teacher is assisted by at least one part-time assistant. Research on this aspect has to be continued with the purpose to determine a more accurate teacher/assistant ratio. This also applies to the determination of the existing or required student/teacher ratio for photogrammetry and remote sensing education and/or training as well as for technical and auxiliary personnel (technicians, secretaries etc.) needed for this purpose.

Information on equipment available for photogrammetry and remote sensing reveals that the amount of such equipment widely varies from more than U.S.\$ 100,000 worth of equipment (investment) per teacher to less than U.S.\$ 5,000 per teacher. It should be noticed here that there is a requirement to complete the available equipment according to the latest equipment development trends such as the increased use of analytical plotters and orthophoto equipment in photogrammetry and numerical processing of imagery data in remote sensing. Although there is a large amount of information available on available equipment for photogrammetry and remote sensing teaching, more compilation work has to be done to eventually arrive at some kind of a standard model of equipment required for teaching photogrammetry and remote sensing.

It is of considerable interest to know how much money is presently spent per year in the world for photogrammetry and remote sensing teaching. Some first approximations on such expenditures can be obtained by extrapolation using up-dated data from Reference 2. This would yield an amount of about U.S.\$ 70 million (excluding teaching for strictly military purposes). Evidently, the question can be raised here whether this amount is considered appropriate under due consideration of future requirements. To get a clearer idea of required outlays obviously still more analysis and work has to be done to eventually come up with more specific figures.

INVENTORY ON RESEARCH (R&D) FACILITIES IN PHOTOGRAMMETRY AND REMOTE SENSING

Although a considerable amount of information has been collected on available research facilities in photogrammetry and remote sensing, further data collection will be necessary to present a comprehensive inventory on the world's R&D facilities in these fields. All that can be done at this time is to give some rough ideas or to indicate some guidelines on how much manpower might be or is supposed to be involved in this operation and on the amount of money which might be or is supposed to be spent. - From Reference 2 it can be concluded that about 1.66% of the world's total photogrammetric and remote sensing manpower and annual expenditures (excluding strictly military photogrammetry and remote sensing operations) might be or is supposed to be involved in photogrammetry and remote sensing R&D. With a world's total photogrammetry and remote sensing manpower of 150,000 and total annual expenditures of about U.S.\$ 2 billion for non-military photogrammetry and remote sensing work, this would yield a total R&D manpower of about 2,500 and total annual R&D expenditures of about U.S.\$ 33 million or about U.S.\$ 13,000 per R&D employee. - There are other items which need further clarification and for which further data collection will be necessary such as on the existing or desirable ratio between U, T, and A level R&D manpower, on available or required equipment, on the ratio of R&D done in government agencies, educational institutions and private enterprise. - Of special significance is the photogrammetry and remote sensing R&D activity at U-level educational institutions particularly in developing countries where in many cases R&D qualified personnel exists nowhere else except at U-level educational institutions. For such cases it appears urgent to provide the necessary funds by formal agreements specifying that an appropriate portion of the country's surveying and mapping budget should be reserved for R&D programs in photogrammetry and remote sensing at U-level educational institutions.