A MASTER'S DEGREE PROGRAM IN REMOTE SENSING - AN AUSTRALIAN EXAMPLE

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ABSTRACT

Following the recommendations of an ad hoc committee of the Professorial Board of the University of New South Wales, a masters degree program in remote sensing was offered for the first time in 1982.

It is believed to be the first integrated, formal, graduate program to be offered in Australia and one of only a few such programs available internationally. The program consists of a compulsory core of subjects dealing with the principles, application and computer image processing of remotely sensed data, with associated elective subjects and/or a project. Entry requirements for the program are a four year undergraduate degree background in engineering, geography, geology, surveying, computer science, or a relevant environmental, biological or agricultural science. A graduate diploma program is also offered to cater for graduates with three year degrees. The structure and syllabi of the courses are given in the paper.

INTRODUCTION

The use of remote sensing in Australia has a very long history dating back to very early applications of air photo data to interpretation and mapping of land cover types. Most courses given in surveying, geography and geology incorporate subject areas that provided the principles of interpretation and for surveying the more mathematically related subject area of photogrammetry. Particularly since the launch of the Landsat series of satellites in 1972 there has been an increasing awareness and application of this data. Australia with its vast land area, small, well educated population, and largely arid or sub-humid climates was well placed to reap the benefits of remote sensing. In 1977 the Australian Federal Government took the decision to establish a Landsat receiving station, consisting of a data acquisition facility located at Alice Springs in Central Australia, and a data processing facility in Canberra, the nations capital. Landsat data has been acquired by the Australian station on a regular basis since November 1979.

At this time, within the University of New South Wales (located in Australia's largest city, Sydney) a number of specialist groups in photogrammetry, cartography, land management, data analysis and exploration geology had developed particular skills in remote sensing research and application and were moving towards the acquisition of a computer aided analysis facilities to support their work. As well a number of undergraduate and graduate remote sensing subjects were being taught in various disciplines. This activity within the University convinced the Professorial Board to establish a committee to examine "...the matter of teaching in

the area of remote sensing... for co-ordination and report to the Board."[1]

The committee noted that, "...whereas important research and applications in remote sensing are being carried out by several organisations in different parts of Australia, these are geographically and systematically uncoordinated and... not truly self sustaining in the sense of generating their own training procedures."[1] After much deliberation and the widening of the scope to include the concept of a centre for remote sensing the committee concluded "...there was scope for at least one major entry in this field by an established university, and the University of New South Wales was relatively well placed to respond to this need."[1] The final recommendations of the committee were in part that a Master's Degree program in Remote Sensing be introduced from 1982 with the degree to be obtainable in either the Faculty of Engineering or in the Faculty of Applied Science, and that a Centre for Remote Sensing be established within the University with the broadly defined roles of administering University teaching and further education (short course) training in remote sensing and to develop and coordinate the multi-disciplinary research that should accompany and support the teaching of remote sensing. To justify these recommendations the report cited (i) existing staff skills and activities (ii) existing resources in equipment (iii) an appropriate professional and technological bias in a a number of relevant areas and (iv) the University's position in a major conurbation close to several groups practising remote sensing applications.

The University of New South Wales, is one of the largest of Australia's nineteen universities, with a student population of approximately 20,000. It was founded in 1948 as a technological university, although it now covers the whole spectrum of academic endeavour, and has very strong well established Faculties of Engineering and Applied Science. The University is located near the centre of Sydney, an eastern seaport city and the capital of the state of New South Wales. Sydney is the largest city in Australia with a population of approximately 3½ million persons.

THE MASTER'S DEGREE PROGRAM

The University views remote sensing not as a discipline but as a value-added skill. As a result its training and teaching activities are arranged to take an already-trained professional and provide the additional expertise remote sensing has to offer. The Master's Degree program was therefore developed with a careful balance between fundamental principles, data analysis and application areas, but with sufficient elective and project material to cater for applicants with widely varying discipline backgrounds and to allow for the greatest amount of inter-disciplinary exchange.

1 Report of Ad Hoc Committee on the Teaching of Remote Sensing, University of New South Wales, Sydney.

The course consists of 36 credits (where one credit approximately equates with one hour per week of contact time for a 14 week session) and can be completed in one academic year (two sessions) full-time or two years part-time. Eighteen of the credits derive from compulsory core subjects, and the balance from either elective subjects and a 9 credit project or solely from an 18 credit research project. The compulsory subjects are (see Appendix for details).

(i) Remote Sensing Principles and procedures (6 credits) (1st and 2nd session).

(ii) Image Analysis in Remote Sensing (3 credits) (1st session).

(iii) Remote Sensing Applications (3credits) (1st session).

(iv) Ground Investigations for Remote Sensing (3 credits) (2nd session).

(v) Computing Techniques in Remote Sensing Image Analysis (3 credits) (2nd session).

The first of the compulsory subjects incorporates a 3 credit practical exercise designed to reinforce the theory but also importantly to provide a vehicle for interdisciplinary discussion. This it does by approaching the practicals as group exercises, the groups being comprised of 3 or 4 persons each from different discipline backgrounds. All compulsory subjects are well intergrated so that some overlap and reinforcement of other subject areas occurs in each subject. The use of current technology is stressed in all of the subject areas and the course is well placed in terms of equipment to support this view.

Facilities available include a Dipix Aries II image analysis computer system with 224 Kbyte of main memory, 200 Mbyte of disc memory and 6 Mbit of video memory. It includes all state-of-the-art software and hardware required for registering, correcting, enhancing, classifying and displaying image data from a variety of remote sensing sources. Hard copy of image products is provided in 35 mm slide format by means of a Calcomp Model 32 camera. System input is via a dual density tape drive and a coordinate digitiser. Also available are a range of analog image analysis and photogrammetric instruments, and four channel and continuously recording radiometers.

Elective subjects can be chosen from a wide range of subject areas depending on the discipline interest of the student. Subjects include for example Decision and Syntactic Systems for Digital Pattern Recognition, and Digitial Image Processing Systems, Scene Analysis and Machine Vision given by the School of Electrical Engineering and Computer Science, Mathematical Methods for Spatial Analysis, and Soil Erosion and Conservation, given by the School of Geography; Remote Sensing for Geologists, given by the School of Applied Geology; and Photogrammetric Production Processes, and Land Information Systems given by the School of Surveying.

Entry requirements for the program are a four year undergraduate degree background in engineering, geography, geology, surveying, computer science or in a relevant environmental, biological or agricultural science. An acceptable qualification is a degree at Honours level, or at a Pass level to a superior standard, the latter being defined as an average of 65% over the last two years of a full-time course taken in minimum time. A Graduate Diploma is also available to cater for graduates with three year degrees, and practising professionals who wish to gain added skills in remote sensing without needing to complete the requirements of a full Master's program. The diploma course has a number of common subjects with the Master's program, but others that have a more application bias. The course is comprised of 30 credits and no project or research project is required. In addition approximately six short courses per year ranging from one to four days, are given by the Centre for Remote Sensing. Over the period 1982/1984 over 200 persons have attended these courses.

Total enrolments in both the Master's and the Diploma program have increased from 8 in 1982 to 26 in 1984. The latter figure includes 14 Master's program, and 12 Diploma program students, with 11 of the 26 being continuing students from 1982 and 1983, who will complete early in 1984. The background of students is quite varied although the majority have come from resource discipline backgrounds of geography or geology.

REMOTE SENSING TRAINING IN AUSTRALIA

In 1982 the School of Geography and the Centre for Remote Sensing at the University of New South Wales initiated a survey of tertiary educational remote sensing training in Australia and the following summary draws heavily on the resulting report (Garth and Richards, 1983). One hundred and fifty four survey questionnaires were distributed to departments of Geology, Engineering, Geography and Surveying, and to registrars at all Universities, Colleges of Advanced Education and Institutes of Technology. Of the 89 questionnaires returned, 45 respondents offer some remote sensing training and education, and all but 5 offer undergraduate subjects which contain a remote sensing element to some extent. Sixty one undergraduate subjects are offered by the 40 departments, and of these 25% are wholly remote sensing and 75% have a partial remote sensing content. In 1982/83 approximately 200 undergraduates were enrolled in wholly remote sensing subjects, and approximately 1000 in partly remote sensing subjects.

Postgraduate subjects are offered by 15 departments (a total of 24 subjects), with 87% being wholly remote sensing and 13% partially remote sensing. In 1983/83 approximately 150 students were enrolled in postgraduate subjects with 7% of those being in partial remote sensing subjects. Four institutions also offer (or propose to offer) postgraduate course work programs in remote sensing leading to a degree or a diploma. Australia wide, 6 students are enrolled for Ph.D. research programs in remote sensing and 9 for research Masters.

Respondents offering remote sensing, at any level, came mainly

from Geography (29%), Surveying (18%) and Geology (13%) departments. A comparison of the departments responding with the total number of relevant departments in Australia, showed 80% of Surveying departments and 75% of Geography departments offered some form of remote sensing education or training.

CONCLUSION

It is apparent that remote sensing education has taken giant steps in Australia over the past decade to now be in a position to satisfactorily support this new discipline area. The outline of the Master's degree program offered by the University of New South Wales is considered an appropriate model for the development of programs elsewhere, in Australia and overseas. In terms of student numbers, subjects given and equipment facilities it is the major remote sensing program offered in Australia.

APPENDIX

Compulsory subjects in the Master's Degree Program:-

(i) Remote Sensing Principles and Procedures

Electromagnetic radiation. Definition and physics of basic quantities. Photographic film, images and sensors. Electro-optical sensors. Data systems. Examples of operational systems. Positioning, preprocessing, deconvolution, enhancement and classification theory and application to Landsat data. Project involving processing of Landsat data.

(ii) Image Analysis in Remote Sensing

Techniques for extracting information from remotely sensed data with particular emphasis on satellite imagery. Topics taken from: nature and characteristics of earth resources and related satellites; satellite sensors and data formats; image enhancement techniques; image classification methods, including clustering, classification and feature selection; image classification methodologies; new horizons in remote sensing image analysis.

(iii) Remote Sensing Applications

The application of remotely-sensed data and information in the description, classification and assessment of earth resources and environmental conditions. Different types of remote sensing data and imagery, their attributes, acquisition and uses. Relevance of remote sensing data and imagery to a range of applications, including assessment of conditions of terrain, soils and surface materials; multi-temporal monitoring and inventory of rangelands, croplands and forests; rural and urban land use assessment; surveillance of surface water resources and sedimentation; appraisal of changes in the coastal zone. Use of remote sensing in environmental management and in environmental impact assessment.

(iv) Ground Investigations for Remote Sensing

The spectral, temporal and spatial characteristics of various surfaces, and the available sensors to effect maximum differentiation. Ground and image comparisons. Instruments available for field measurements. Field investigation procedures including positioning and sampling considerations.

(v) Computer Techniques in Remote Sensing Image Analysis

A detailed treatment of computer methods for implementing analytical techniques used with remotely sensed data. Topics include: software requirements for image enhancement and analysis; structure and capabilities of the software packages LARSYS, ORSER, BICEP, LASP; implementation of classification methodologies, introduction to image processing hardware and associated operating systems; interactive image processing.

REFERENCES

GARTH, R.E. and J.A. RICHARDS, 1983. "Survey of Tertiary Educational Remote Sensing Training in Australia". Centre for Remote Sensing, University of New South Wales, pp. 35.