An Analysis of Photogrammetric and Remote Sensing Education in Australasia and Oceania

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In an attempt at obtaining up-to-date information about the teaching of Photogrammetry and Remote Sensing in the Australasian and Oceanic region a questionnaire (see Appendix 1) was prepared and sent to 51 Universities and Colleges of Advanced Education (i.e. Tertiary level institutions). This paper analyses the information contained in the 29 replies received.

Courses in Photogrammetry and Remote Sensing are conducted in a variety of Departments at Universities and Colleges. These include Departments of Land Surveying and Cartography, Applied Geology, Land Information, Geography, Environmental Planning, Earth Sciences, Applied Physics, Forestry, Applied Science, Electrical and Electronic Engineering, Communications Engineering and Geographical Sciences.

Courses vary greatly in their hourly contact, content, number of attending students and level. Some courses are project based, others are in the form of short courses. Courses of quite short duration (4-6 hours) are offered by some Departments and others conduct formal courses of up to 126 hours. Table 1 shows some examples of course level, number of students and number of hours taken up by such courses. The content of courses conducted in Australasia and Oceania is also quite diverse. Some of the syllabi forwarded as part of the replies to the questionnaire are incorporated in Appendix 2. It should be noted that these syllabi represent a wide range of course level and hourly contact.

The intention of incorporating them is to illustrate the variability and extent, and not as the means of arriving at a 'perfect or ideal' syllabus to be promulgated to all courses with Photogrammetry and/or Remote Sensing content.

In Departments conducting Land Surveying and Cartography courses the emphasis remains, as expected, on Photogrammetry. Some, however, are reducing the content and time allocation for Photogrammetry and increasing, accordingly, Remote Sensing. A number are also conducting graduate programs specifically in the area of Remote Sensing.

Level of Course	Degree Name	No. of Students	No. of Hours
1st year			
	Surveying	30	42
	Cartography	30	28
	Geography	250	4-6
	Geology	120-140	15
	Surveying & Geography	35	42
2nd year			
	Geography	53	70
	Surveying	30	56
	Cartography	30	140
	Surveying	30	28
	Geography	50	50
	Applied Science	40	48
	Surveying	12	42
3rd year			
	Surveying	30	42
	Cartography	25	84
	Geography	15-20	8-10
	Surveying	15	84
	Surveying & Geography	25	56
4th year			
	Geology	15	14
	Geology	12	25
	Geography	2	25
Not specified by year			
	Geography	80	65
	Geography	15	65
	Geography	2	65
	Geography	11	126
	Geography	9	80
	Geography	46	36
	Geology	8	18
	Geography	20	100

Table 1: Some examples of course level, degree name, number of students and hours of study undertaken.

Other Departments (e.g. Geography and Geology) are more interested in Remote Sensing and if Photogrammetry is taught at all it is being reduced and Remote Sensing expanded.

Land Surveying and Cartography Courses	
% Photogrammetry	% Remote Sensing
76	24
77	23
80	20
67	33
75	25
Other Courses	
% Photogrammetry	% Remote Sensing
0	100
40	60
0	100
0	100
30	70
33	67

Table 2: Content (in terms of hours devoted to Photogrammetry and Remote Sensing (expressed as a percentage))

Significant changes in both Photogrammetry and Remote Sensing were envisaged by Departments with Surveying and Cartography courses. All foresaw a decreasing interest in, and emphasis upon, the analogue aspects of Photogrammetry. Analytical Photogrammetry however, would continue to be important especially the areas of computer-assisted mapping, the collection and processing of digital images, and non-metric, non-standard photogrammetric applications. Remote Sensing was seen as an expanding area with interest being centred on advanced image processing especially the processing of high resolution satellite data and its consequent utilisation in mapping and Geographic Information Systems (GIS).

Areas other than Surveying and Cartography appreciated the need to retain some Photogrammetry. However, photogrammetry in its traditional sense was being de-emphasised and in some cases discontinued. All respondents believed Remote Sensing teaching would expand significantly. Digital image processing, mapping applications and interfacing with GIS were suggested as the areas of future growth.

For students undertaking courses in Photogrammetry and Remote Sensing the main areas of support subjects were seen to be:

- mathematics (topics should include statistics, numerical analysis and matrix manipulation)
- computing (topics should include digital image processing, data structure and data base concepts, pattern recognition and computer graphics)
- applied physics (topics should include optics, electromagnetic radiation and its transfer especially through the atmosphere, introductory electronics especially sensor systems).

With regard to Graduate Studies, a number of Institutions provide a range of courses.

The Centre for Remote Sensing at The University of New South Wales, Sydney conducts a Graduate Diploma in Remote Sensing, a Masters Degree in Remote Sensing and has a number of students proceeding to the degree of Ph.D. in the Remote Sensing field.

Other Institutions offer a Graduate Diploma only, others a Master of Applied Science by research. There are Institutions which within their Masters and Doctoral programs offer courses in Photogrammetry and/or Remote Sensing.

A number of Institutions offer Photogrammetry and Remote Sensing courses within other graduate programs. For example, The Royal Melbourne Institute of Technology offers two units of Remote Sensing within the Graduate Diploma of Land Data Management.

There are a number of Universities within the region that are involved with research programs which utilise Photogrammetric and Remote Sensing techniques and methodologies but are not entitled Photogrammetry and/or Remote Sensing explicitly. Photogrammetry and/or Remote Sensing are seen as tools to assist in a particular research program.

In the Oceania region, Photogrammetry and Remote Sensing are taught, used and studied at all levels of tertiary education from undergraduate to doctoral programs. Courses are conducted in a wide range of home Departments.

Photogrammetry is most readily found in Departments conducting courses in Land Surveying and Cartography. And its future is likely to remain within these fields.

Remote Sensing, however, is represented in a wide range of Departments and is taught and used in a variety of ways. Some courses treat the subject in a very cursory manner, others in great depth. Many courses are subject specific, others adopt a broad approach. In some cases Remote Sensing is seen as a research tool and courses are not conducted at all. No identifiable home Department in Remote Sensing has evolved. Remote Sensing has developed as a service to many other subject areas. This creates potential problems as the expert in the subject area may understand little about Remote Sensing and vice versa. This problem is being addressed by some Institutions. One approach is to establish short courses and specialist programs to meet individual user demands.

Remote Sensing is still evolving as a field of academic study. In setting up appropriate courses many problems still need to be resolved. However all the respondents to the questionnaire, no matter what their field, were of the view that Remote Sensing would expand and become more significant in the future.

Note: the authors would like to thank those who replied to the questionnaire upon which this paper is based.

For more detailed information regarding courses in Photogrammetry and Remote Sensing in the Australasia and Oceanic region, please, contact the authors.

Appendix One

The questions contained in the questionnaire forwarded to the various Universities and Colleges of Australasia and Oceania, were as follows:

The names of Departments and Courses teaching Photogrammetry and/or Remote Sensing and, if possible, brief syllabi of such courses.

The number of hours taken up and the number of students enrolled in such courses.

What is the current balance between Photogrammetry and Remote Sensing? How much, and what, Photogrammetry is being dropped and in what ways is Remote Sensing expanding?

What, in your opinion, are the likely future changes in Photogrammetry and Remote Sensing?

What service teaching areas (i.e. Maths, Computer Science, Physics etc.), in your view, are and will continue to be, of importance to students taking courses in Photogrammetry and Remote Sensing?

Appendix Two

Examples of the content of Photogrammetry and Remote Sensing courses at the various institutions which replied to the questionnaire are:

Photogrammetry

Number One: Remote Sensing data acquisition systems; photography, electro-optical, linear array and microwave systems. Photograph geometry. Interior orientation. Stereoscopic vision. Collinearity equations and deviations from collinearity encountered in practice. Space resection. Relative orientation; concept procedure, error effects. Ground control selection, absolute orientation. Analogue stereo-plotter principles.

Number Two: Mathematical fundamentals. Geometry of the aerial photograph. Aerial photography and cameras. Stereoscopy. Analogue orientation. Topographic plotting. Photogrammetric instrumentation. Control extension. Analytical methods. Rectification and orthophotography. Calibration. Terrestrial photogrammetry. Flight and project planning.

Number Three: Photogrammetric cameras. Single-picture theory, radial-line methods; rectification, mosaics. Stereoscopy. Parallax heighting. Spatial methods, relative and absolute orientation, scaling. Aerial triangulation. Errors. Operational methods.

Number Four: To acquaint students with basic procedures of map and air photo interpretation and analysis and of map making. Considerable practical and field work in Photogrammetry is included.

Number Five: Transformation of single photo coordinates. Tilted photography and rectification. Analogue stereoplotting equipment. Empirical orientation and model deformation. Mosaics and orthophotos. Radial line triangulation. Map revision. Planning aerial photography and control.

Number Six: Analytical methods of relative and absolute orientation. Principles of analytical plotters. Map compilation by photogrammetric techniques. Map production. Differential rectification, orthophotos and mosaics. Map revision. Principles of aerial triangulation. Project planning.

Aerial triangulation block adjustment by models and bundles. Control requirements, accuracies of aerial triangulation. Camera calibration. Application in non-topographic methods using metric and non-metric systems. Digital elevation models. Computer assisted mapping techniques in Photogrammetry.

Remote Sensing

Number Seven: The physics of various Remote Sensing techniques; interpretation of conventional aerial photography in exploration; infra-red Remote Sensing techniques; side-looking airborne radar; theory and applications of Landsat imagery; enhancement techniques for satellite imagery, interpretation of Landsat photographic products and application to several case history areas. Integration of Remote Sensing information with the overall data base as applied to exploration.

Number Eight: A computer-oriented unit aimed at giving students an introduction to the techniques commonly used to manipulate, process, analyse and interpret digital images of the Earth. Such images are gathered by satellites such as Landsat and Magsat, as well as by airborne geophysical instrumentation. The physical principles of multispectral scanning, synthetic aperture radar, and satellite and airborne magnetometry will be discussed.

Number Nine: Principles of Remote Sensing, status and future developments. Electromagnetic radiation at the Earth's surface. Earth surface and atmospheric interactions with electromagnetic energy. Principles of air photography. Satellite imagery: systems and sensors. Airborne scanners, radars. Image processing. Applications.

Number Ten: Electromagnetic radiation. Spectral reflectance. Imaging systems. Data storage and processing. Display. Discrimination. Ground control. Rectification. Interpretation. Auxiliary data sources.

Number Eleven: The use of the computer in processing spatially located data as measured and collected by such diverse methods as electronic distance measurement and the Landsat multispectral scanner. Emphasis is also placed on the increasing role of the computer in the graphical presentation and display of the results of such analysis, particularly in relation to the inventory and monitoring of the Earth's resources.

Number Twelve: Satellite tracking and tracking aids. Data transmission formats. Preprocessing techniques (radiometric correction, geometric correction, destriping). Analysis techniques (histogram analysis and stretching, boundary detection, gradient operators, image series analysis).

Number Thirteen: Introduction to environmental monitoring techniques. Remote Sensing and environmental monitoring. Image processing, interpretation and analysis. Environmental monitoring methodologies including sampling strategies, data collection and assessment techniques. Case studies.