The structure of academic surveying and spatial science programs in Australia and New Zealand as an educational pathway to land surveyor registration

S.Simmons

Faculty of Engineering and Surveying, University of Southern Queensland, Baker

St, Darling Heights, QLD, 4350

Abstract

A national shortage of qualified personnel within the surveying profession to meet the demand of industry hungry for qualified workers is just one of the challenges that the profession must meet. Addressing the problem requires the provision of sufficient qualified personnel and new entrants to the profession with appropriate training and education to meet the regulatory registration and professional certification required for a range of surveying services.

This paper summarises the current structures of academic programs and the registration pathways for cadastral surveying around Australia and New Zealand.

1.0 Introduction

Like all professions, the surveying profession continually faces challenges to evolve and adjust as society changes. The impact of technological advancement creates opportunities for surveyors to broaden skills and competencies and opens new directions for surveyors to expand and develop their expertise. Technology is not the only challenge facing the surveying profession, a national shortage of skilled and qualified personnel exists with widespread acknowledgment of the shortage of skilled workers in the surveying and spatial science professions. The Australian Government Department of Education, Employment and Workplace Relations (DEEWR, 2012) identified that surveyors, planners and draftspersons represent occupations, generally around Australia, where there is a skills shortage. In order to increase the potential pool of land surveyors, a commensurate increase in the pool of graduates with appropriate qualifications requires increased student numbers within academic programs across Australia.

Low numbers of enrolments into surveying and spatial science programs have affected the viability of those programs. Failure of the financial viability of those

programs has seen both demise and changes in academic programs, for example, the loss of the University of Queensland surveying program in the late 1980's and the University of South Australia surveying program in the 2000's (subsequently revived). For over a decade, almost every surveying degree program in Australia has struggled to attract its full quota of students (Hannah et al, 2008). Blanchfield (2005) commented that given the trends in output of surveying graduates and the decline in numbers of registered surveyors, then the profession will not be able to provide the current range of surveying services with a declining number of registered surveyors.

This paper will provide a broad summary of the educational pathways required for cadastral licensing requirements in Australia and New Zealand and the generic academic structure of four year surveying and spatial science programs across Australia.

2.0 Educational pathways for cadastral licensing requirements

A generic educational structure encompassing vocational education, two year associate degrees, three and four year bachelor degrees leading to professional and para-professional registration is documented in Figure 1.

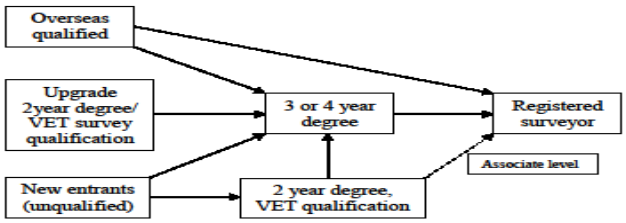

Figure 1: Generic registration pathway for undergraduate programs

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FIG (2004) defined the surveyor as a professional person with the academic qualifications and technical expertise to undertake amongst other activities and functions the determination of the position of the boundaries of public or private land, including national and international boundaries, and the registration of that land with the appropriate authorities.

The principal function for the Surveyors Board in each of the states of Australia and New Zealand relates to the registration of surveyors. The registration of surveyors generally includes the assessment of applicants for registration and registration endorsements across a range of surveying disciplines. Arguably, land/cadastral surveying is the most important as it ensures public confidence in the cadastral and land registration system for the efficient and secure registration and transfer of land title.

Consequently, each Board has a framework or process to assess the competence and/or academic qualification of persons or applicants seeking registration as a

land surveyor with the Board. Generally, the framework for assessment includes the following requirements:

- academic qualification;
- period of training and/or relevant experience;
- an examination or project assessment; and/or
- interview

Given that a Board is limited by the resources and funding available to them by government regulation, a strong academic qualification supplements an assessment framework as an important step for quality management of registration assessment. Consequently, academic qualifications usually form the initial basis of an application for assessment supplemented by other requirements including a period of relevant experience or a professional training agreement, passing a licensing examination or a professional assessment project, and/or oral interview process.

Hannah et al (2008) stated that the requirements for registration in Australia and New Zealand include an appropriate four year degree (or equivalent) and a defined level of knowledge, understanding and ability in spatial measurement, land law, land boundary definition, planning, and municipal engineering. Furthermore Hannah et al (2008) opined that if traditional structures are retained – the structures may no longer be appropriate for the 21st century challenges of the profession as a whole. The driver for a change in structure of an academic program not only relates to the financial viability of the program and technological advancement, but also the alignment of trans-national education and qualification frameworks internationally.

In Europe, through a collaboration of 47 member countries and states established the European Higher Education Area (EHEA) and what is known as the Bologna Process. The Bologna Declaration (1999) recommended adopting a system of easily readable and comparable degrees, to increase employability and the international competitiveness of the European higher education system. The system is primarily based upon on two cycles, undergraduate and graduate. Access to the second cycle requires the completion of first cycle studies for a period of a minimum of three years study. The second cycle should lead to the award of a master and/or doctorate degree. The Bologna process program essentially has a generic three year undergraduate degree which may be taken by a number of different and related disciplines, which is followed by a graduate program of one and a half to two years duration in a specialised discipline.

For example, the University of South Australia surveying program has been resurrected as a Bologna style program for accreditation and land surveyor pathway to registration in South Australia. The University of Tasmania has a three year surveying program plus a one year graduate diploma for applicant's seeking land/cadastral surveying registration. The University of Melbourne has also followed the Bologna style model for surveying and spatial science.

The remaining academic institutions in Australia and New Zealand have four year program duration for their Bachelor of Surveying/Spatial Science programs.

The following Table 1 lists a general summary of the land surveyor academic qualifications pathway to cadastral survey registration for tertiary programs in Australia and New Zealand:

	Surveying/ Spatial Science undergraduate degree	Generic Science undergraduate degree	Surveying/ Spatial Science graduate degree	Land surveyor pathway registration
University of New South Wales	4 years			Yes
University of Newcastle	4 years			Yes
University of Southern Queensland	4 years			Yes
Royal Melbourne Institute of Technology	4 years			Yes
Curtin University of Technology	4 years			Yes
University of Otago	4 years			Yes
Queensland University of Technology	4 years			Yes
University of Tasmania	3 years		1 year	Yes
University of Melbourne		3 years	2 years	Yes
University of South Australia		3 years	1.5 years	Yes

Table 1: General summary of land surveyor pathway to registration for tertiary programs in Australia and New Zealand

3.0 Competency of a graduate surveyor and academic program development

Most academic programs and institutions will seek accreditation for a program based upon a defined set of graduate attributes outlining the professional and technical competencies and capabilities expected for a graduate. The curriculum development for a program will usually involve a process of industry advisory functions and collaboration prior to seeking accreditation. An accredited program will have been subject to review by an accrediting authority (the Board) after the tertiary institution has met specific requirements and criteria which may require changes to the proposed program curricula. Once the Board has accredited an academic program, the structure of the program should satisfy by association, the

competencies expected of a graduate surveyor. Campbell and Liddle (2010) reasoned that a Board through accreditation has a *de facto* competency framework for graduate registration by accepting that tertiary institutions have established expertise in assessment at the scope and depth required for a competent surveyor.

The competencies expected of a graduate surveyor are subject to national and regional bias, Hannah et al (2008) stated that within regions, there are clear variations in professional structures, skills, practice and expertise. FIG (2004) defined the surveyor as a professional person with the academic qualifications and technical expertise to conduct one, or more, of the following activities;

- to determine, measure and represent land, three-dimensional objects, point-fields and trajectories;
- to assemble and interpret land and geographically related information;
- to use that information for the planning and efficient administration of the land, the sea and any structures thereon; and
- to conduct research into the above practices and to develop them.

Furthermore, FIG (2004) detailed the functions of a surveyor to encompass professional tasks that may involve one or more of eleven activities which may occur either on, above or below the surface of the land or the sea and may be carried out in association with other professionals.

In Australia, the registration and regulation of surveyors and other professions has been derived from principles which evolved in 1995, when state, territory and federal governments in Australia formed an agreement on a National Competition Policy. The National Competition Policy impacted on surveying with the 1996 publication of the *National Competency Standards for Professional Surveyors*, published by the Institution of Surveyors, Australia. The *National Competency Standards for Professional Surveyors*, Institution of Surveyors, Australia (1996) identified eleven core units of competency:

1. Professional practice
2. Collection of data and information
3. Management of data and information
4. Presentation of information
5. Business, management and supporting quality assurance programs
6. Communications
7. Spatial reference systems and core databases
8. Land administration and property development
9. Controlling, measuring and locating developments
10. Research, development and commercialisation
11. Education and training

The first four units, unit six and at least one unit from units seven to ten were generally prescribed as the minimum required units of competency for a professional surveyor and for membership as a graduate surveyor with the Institution of Surveyors, Australia (ISA 1996). In 2005, the Surveyors Board of Queensland introduced a competency based framework for graduates that

required applicants to demonstrate competency in the first nine units and the competency framework addressed the qualifications, skills, experience and knowledge expected for a particular professional level of endorsement.

Whilst the above competencies, functions and any national or regional bias may form the basis for the expected competencies for a graduate surveyor, the units of competency may not necessarily neatly align with an appropriate program and curricula development structure. The courses within a program may traverse multiple units of competency, requiring the mapping of qualification against competency.

4.0 General structure of four-year surveying/spatial science programs

Typically, the structure of a four year tertiary degree comprises thirty-two units of study. Students may study a total of thirty-two theory units or subjects of equal weighting and will usually undertake the study of eight units or subjects per year. Not all units are of equal weighting, for example Curtin University of Technology currently has four units that have a 50% unit weight.

In order, to compare the general structure of academic surveying programs, the structure of five selected tertiary surveying programs have been classified by subject matter. The aim was to reduce a diverse thirty-two unit structure over five different programs down to sixteen individual elements of classification. A generic element breakdown of a surveying program would include introductory surveying, cadastral surveying, geodesy, cartography, planning etc. A more specific example is where the first year in a program includes physics, science, physical science, foundation computer related courses or in the case of the University of Southern Queensland, problem solving courses that include problems based upon the aforementioned areas. These general science type courses tend to be taught across a multi-disciplinary divide and consequently have been linked together as an individual element or class. The core competencies developed with the *National Competency Standards for Professional Surveyors* (1996) have then been linked to an individual element or class - where the core competency can be easily identified.

A comparison of five academic programs delivered in 2012 has been undertaken: University of New South Wales (UNSW), University of Newcastle (UNewc), University of Southern Queensland (USQ), Royal Melbourne Institute of Technology (RMIT) and Curtin University of Technology (CUT). These programs have been selected for ease of comparison on the basis of their thirty-two unit structure. Tertiary programs based upon the Bologna process have not been included. The University of Otago has twenty-nine courses of equal weighting making it difficult to compare against thirty-two unit structures. The Queensland University of Technology made the decision in 2012 to not offer a four year surveying degree in 2013 and was not include on that basis.

Table 2 represents classification across sixteen classes with the core competency identified with that class, for five selected academic programs, as follows:

Class or element(core unit of competency)	UNSW units	UNewc units	USQ units	RMIT units	CUT units
Basic survey introductory	3	4	2	4	3

courses (2)					
Non-cadastral specialist survey courses (2)	1	1	2	2	3
Cadastral/land law courses (8)	1	2	2	2	0.5**
Map projection/geodesy/global navigation satellite systems (2,7)	2	2	3	2	**5**
Cartography/GIS/CAD/ geo-spatial courses (4)	2	1	2	**5**	**4.5**
Photogrammetry/remote sensing & imagery courses (2)	0	2	1	2	3
Land administration & management courses (8)	1	1	1	0	0
Urban planning & development courses (8)	1	1	2	1	1
Civil engineering courses (9)	1	**6**	1	0	0
Programming/computations & network analysis courses (3?)	1	3	3	2	3
Physics/science/geography/ problem solving courses (?)	2	1	3	2	0.5
Professional practice/societal/ communication courses (1)	2	1	2	2	1
Business/economics/project management courses (5)	1	1	2	0	0
Undergraduate project (6)	**4**	2	2	2	1
Statistics/maths courses (?)	3	2	2	3	**4.5**
Flexible elective courses (could be any competency)	**7**	2	2	3	2

** 2 unit Cadastral survey option available

Table 2: Class and core competency summary across five selected four year academic programs in Australia

Some of the major differences across the five academic programs have been highlighted in **bold** in Table 2. A major difference between the academic programs was identified as being a 1.5 or 2 unit gap in the element or class between academic programs. Note that for zero rated courses, the class content area may be taught at that tertiary institution, but not at the level where it is the dominant content area in a unit for the unit to be rated in a specific class.

Individual academic programs will have structures that are affected by regional bias, staffing issues, financial viability and the desired content for the program. The major points of differentiation across the academic programs were noted and identified.

There is a strong geodetic surveying and geo-spatial/spatial science focus in the program at the Curtin University of Technology which combined with the strength of the mathematics/statistics courses reduces the scope and diversity of the program. It is worth noting that the statistics course is cartographic statistics and could arguably be shifted to the geo-spatial class. Another interesting point of difference lies with the use of electives as a land/cadastral surveying option at

the Curtin University of Technology. When you look at both the Royal Melbourne Institute of Technology and Curtin University of Technology programs, it can be seen that they both in all likelihood contain the most survey and spatial science specific content in an academic program. This strong technical focus may have evolved through their links with the vocational sector. Similarly, the University of Southern Queensland evolved from a vocational background to a higher education institution, retaining the strong practical knowledge strength base to the program. Interestingly though, the University of Southern Queensland has a wider scope and diversity of content to its academic program.

At the University of Newcastle there is a strong civil engineering focus which may reflect the emphasis on municipal engineering in New South Wales, however this is not duplicated at the University of New South Wales and may rather reflect the strength of staff teaching in that area. The flexibility of the program at the University of New South Wales due to the choice of available elective subjects is significantly higher than all other programs. You could argue that other programs are too low in flexibility, ideally an academic program structure should allow an elective choice per year thus four elective choices can allow a student to study a discipline minor in a program e.g. urban planning. The unit size of the undergraduate project at the University of New South Wales is more likely to encourage an academic pathway which may reflect the research focus of the University of New South Wales.

5.0 Generic structure of four-year surveying/spatial science programs

A generalised structure for a four year program can be formulated through determining a consensus across the academic programs as indicated in Australia. The median and average result across all academic programs was calculated and compared to determine a unit total (rounded to 0.5) for each class to determine a generic academic program structure, as follows in Table 3:

Classes (core unit competency)	**Generic unit total median/average**
Basic survey introductory courses (2)	3
Non-cadastral specialist survey courses (2)	2
Cadastral/land law courses (8)	2
Map projection/geodesy/global navigation satellite systems (2,7)	2.5
Cartography/GIS/CAD/ geo-spatial courses (4)	2.5
Photogrammetry/remote sensing & imagery courses (2)	2
Land administration & management courses (8)	1
Urban planning & development courses (8)	1

Civil engineering courses (9)	1
Programming/computations & network analysis courses (3?)	2.5
Physics/science/geography/ problem solving courses (?)	2
Professional practice/societal/ communication courses (1)	2
Business/economics/project management courses (5)	1
Undergraduate project (6)	2
Statistics/maths courses (?)	3
Flexible elective courses (could be any competency)	2.5

Table 3: Generic unit totals for each Class across academic programs in Australia

Based upon the structure, results and core competencies in Table 3, unit totals can be calculated to determine the total units required to satisfy the *National Competency Standards for Professional Surveyors* (1996) for a graduate surveyor. Utilising core competencies one to four, six and say seven, at least sixteen units must be studied to satisfy the core competencies for a generic graduate surveyor. The determination of the unit total could allow a three year first cycle Bologna process academic program to be developed with the inclusion of generic elements relating to science, maths, electives etc. The second cycle Bologna process for survey specialisations may require a graduate program of a minimum duration of 1.5 years, after a generic spatial science degree. The downside of a Bologna process type structure to a prospective student, is the extension in time of the program duration leading to graduation, thus possibly discouraging new entrants from entry.

6.0 Conclusion

There are a number of competing interests that affect the development of higher education academic programs from regional bias to staff and university strengths but also the overarching structures of qualification pathways and frameworks and educational standards to allow standardisation of qualifications across international boundaries. The overall structure of an academic program is essential to face these challenges. Unless new entrants are attracted to the surveying profession, the higher education survey programs that are faced with the prospect of declining enrolment may be scrutinised for the viability of the academic program.

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BIOGRAPHICAL NOTES

Shane SIMMONS, B.Surv.(UQ), G.Dip.Surv.Pr.(QUT), G.Dip.Bus.(Prop.St.) (UQ), G.Cert.Finance (SIA), cadastral surveyor, MSSIQ, MIEE, MAPI.

Since 1995, Shane has been a lecturer in surveying at the University of Southern Queensland and is currently program coordinator of the surveying and spatial science discipline. Prior to 1995, Shane was an endorsed cadastral land surveyor with 16 years experience in both the private and public sectors primarily involved with engineering and construction projects. Shane completed a Graduate Diploma of Business (property studies major) at the University of Queensland in 2000. Since 1998, Shane has been honorary editor of the Queensland professional journals, *Queensland Surveyor* and *Spatial Science Queensland*. Shane's principal research interests include professional issues, land development and land law. Shane is actively involved locally with the USQ rugby club as a volunteer administrator and manager.

CONTACTS

Mr Shane SIMMONS
Senior lecturer and endorsed cadastral surveyor, Queensland.
University of Southern Queensland
Baker St, Toowoomba, Queensland 4350
Australia
Tel. +61 7 46312910
Fax: +61 7 46312526
Email: simmonss@usq.edu.au
Web site:
http://apps.usq.edu.au/StaffSearch/default.aspx?staffsearchaction=showdetails&staffsearchrecordid