TITLE: SPATIAL SCIENCE EDUCATION DIRECTIONS FOR QUT

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Abstract
The Faculty of Built Environment and Engineering external review conducted in 2003 mandated recommendations for a strategic renewal and regeneration of the Faculty. The Faculty has become a value-driven organisation with a vision and strategic direction that accord with the Queensland University of Technology Blueprint and external directions.

Courses offered by the Faculty have undergone redevelopment in accordance with the University’s quality assurance process. This process ensures courses are up-to-date and industry relevant. Changes resulting from the redevelopment offer students exciting new opportunities for a broader interdisciplinary education that will enhance their career prospects and will include options such as: practical experience in the workplace; the opportunity to study a unit set of four units from a related discipline area; and involvement in cross disciplinary project teams.

In rationalising and prioritising factors for the delivery of these options, the Faculty developed three courses. These broad courses are Bachelor of Design with four first majors; Bachelor of Engineering with nine first majors; Bachelor of Urban Development with five first majors including Spatial Science. Each course is managed by a single course coordinator.

This paper discusses the educational philosophy behind the course structure and pedagogical directions of the new four year Spatial Science major. The education model adopted for the Spatial Science program includes core areas of measurement science, land management and spatial information management. It also outlines the newly implemented Criteria Referenced Assessment policy and the adoption of Work Integrated Learning environments to prepare undergraduates for a lifelong learning experience.

Introduction
The Four Year Bachelor of Surveying Course at the Queensland University of Technology (QUT) accepted its last intake in 2005. The new Spatial Science program commenced in 2006 as a major within the Bachelor of Urban Development. This paper covers background issues and outlines some of the changes imposed upon the disciplines within the Faculty of Built Environment (BEE) by the agenda of reform for the higher education sector driven by political and industry factors. It focuses upon the new course structures and educational design for the new spatial sciences program at QUT. First graduates from the Bachelor of Urban Development (Spatial Science) are expected at the end of 2009.

Organisational Review
The higher education environment is complex and subject to ongoing change. We cannot predict with certainty the detail of events in the future, but we can anticipate some elements of change to come, and we can prepare ourselves to be best positioned to take advantage of opportunities (Coaldrake 2004).

QUT Blueprint, QUT Strategic Plan 2004 set the strategic direction for the university, and clearly spoke of a future of regeneration, engagement and experimentation. In implementing the philosophy of the Blueprint, the Faculty of Built Environment and Engineering (BEE) quinquennial review report mandated the Faculty to a future of significant organisational change and renewal. The Faculty White Paper, prepared in response to the Blueprint, presents a vision of:
A Faculty committed to renewal and recognised globally for the strength and relevance of its integrated disciplines (Betts 2004).
The Faculty used a model of knowledge development based on an entrepreneurial approach to integrated Scholarship. In particular, two significant works on higher education systems were used to develop the proposed structure and mode of working in the renewed Faculty. These were Ernest Boyer’s work on scholarship and Burton Clarke’s work on successful entrepreneurial universities (Boyer 1990 and Clarke 1998). The Faculty’s new model of working (Figure 1) depicts the scholarly activities of teaching, discovery and application coming together with areas of focused overlap and a central core of scholarly integration (Savage and Betts 2005). Faculty activities are prioritised in accordance with this model; those falling within the central core of integration receiving higher priority.

**Figure 1: Faculty of BEE model of working** (modified from Crowther and Savage 2005).

New courses within BEE would seek to integrate the scholarly activities of teaching, discovery and application. No longer would teaching and learning activities sit in isolation, rather students would engage with discovery and application as structured parts of their undergraduate program of study.

Previous to 2005, the Faculty of BEE had approximately seventy three undergraduate courses; a hugely disproportionate number for its student population of approximately 4400. An associated reduction in the number of units (subjects) being taught was also called for in the White Paper. More significantly, the university had called for course structures to facilitate students studying across faculty boundaries; thereby engaging in secondary fields of study that would see their specialising or broadening their education beyond their primary field of study (Crowther and Savage 2005).

Professional organizations have called for graduates that are more able to operate collaboratively as team members within a broader group of professionals operating on complex problems not limited to one discipline. In particular, QUT graduates need to be: outgoing and connected; enterprising and innovative; community and society responsible; and providing and focusing on leadership (Engineers Australia 1996).

There is an increasing need also for broader social views and multi-disciplinary skills and a student focus on values (Foxell 2003). In essence QUT graduates need to be more outward looking as transdisciplinary specialists.
New courses would therefore have to develop broader capabilities within our graduates, and in so doing offer students a greater range of study choices.

The renewed courses share a common structure; all courses ‘fit’ the structure shown at Figure 2 (note that this diagram is not temporal but simply proportional) (Crowther and Savage 2005).

**Figure 2: Model of the Shared Course Structure**

The structure for the renewed BEE courses sees just three undergraduate degrees within the faculty, each with a number of majors, or discipline study areas. Groups of cognate disciplines come together around agreed and shared broad fields of knowledge, forming three like-minded groups of disciplines, each developing its own course.

- **Bachelor of Engineering** (with majors in: Aerospace Avionic, Civil, Civil and Environmental, Civil and Construction, Computer Systems, Electrical, Infomechatronics, Mechanical, Medical, and Telecommunication, with scope in the future for Chemical Engineering, Process Engineering, Building Services Engineering, and others).
- **Bachelor of Urban Development** (with majors in: Construction Management, Property Economics, Quantity Surveying, **Spatial Science**, and Urban and Regional Planning, with scope in the future for Sustainable Development, Property Law, and others).

**Changing Educational Environment**

McDouggall (2000) made some predictions of the impacts of the Dawkins’ reforms and unification of higher education institutions. These reforms have resulted in a number of important changes to the tertiary and higher education environment.

- The competition for funding now dominates the activities of universities;
- The system is now geared for large-scale graduate production rather than the smaller elite;
- Many specialised courses and disciplines find it increasingly difficult to remain viable; and
- Universities have become more responsive and entrepreneurial, treating students as customers and industry as clients.

Staff involved with the spatial science program at QUT have seen these reform predictions eventuate along with a concerning climate of reduced funding/ equipment resources and alarming increases in academic staff : student ratios.
As outlined by Bellman et al (2006) at this conference, and recognised by university Heads of Departments meeting in February, the Australian higher education sector continues to undergo substantial change that is being driven aggressively by government. In particular, government continues to reduce their financial contributions to institutions by limiting indexation of funding and requiring universities to supplement the shortfall through alternative sources such as international student fees. In response to this pressure, universities are adapting their business models to focus on high volume, low overhead programs. In this context, programs in all areas of the spatial sciences are under threat because they traditionally have relatively small enrolments and are unable to attract large numbers of fee-paying students (Bellman et al 2006).

**Future Skills Shortage**

Australia is already facing a major skills formation challenge across a number of professional occupations. This situation is likely to deteriorate with demand for professionals increasing faster than for any other occupation group. Concerns about skills shortages are receiving increasing attention in the media and within industry and professional groups. The concern is not only about the numbers of professionals in any given occupation but also about whether the skills of graduate professionals are keeping pace with new technologies and the requirements of businesses operating in a competitive global market.

New technologies are impacting on the composition of some occupational profiles and the changing skill requirements within some occupations. Ongoing structural change in many industries will impact on the nature of new skills required and the sources of these new skill sets. Shortages of skilled professionals will become a more critical issue over the next decade as the number of new entrants into the workforce declines and the population ages (Professions Australia 2005).

**Spatial Science at QUT program**

The spatial science course structure (Figure 3) has been aligned with the faculty model of shared course structure. Six units are common within the School of Urban Development and two are common across the Faculty: *Introducing Professional Learning and Introducing Sustainability*. A Science minor unit set (four units) is included consisting of two university wide maths units, a physics unit tailored for measurement science, and a mathematical computations unit aimed directly at ensuring relevant surveying and spatial science skills.

**Figure 3: Annotated Bachelor of Urban Development (Spatial Science) Course Structure**

<table>
<thead>
<tr>
<th>Course Structure: UD40 Bachelor of Urban Development (Spatial Science)</th>
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<tbody>
<tr>
<td><strong>Year 1</strong></td>
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<tr>
<td>Semester 1</td>
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<tr>
<td>FACULTY WIDE UNITS</td>
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<tr>
<td><strong>MINOR (SCIENCE)</strong></td>
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<tr>
<td>Introducing Professional Learning</td>
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<tr>
<td>Geospatial Positioning and GPS</td>
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- Underlined = School based common unit
- C = Faculty-Wide unit
The Faculty requirement for eight shared common core units - six broad units sourced from the school (underlined italics in Figure 3) and two faculty wide units - has been meet with this structural design. The second, third, and fourth years of the remaining themes within the program have been influenced by McDougall’s (2000) design of a professional level course in surveying and mapping; and by Cook’s (1998) work as part of the development of an industry model evolving from the Surveying and Mapping Professions Education and Advisory Committee (SAMPEAC). It is recognised that graduate capabilities are formed and developed in units as students progress through their degree. It is not necessarily an expectation that any one unit contributes solely to a particular capability or learning outcome. More typically, units progressively engage in the development of a number of capabilities such that a sequence of units develops capabilities throughout the four year courses. Of further note, it is significant that capabilities, to which units contribute, are embedded within the curriculum of each unit and form part of the assessment process (Campbell et al 2004). Professional learning aspects are covered firstly, in the first semester unit Introducing Professional Learning and under the school common units Research Methods and Business Skills.

Three distinct and parallel learning themes emerge from the new undergraduate structure for spatial science. The central theme is Measurement Science (Surveying) with suitable designed linkages between the central theme and other themes/minor. Each of these themes consists of a sequential learning approach building upon the foundation level knowledge and skills to more advanced levels of analysis and application to the broader industry. A common aim of many of the final year units is to provide the student with advanced knowledge and/or specialist experience using the knowledge and skill base developed over the first three years of the course.

New Course Expectations
We expect that the new Spatial Science course will produce: graduates with a broader range of spatial science practice skills; graduates more adapted to the demands of the contemporary workplace; and graduates more able to operate in the diverse team environments of modern spatial science and surveying. In temporal terms, the program will have Spatial Science students commencing their studies in an environment catering for students from a broad range of similar disciplines. These students will share content and context with students of the other urban development fields. As students progress through second, third, and fourth year levels, they will progressively focus their attention further on the spatial science discipline.

Increasing numbers of our students appear to be travelling and working internationally as the world becomes more globally orientated. The universities themselves are also becoming more ‘internationalised’ as they compete for students and position in the tertiary education market. The essential aim of the new Spatial Science course is to develop in graduates the values, attitudes, knowledge and skills appropriate to the practice and culture of the broad spatial science industry. The objectives are consistent with the generic attributes of QUT graduates, including the development of:

- General educational knowledge and problem-solving skills, attitudinal attributes and social skills.
- Specialist knowledge and problem solving skills within the broad discipline of spatial science.

A team teaching approach strives to maintain the “University for the Real-World” market phrase through the effective use of practical and applied methods of teaching and instruction.

Criterion Referenced Assessment (CRA)
CRA is a test or other type of assessment designed to provide a measure of performance that is interpretable in terms of a clearly defined and delimited domain of learning tasks (Linn & Gronlund 2000).

Put more simply by the ACT Board of Secondary School Studies (2002), CRA is the assessment of the "extent to which a student has achieved the intended learning and performance outcomes of a subject", or - at university - the goals of a full course. The ACT Board explain that such assessment should be "carried out against previously specified yardsticks (criteria) and, where a grade is assigned, it will be assigned on the basis of the standard the student has achieved on the criteria.”
Linn & Gronlund (2000) provide the following additional information about criterion-referenced assessments: "...criterion-referenced tests include items that are directly relevant to the learning outcomes to be measured, without regard to whether the items can be used to discriminate among students. No attempt is made to eliminate easy items or alter their difficulty. If the learning tasks are easy, then test items will be easy. The goal of the criterion-referenced test is to obtain a description of the specific knowledge and skills each student can demonstrate. This information is useful for planning both group and individual instruction."

Unlike norm-referencing, there is no pre-determined grade distribution to be generated and a student’s grade is in no way influenced by the performance of others. Criteria for assessment should be detailed, transparent and justifiable (Australian Universities Teaching Committee 2002).

According to Bond (1996), CRA illustrates how well students are doing relative to a pre-determined performance level on a specified set of educational goals or outcomes included in the school, district, or state curriculum. In essence, students are measured against identified standards of achievement rather than being ranked against each other. Bond goes on to say that educators or policy makers may choose to use CRA when they wish to see how well students have learned the knowledge and skills which they are expected to have mastered. This information may be used as one piece of information to determine how well the student is learning the desired curriculum and how well the school is teaching that curriculum.

As the new Faculty undergraduate courses are phased into operation, so too will be the application of CRA to the assessment regime of the new units.

**Work Integrated Learning (WIL) Environments**

Workplace learning constitutes the learning opportunities that take place in a workplace as a formal component of the course or program, involving a number of internal and external stakeholders and offers opportunities for authentic assessment tasks, and embodies appropriate quality assurance mechanisms (APPU-QUT 2005).

The courses of the Faculty of Built Environment and Engineering are focused, in part, on enabling graduates to practice as professionals in a design, engineering, or urban development context. A significant part of such ability is an understanding of the professional work place. WIL unit(s) seeks to facilitate such an understanding through exposing students to the work place as a learning environment. For some students, WIL units form part of their compulsory core unit set prescribed by professional accrediting bodies, while for others, a WIL unit may be one of several work integrated learning units selected as part of a minor unit set.

The WIL unit aims to provide students with first hand experience of the work place. Such experience will include aspects of attendance, participation, observation, and reflection. These structured activities will allow students to develop a range of understandings of the work place and the practice of their chosen profession. The content of the unit(s) is based around aspects of: experience in, and of, the work place; the professional application of theoretical knowledge; the business of practice; its interaction with and within society and practice generally.

The teaching and learning content in the WIL unit(s) predominantly will be delivered in the work place, usually in the office of a professional practice, under the supervision of a practicing professional. The duration of the WIL directed employment will vary as required by the specified Course/Major (study area). This could range typically from 6 weeks to 6 months. The work place learning may be supplemented with a number of lectures, seminars, tutorials, and/or Internet (On-Line Teaching) based tools and resources.

**Conclusions**

The professions of the Built Environment are becoming less concerned with academic and institutional boundaries than with the capacity of tertiary institutions to educate graduates capable of working across boundaries to solve problems of social and cultural importance. The structure of the new courses will ensure graduates of the Faculty of Built Environment and Engineering leave QUT with a broader understanding of professions, disciplines and workplaces, combined with accreditable professional competence. The flexible and adaptable structure, which allows students to study in both traditional and niche areas and across traditional boundaries, will ensure that the QUT is able to respond to changes in demand which all professions increasingly are facing – Spatial Science in particular.
References


