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Education for Surveyors in Australia: A Vision for the 21st Century

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La Formation des Géomètres en Australie: Vision pour le XXIème siècle

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ABSTRACT

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 that the surveyor's primary role is in the measurement and management of spatial data in the broadest sense. It is based on maintaining a balance between measurement science and land management, and on retaining a strong scientific foundation to the discipline, but above all else remaining flexible in today's changing world. The paper illustrates this vision by describing the programs at The University of Melbourne.

ZUSAMMENFASSUNG


RÉSUMÉ

Cette présentation fournit une perspective historique sur la formation des géomètres en Australie et établit une distinction entre les tendances locales et les tendances internationales. Elle fournit les éléments d'une vision qui reconnaît que le rôle principal du géomètre touche au travail de mesure et de gestion des données spatiales au sens large. Son rôle se fonde donc sur le maintien d'un équilibre entre la science des mesures et la gestion du territoire et aussi sur le maintien d'une approche scientifique pour sa discipline, mais avant tout le géomètre doit rester souple dans notre monde actuel qui est en évolution constante. La présentation illustre cette vision en décrivant les programmes enseignés à l'université de Melbourne.
1. INTRODUCTION

In designing an education structure for surveyors in Australia, three factors were recognised as being fundamental influences on the process. Firstly, the history of Australia was characterised by an early phase of rural settlement and establishment of an agricultural industry followed closely by rapid urbanisation as trade, mining and manufacturing industries developed. All this development relied to some degree on the exploitation of the land resources and in the early years, in a country where few professionals were available, the surveyor played a major and highly varied role. This included those of engineer, planner, land manager, land valuer, environmental manager and land developer. What perhaps distinguishes the Australian surveyor from others is the fact that they have always possessed a balance of fundamental skills in both measurement science and land management. These were seen to have given the Australian surveyor a competitive edge over other more narrowly defined professions. Thus, one of the aims adopted for the education framework was to maintain the balance of fundamental skills associated with these two areas, and to have the community recognise that the surveyors' role is concerned with the measurement and management of spatial data in the broadest sense.

Secondly, it is important to recognise that technology is changing rapidly and that the half-life of technical skills is now measured in a few years rather than decades. Thus, it was considered essential that surveyors be well grounded in those fundamental sciences and principles that would form attitudes to allow the ready acceptance of new technology and the foundation for building new technical skills. A third principle adopted in designing education programs in today's environment is a requirement for flexibility within the program itself and the ability within the organisation to react quickly to change.

This paper describes a vision for the education of Australian surveyors for the 21st Century based on the above principles. It is a view founded on a rigorous attempt to determine the future role of surveyors, while at the same time ensuring they maintain their historical significance within the broader community. The paper describes the philosophy behind the development of 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, it should also be recognised that the role of the surveyor in the Australian community is quite different to that of our counterparts in the UK, Europe, North America and Asia, and this should be reflected in our education programs.

The Department of Surveying and Land Information at The University of Melbourne undertook a major course revision in 1987 which resulted in the introduction of the new Bachelor of Surveying course in 1988, and subsequent combined degrees of Surveying/Science and Surveying/Arts in 1989 and 1993. 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 1990s 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 the country or to become "everything to everybody". The course 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 the 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.

2. HISTORICAL PERSPECTIVE

From the late 18th century until the Second World War, surveyors in Australia were at the hub of an extensive and rapid land settlement program. The nature of the task required not only skills in measurement science but also those of land managers, land developers, engineers, valuers and planners. By and large, there were no formal education courses and surveyors received their education by way of apprenticeships where trainees signed an 'article of agreement' with a master surveyor to receive training in return for service. The process was supervised by State government Surveyors Boards who conducted examinations and issued licences to successful candidates. While the cadastral aspect of land settlement was dominant, surveyors participated in all other facets including engineering design for road making and drainage and the administration associated with the land use planning process. Thus, the balance between measurement science and land management was well established at this time in both the profession and 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. This resulted from the technological advances made during the war being applied to the major engineering developments undertaken in Australia, and the adoption of a national mapping program which included the first national geodetic survey. Both activities attracted expert Europeans to the scene and a popularising of the technical aspects of measurement science followed. As a consequence there was less emphasis on maintaining the public profile of the surveyor as a land manager. This was also the period in which many degree programs for surveying were started, and it is not surprising that the syllabus 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, no doubt influenced again by the presence of European experts in the current engineering and mapping projects.

It was also a period of great expansion in the Australian economy with no scarcity of employment. There was no concern from the profession with the growth of new planning and landscape architecture schools in universities 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 - and 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 institutions.

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 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 the 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, almost 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. Accordingly, 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 program to meet the current as well as the future needs of the practising surveyor in Australian society.

3. AN AUSTRALIAN SURVEYING EDUCATION MODEL

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 courses for the Australian 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 normal in Australia to take a four year surveying degree to become a professional land surveyor. This is not so in North America. Those students that undertake one of the well known surveying programs such as 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 a depth of 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 and applying these systems and the technology. It is only now that 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 majority of teaching and research staff in most surveying departments are working 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 or 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 a 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 across the country. 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 have seen the Canadian surveyors create an Institute of Geomatics in contrast to the former 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 the point that 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".

4. IMPLEMENTATION OF AN AUSTRALIAN 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 on 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 are as shown in Table 1.

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

Whilst the BSurv program has an emphasis on computer and environmental 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 or environmental science.
With regard to computer science, it is considered 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 program where successful students obtain two degrees. Students may also take other specialisations in the BSc component. A popular choice is a program in Environmental Studies. This reflects a growing belief in the community that land management needs to be in harmony with the concepts of conservation and sustainable development.

<table>
<thead>
<tr>
<th>STREAM</th>
<th>COMPRISING SUBJECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics and Science</td>
<td>mathematics, physics, statistics, electronics</td>
</tr>
<tr>
<td>Computer Studies</td>
<td>computer science, programming, computer systems, computer graphics</td>
</tr>
<tr>
<td>Surveying Science</td>
<td>plane surveying, engineering surveying, geodesy, photogrammetry, geodetic surveying</td>
</tr>
<tr>
<td>Land Information Technology</td>
<td>cartography, spatial analysis, remote sensing, land and geographic information systems</td>
</tr>
<tr>
<td>Land Management</td>
<td>land law, cadastral surveying, land development and administration, land economy, town planning, ecology, geology, environmental assessment</td>
</tr>
<tr>
<td>Professional Studies</td>
<td>written, verbal and graphic communication, economics, management, project planning, minor thesis</td>
</tr>
</tbody>
</table>

Table 1: Major Undergraduate Study Streams - The University of Melbourne.

The percentages of the material making up these major study streams in the B. Surv and the combined B. Surv/B. Sc degrees is shown in Table 2. It should be noted that the combined degree runs over 5 years.

<table>
<thead>
<tr>
<th>STREAM</th>
<th>B. Surv % (4 year course)</th>
<th>B. Surv/B. Sc % (5 year course)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics and Science</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Computer Studies</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Surveying Science</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Land Information Technology</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Land Management</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>Professional Studies</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2: Course content – B. Surv and B. Surv/B. Sc
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 Graduate Diploma in Surveying Science, 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 programs, 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 (MAppSc) (by research or coursework) in GIS and students may progress to PhD.

5. SOME PRACTICAL HINTS FOR 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 5-6 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 profession and perhaps discontinued.
(2) Use your advisory committee for more than an 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 a necessary vision for the future, and always 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 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. GIS, remote sensing, spatial analysis, and computer science are just some of the new tools required by surveyors.

(5) Get the views of international 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 this field. Most of these people have visited Australia in the last few years and local evidence is that most of them are only too willing to examine and comment on new initiatives. It also helps build research links with staff and graduate students.

(7) 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 illuminating and at times quite sobering.

6. CONCLUSION AND RECOMMENDATIONS

This paper has attempted to show that the skills and expertise of the Australian practising land surveyor 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 be designed specifically to address these needs. Unfortunately, insufficient attention has been paid to this in the past as courses have tended to be modelled on overseas programs. There is, fortunately, a trend now to listen to "users" to a greater extent and to design courses to meet Australian requirements. It is essential for the future of the profession that this trend maintained. In continuing this trend, it is recommended that all surveying courses should follow three main principles:

(1) Maintain an emphasis on those basic sciences and fundamental principles which do not have a "Use By Date", regardless of whether those principles are in the measurement science or the land management areas;

(2) Maintain a balance between measurement science and land management; and

(3) Retain flexibility by being able to change course structures as the need arises.
REFERENCES


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