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EDUCATION FOR SURVEYORS - A VISION FOR THE 21ST CENTURY

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ABSTRACT

The history of surveying in Australia over the last two hundred years has shown the surveyor to have played many roles besides that of solely measuring features on the earth's surface. These include those of engineer, planner, land manager, land valuer, environmental manager and land developer. What has given the Australian surveyor a competitive edge over other more narrowly defined professions, is the fact that surveyors have always possessed a balance of fundamental skills in measurement science and land management. It should be noted however, that surveying education has taken many different directions in the same period, often being more influenced by overseas trends and models rather than the needs of the practising Australian surveyor - even though the role of the surveyor in the broader community in Australia has not changed to a great extent over the last two hundred years. This paper discusses the historical perspective of surveying education in Australia and draws distinctions between local and international trends. It presents a vision which recognises the surveyor's primary role is the measurement and management of spatial data in the broadest sense. The vision is based on maintaining a balance between measurement science and land management, on retaining a strong scientific foundation to the discipline but above all else remaining flexible in today's ever changing world. The paper illustrates this vision by describing the programs at the University of Melbourne.

INTRODUCTION

The history of surveying in Australia over the last two hundred years has shown the surveyor to have played many roles besides that of solely measuring features on the earth's surface. These include those of engineer, planner, land manager, land valuer, environmental manager and land developer. What has traditionally given the Australian surveyor a competitive edge over other more narrowly defined professions is the fact that surveyors have always maintained a balance of fundamental skills drawn from measurement science and land management, and have recognised the surveyors' role is concerned with the measurement and management of spatial data in the broadest sense. What is important now is to recognise that the world is changing rapidly and that the half life of technical skills is now measured in a few years rather than decades. Therefore it is essential that surveyors are well grounded in the basic sciences and principles. A third fundamental principle in designing education programs in today's environment is a requirement for flexibility and an ability to react quickly to change.

This paper describes a vision for the 21st Century based on the above principles. It is a vision based on a rigorous attempt to determine the future role of surveyors while ensuring that they maintain their historical significance within the broader community. The paper describes the philosophy behind the three undergraduate programs at The University of Melbourne as an example of that vision.

The paper also emphasises the need to understand the historical development of the surveyor both within the Australian context and internationally. While it is essential to consider world wide trends in surveying education, especially in the scientific areas, the reality is that the role of the surveyor in the community in Australia is quite different to that of our counterparts in the UK, Europe, North America and Asia.

With these principles in mind, the Department of Surveying and Land Information at the University of Melbourne undertook a major course revision in 1987 which resulted with the introduction of the new Bachelor of Surveying course in 1988. The Department started the process by looking at the needs of the community for professional skills in the measurement and management of spatial data. While the review was initially based upon an understanding of present needs, it also attempted to identify those which would be of significance over the next decade. This "needs and user requirements analysis" was used to identify the discipline areas and the associated skills that would form the basis of a surveying degree for the 1990's and led to the design of major study streams in the undergraduate degree.

For several decades, the degree program at the University of Melbourne has been recognised as having particular strengths which have distinguished it from other programs around Australia. The individuality of the program was seen as a strength and there was no desire to be the "same" as the other programs around Australia or to become "everything to everybody".

The degree at the University of Melbourne has traditionally attracted very good students and has had a more academic emphasis than many other programs perhaps reflecting the Guiding Values of the University itself. The course has traditionally emphasised photogrammetry rather than geodesy and has had a much greater interaction with industry in form of research consultancies than many other programs.

A major review of the Department in 1986 recommended that the major thrust for the future should be in land and geographic information systems while maintaining a strong measurement science component. The vision outlined in this paper is in accord with that direction while acknowledging that this thrust would build on the strengths of the Department in digital mapping, surveying science and photogrammetry.

HISTORICAL PERSPECTIVE

From early settlement until the Second World War, surveyors in Australia were also land managers, land developers, engineers, valuers and planners. They typically learnt on the job under an articulated system. The balance between measurement science and land management was well established at this time in both the profession and in the education process.

The period from the Second World War up to the early 1970s was the heyday of the geodesist, photogrammetrist and measurement scientist. As a result of the technological advances made during the war and the major developments undertaken in Australia such as the Snowy Mountains Scheme, and the mapping of Australia, there was little emphasis on or public profile for the land management role of the surveyor. This was the period in which many degree programs were started and it is not surprising that the syllabi reflected the high level of activity in the strict measurement science area. The courses were usually established in engineering schools and this again led to an emphasis on the role of science and technology. The course structures tended to be modelled on the measurement science streams of the European schools; however they did not emulate the equally important land management studies within these European models.

It was also a period of great expansion in the Australian economy with no scarcity of employment. There was no concern from the profession in the growth of the new planning and landscape architecture schools in architecture faculties during this period, which gradually narrowed the surveyors' role. During this period the surveying departments in universities and colleges placed major emphasis in both teaching and research on measurement science - land management to a large extent was a "dirty word". This period more than any other resulted in the education process of surveyors losing its balance to a significant

degree. The profession continued to keep the balance between measurement science and land management in practice but it received little support from the education process.

The late 1970s up to the mid 1980s saw the growth of the land studies and land information management concepts in surveying programs in Australia and Canada, primarily from the University of New South Wales and the University of New Brunswick respectively. This reflected the growing awareness of the importance of land management in both education and research in universities. The development of courses over that period did start to address the imbalance in their programs by giving much more attention to land management and land information systems. However the major thrust of education and research was still in measurement science, not land management.

The mid 1980s to the mid 1990s have seen and will continue to see a growth in attention by the educational institutions to address the needs of the profession as it becomes more a part of the information society with its particular contribution being associated with the management and measurement of spatial information.

Land and geographic information systems (LIS/GIS) gained their major impetus in Australia from surveying departments during this period although the emphasis has been on technology, algorithms and operational procedures. During this time, LIS/GIS and related land management activities gained equal academic standing with the traditional disciplines of geodesy and photogrammetry. As a consequence, virtually all surveying programs in Australia have attempted to address the growing needs of the profession in its use and management of spatial data, but it has been done to differing degrees and many schools still carry much of the baggage from the past.

The program at the University of Melbourne was designed from the "ground up", recognising the historical role surveyors have played in this wider area of land management and planning a programme to meet the current as well as the future needs of the practising surveyor in society in Australia.

BACKGROUND TO THE VISION

A key question to be asked by the profession regarding our academic programs should be - "has the Australian surveying profession matured sufficiently in order to develop specific programs for the Australian professional surveyor, now and in the future, rather than copy a North American or European model?" In order to answer this question it is important to understand aspects of these overseas systems.

The North American system is quite different from that existing in Australia. To date there are only about a dozen surveying departments in the USA and Canada, for a population far greater than our own. It is not the norm to take a four year surveying degree to become a professional land surveyor. Those that undertake one of the well known surveying programs such as those at the University of New Brunswick, University of Maine or University of Calgary, graduate as survey engineers. They are usually engineers first and surveyors second. In general, the North American programs concentrate almost solely on the measurement science aspects of surveying education and research, with the exception of the University of Maine and the University of New Brunswick. It must be realised that the major thrust into Geographic Information Systems (GIS) and Land Information Systems (LIS) is not in surveying programs but usually in geography or landscape architecture departments and related areas.

In a similar way, GIS is the responsibility of geography departments in Europe and the United Kingdom, although LIS is a significant discipline in the European programs and at the new University of East London (formerly the Polytechnic of North East London). In the UK virtually all the other land surveying programs concentrate heavily on measurement science with separate departments of land management or land economy training the land related surveyors. Australia does not have this other range of programs to educate the land related surveyors with the exception of the valuation courses which have little in common with our surveying programs.

In Europe, students can specialise in either the measurement science or land management (sometimes called rural engineering) streams. They rarely undertake programs which give them in depth education and expertise in both areas, as in Australia. The Australian surveying programs have followed the measurement science streams in content and structure and have not replicated the land management streams. In practice however, the Australian surveyor has maintained expertise in both measurement science and land management and consequently requires in-depth education in both areas.

In addition, in Australia, it is the surveying profession, particularly in government and universities, that have embraced LIS/GIS. Australian surveyors have given leadership in grasping LIS systems and technology, and applying it. It is only now that some other disciplines are moving into the area. On the international scale, Australian surveyors' expertise and commitment to the area is almost unique.

Unfortunately, in order to maintain commitment and a relevant program in both measurement science and land management, it is essential to have permanent full-time staff within a department who both teach and undertake research in the discipline. This has not happened to a significant degree until the last decade in surveying programs in Australia, and even now the major group of the teaching and research staff in most surveying departments are in the measurement science area. There is however a move to obtain a greater balance between the areas.

As a result of the specific requirements of the Australian surveyor, now and in the future, none of the UK, European nor North American programs are appropriate models to be adopted in Australia.

Another very important aspect to be considered in the future direction of surveying is the move of communities towards an information society within a global village. This will have a major influence on the future operations of the profession. We are seeing under the Clinton administration in the USA, the consideration of nationwide network of "information super highways". This is a US\$200 billion program to provide a fibre-optic network to carry massive amounts of digital information. This concept is considered as important and as expensive as creating the national interstate highway systems after the Second World War in the USA.

At the same time we are seeing the Canadian surveyors creating an Institute of Geomatics in contrast to the existing Institute of Surveying and Mapping. They have defined Geomatics as being "the art, science and technologies involved in managing geographically-referenced information, including its acquisition, storage, analysis and dissemination". A recent review of the Geomatics industry in Canada (McLaughlin et al, 1992) has highlighted that the next decade will have a focus on value added products and services, development of spatial information networks, and integration of spatial databases in environmental applications and in decision support systems. As stated in the report "Technology alone will not be sufficient to ensure a lead role in the future - there is a need for policy support, better marketing and financing strategies, and application driven research".

THE VISION AND THE MODEL

In recognition of the above, the University of Melbourne developed a range of programs to suit the differing needs of the profession and related disciplines at an undergraduate level. Of all the programs, only the Bachelor of Surveying serves the traditional surveying market. The other four programs have been designed to break into non-traditional markets with the result that the horizons of the surveying profession should hopefully be widened. The five programs are as follows:

Bachelor of Surveying (BSurv)

The BSurv is the basic Surveying Degree designed to serve the broad needs of the profession at the present and into the 21st Century. The degree places emphasis on the basic sciences and computer science as well as maintaining a balance between the measurement science and land management streams. The degree has a major emphasis on LIS/GIS as well as Professional Development. The six major streams

(which are expanded in further details in the appendix) are as follows:

- Basic sciences
- Computer Studies
- Measurement Science
- Land Information Science
- Land Management
- Professional Development

Bachelor of Surveying/Bachelor of Science (BSurv/BSc)

Even though the BSurv has a major emphasis on Computer Studies, the University believed that a major strategic direction for the profession over the next decade was to link surveying with an in-depth study of computer science. It is considered that this will give the surveying profession a major competitive advantage in the science and management of spatial information (Geomatics) and the scientific aspects of measurement science. It was recognised however that the Surveying program at the University did not have sufficient depth to provide this computer science expertise. This resulted in the Department of Surveying and Land Information developing a strategic alliance with the Department of Computer Science. As a consequence, a joint degree was developed with the Bachelor of Science component being concentrated in Computer Science. It is a 5-year programme where successful students obtain two degrees. Students can also take other specialisations in the BSc component such as Geography and Environmental Studies but in this case, there is no guarantee that the combined degree can be obtained in five years.

Bachelor of Surveying/Bachelor of Arts (BSurv/BA)

In a similar way to developing a combined degree with the BSc, the University has developed a combined degree with the Faculty of Arts where the arts component will be made up of a major in Geography. It is anticipated that this will give an opportunity for surveyors to strengthen their roles in the context of management and policy associated with environmental management, urban planning and policy and in the applications of GIS. Again students can complete the combined BSurv/BA in five years. They can also do a minor in another Arts subject such as a foreign language.

Graduate Diploma in Surveying Science

The University recognised that there are many people who have degrees in Engineering, Science or related disciplines who want to obtain a theoretical underpinning in measurement science and particularly in one of the areas of digital photogrammetry or geodesy/GPS. As a consequence a flexible nine month graduate diploma has been introduced which draws on a range of undergraduate subjects from the senior years of the BSurv to give these specialisations.

Graduate Diploma in Geographic Information Systems

In a similar way to the Grad Dip in Surv Sc, a flexible nine month Graduate Diploma in Geographic Information Systems has been introduced to give a wide range of professionals an introduction to land and geographic information systems. On completing the Diploma, students understand the underlying science and concepts of LIS and GIS, and have the ability to design and build a GIS. Again the Department of Surveying and Land Information recognised that it did not have all the necessary expertise in GIS, particularly in the area of environmental planning and its applications. As a consequence the Department established a strategic alliance with the School of Environmental Planning to provide appropriate courses. However students can also take courses in the School of Forestry or the Department of Geography to serve their particular needs.

While this paper is primarily concerned with undergraduate programmes, it is important to note the

Department offers an extensive graduate program as a logical extension of its undergraduate courses. Students can undertake a Master of Surveying Science (MSurvSC) and Doctor of Philosophy (PhD) in measurement science, LIS and related areas. For students without a surveying background, the Department offers a Master of Applied Science (MApplSc) (by research or coursework) in GIS and students may progress to PhD.

SOME PRACTICAL GUIDELINE TO COURSE REVISION

Some of the specific lessons over the last few years of undertaking major course changes at the University of Melbourne are set out below, noting one of the most critical over-riding aspects of many of these lessons is the importance of listening to the users whether they are employers, students, graduates, professional bodies or visiting academics.

1. Recognise that a complete review of programs at all year-levels should be done on a regular basis. Allowing sections of courses to become outdated is extremely inefficient as lead-times are long. When allowance for planning, approval and implementation is made, it may take 5 years before graduates with new skills reach the industry. Good educators should be pro-active rather than reactive. Recognise that today's courses are very much creatures of the market place. If a course is not up-to-date and relevant, student interest will drop and the viability of the course will be questioned very quickly by the institution and possibly discontinued.
2. Use your advisory committee for more than the annual gathering to pat the academics on the back and congratulate them on a job well done. These people are your window to the community and reflect its values and concerns regarding professional education. It is important to have committee members with the necessary vision for the future, and select some representatives from other professions.
3. Course evaluation and restructuring is a continuing process – do not expect to always get it right on the first attempt. It may take three years to get individual subjects right, and even longer to get subject streams integrated correctly both within themselves and with other streams. If mistakes are made, don't be afraid of admitting them and then making the necessary corrections immediately. If a weakness in a program is allowed to slip unnoticed for 2-3 years, the professional community tends to find out half a dozen years later – invariably damaging an institution's reputation even though the mistake may have long been corrected.
4. New course programs almost always mean that new staff with new skills will be needed. It must be recognised that the days of taking surveyors with a wealth of field experience 'straight off the street' and placing them in the lecture theatres are behind us. Young academics today are no longer just good teachers or instrument handlers. They must also be competent researchers and administrators, and will be expected to hold a doctorate degree. GIS, remote sensing, spatial analysis, and computer science are just some of the new tools required by surveyors.
5. Get the views of overseas academics. The world of surveying and mapping education is fairly small and within Australia it is generally known who the leading international academics are in our field. Most of these people have visited Australia in the last few years and local evidence is that most are only too willing to examine and comment on new initiatives. It also helps to build research links with staff and graduate students.
6. Get the students' views. Students should have the opportunity to comment and criticise the content and structure of individual subjects, yearly course loads, and degree programs as a whole – both in private and in public as individuals and as a class. For educators who are not familiar with this approach it can be very illuminating.

CONCLUSION

This paper has attempted to show that the skills and expertise of the Australian practising land surveyors are more broadly based than those of surveyors in the UK, North America or Europe. As such the paper argues that education programs for Australian surveyors should therefore be designed specifically to

address these needs. Unfortunately, sufficient attention has not been paid to this in the past as courses have tended to be modelled on overseas programs. There is however a trend to listen to the "users" to a greater extent and to design courses to address Australian requirements. It is essential for the future of the profession that this trend continues.

In maintaining this trend it is recommended that all surveying courses should adopt three main principles:

1. Maintain an emphasis on the basic sciences and fundamental principles which do not have a "Use By Date", whether those principles are in the sciences or in the land management areas.
2. Maintain a balance between measurement science and land management
3. Retain flexibility

Reference

McLaughlin, J., Nichols, S. and Wood, A. (1992) "Geomatics Industry Review", Industry, Science and Technology Canada.

APPENDIX

AN OVERVIEW OF THE BACHELOR OF SURVEYING DEGREE

Basic Sciences Stream

The course retains the traditional structure which includes a number of basic science subjects mainly in the first 2 years of the course. Some of these are taken in common with science students or other students within the Engineering Faculty. At the 1st year level, the subjects include 2 units of general mathematics, 1 unit of physics and 1 unit of statistics. The physics unit concentrates on optics, electronics and wave motion. The study of mathematics is continued into the second year with a further unit of general mathematics and a unit associated with the processes in measurement science. In the 3rd year of the course a 2 unit course in higher mathematics for surveying is given.

This basic science stream has been designed as a foundation to later studies and to provide the technical background required by a number of subjects in both the LIS/GIS and measurement science streams.

Computer Studies Stream

The computer science stream extends through the years 1, 2 and 3 and is made up of 6 units. In the first 2 years of the course the computer studies include an introductory course in computer and information science, programming and computer systems and software for surveying and mapping. These 4 units are designed to provide students with skills in programming and use of computer equipment and software that is currently in use within the professional practice. The stream is completed with 2 units in the 3rd year on computer graphics as support for studies in LIS/GIS and digital mapping.

Measurement Science Stream

The once distinct studies of geodesy and photogrammetry have been combined into a stream (known as Surveying Science) running through the 4 years of the course. This structure reflects the convergence of these two sciences as both move more and more towards computer based operations sharing the many of the same mathematical principles. The stream covers the traditional areas of plane surveying, engineering surveying, geodesy, photogrammetry and satellite surveying. Hydrographic, mining and route surveying are not taken as separate subjects but given as applications of more fundamental theories and practices in

an integrated course. Adjustment theory is taught in depth within the mathematics courses and introduced as applications within the surveying science programme.

LIS/GIS Stream

This study stream includes the subjects cartography, spatial analysis and 2 units in each of Land and Geographic Information Systems and Remote Sensing. Particular attention is paid to the integration of remote sensing data to LIS/GIS systems. The course in spatial analysis covers the statistical and geometric analysis of spatial data and gives students an understanding of the fundamental spatial operations associated with LIS/GIS systems. The study in this area is supported by earlier courses in mathematics and computer graphics.

Land Management Stream

The Land Law and Management stream extends through years 2, 3 and 4. In second year students are introduced to ecology, statutory town planning and development, and land law. Most of these subjects are taught by staff from other faculties and aim to capture young students imagination early in their degree courses to give them a feel for the profession which they are entering.

Third year takes a much more practical emphasis on land law and management and where students study real-world problems and solutions. They deal firstly with land economy in the form of property valuation and investment appraisal of real estate (with a very business-oriented approach), and secondly learn cadastral surveying and law affecting property development. In the latter subject, they are encouraged to look at problems from their client's viewpoint and to concisely and simply present their options for a possible solution.

In fourth year, students revisit ecological studies but with the environmental assessment of development projects in mind. The focus here is not on 'environment versus development', but rather on effective development that serves the community's needs and yet remains in sympathy with its surrounding environment. The other fourth year subject examines land administration, cadastre and land information systems, and also includes the land development practical project. In the latter, students are introduced to urban design procedures and practice, and receive guidance from guest lecturers in a studio environment who examine their residential development designs.

Professional Development Stream

Courses in professional development are run through years 2, 3 and 4 of the degree. In the early years the study is concentrated on written and verbal communication skills and the use of library resources. The lectures include the use of graphics in report writing and photography and video in their presentation as may be applied to contract proposals, environmental impact statements and appeals to planning tribunals. The final phase of the stream is aimed to give students an understanding of the functions and responsibilities of the professional surveyor within the community. An associated subject concerns the planning and control of large engineering projects. It includes material on industrial relations, quality control, feasibility studies, cash flow and scheduling techniques.

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