A New Undergraduate Model for Broadly Based Spatial Science Curriculum at Queensland University of Technology: Diversity in Surveying Curriculum

Mr Robert WEBB, **Australia**

Key words: Undergraduate curriculum development, work integrated learning

SUMMARY

This paper provides an overview of the current QUT Spatial Science undergraduate program based in Brisbane, Queensland, Australia. It discusses the development and implementation of a broad-based educational model for the faculty of built environment and engineering courses and specifically to the course structure of the new Bachelor of Urban Development (Spatial Science) study major. A brief historical background of surveying courses is discussed prior to the detailing of the three distinct and complementary learning themes of the new course structure with a graphical course matrix. Curriculum mapping of the spatial science major has been undertaken as the course approaches formal review in late 2010. Work-integrated learning opportunities have been embedded into the curriculum and a brief outline is presented. Some issues relevant to the tertiary surveying/ spatial sector are highlighted in the context of changing higher education environments in Australia.

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1. INTRODUCTION

University programs are often reviewed and updated to reflect both internal and external criteria with minor changes undertaken as part of a continuous improvement program. In 2005, the Faculty of Built Environment and Engineering (BEE) at Queensland University of Technology (QUT) began on a strategic direction to implement a broad-based undergraduate education model. The implementation of this BEE model has resulted in some radical changes to its former degree structures and rationalization of the former seventy-three undergraduate courses to just three courses with nineteen majors. These undergraduate structural changes arguably offer the approximately forty-four-hundred BEE students exciting new opportunities for a broader interdisciplinary education that will enhance their career prospects and 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.

The new Spatial Science program commenced in 2006 as a major study area within the Bachelor of Urban Development. This paper briefly summarises background issues and outlines some of the changes imposed upon the disciplines within the Faculty (BEE) by the agenda of reform for the higher education sector driven by political and industry factors. Additionally, this paper outlines a curriculum mapping process model as applied to the review of the existing course. Work-integrated learning opportunities have been embedded into the curriculum with a brief overview provided. The first graduates from the Bachelor of Urban Development (Spatial Science) successfully completed this new broadly based spatial science curriculum in December 2009.

2. THE BEE UNDERGRADUATE MODEL

In 2004, QUT management advocated an organisational re-structure through the so-called QUT *Blueprint* strategic plan (Coaldrake 2004). This *QUT Blueprint* strategic plan set the 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 to a future of significant organisational change and renewal. The Faculty of BEE 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).

2.1 Broadly-Based Undergraduate Education Model

The Faculty of BEE utilized a model of knowledge development based on an entrepreneurial approach to integrated scholarship. In particular, two significant works on higher education systems have been utilized 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).

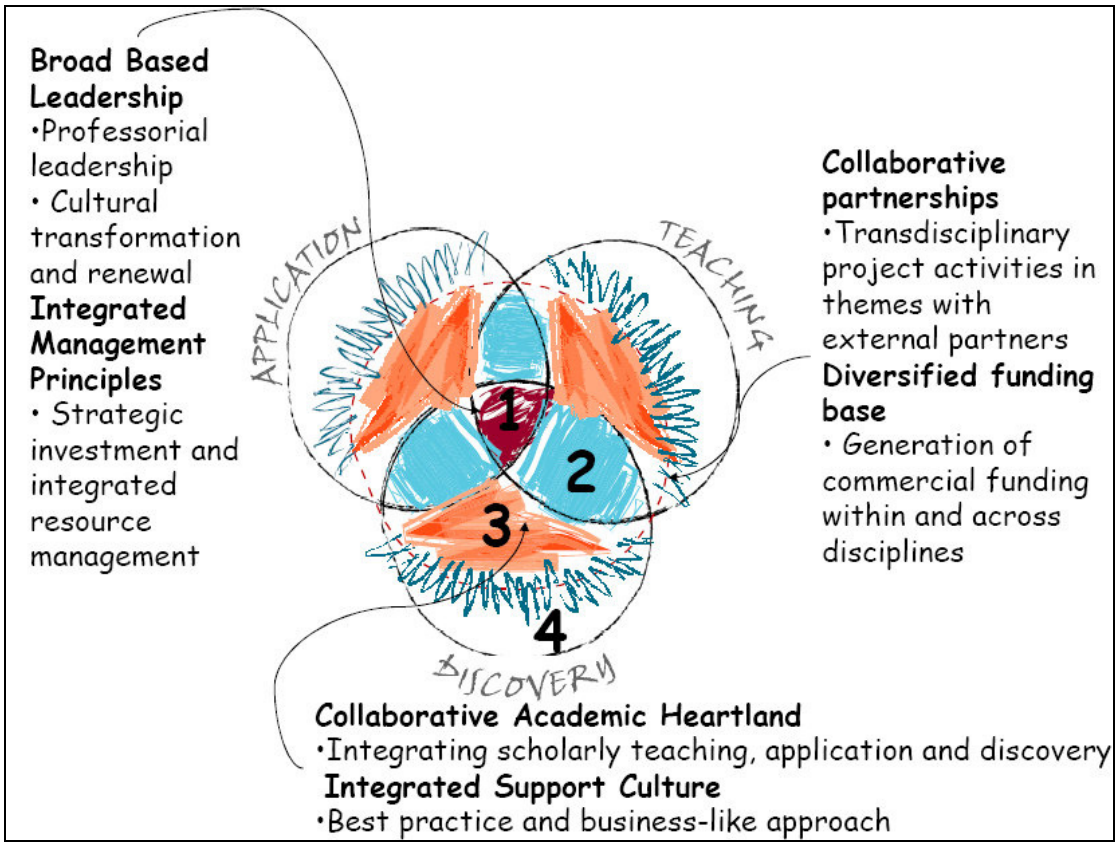


Figure 1: Faculty of BEE model of working (modified from Crowther and Savage 2005).

The Faculty of BEE 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 such that that those falling within the central core of integration receiving higher priority. No longer would teaching and learning activities existing in some isolation (previous SILO model), 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 that were considered a largely disproportionate number for its student population of approximately 4400 at 2005 (~4900 students in 2009). An associated reduction in the number of units (subjects) being taught was also declared for in Betts (2004) white paper.

Professional organizations have called for graduates that have more capacity to be able to operate collaboratively as team members within a broader group of professionals operating on complex problems not limited to one discipline. In particular, it was considered desirable for BEE graduates to be..... outgoing and connected; enterprising and innovative; community and society responsible; and providing and focussing on leadership (Engineers Australia 1996). Australian higher education literature supports the notion of an increasing need for broader social views, multi-disciplinary skills and a student focus on values (Foxell 2003). In essence, QUT graduates were required to be more outward looking as trans-disciplinary specialists. Design of new under graduate courses would therefore have to develop broader capabilities within our graduates and arguably offer students a greater range of study choices.

2.2 BEE Model for Shared Course Structure

The renewed BEE undergraduate courses share a common structure such that all courses 'fit-the-mould' shown at figure 2. It is important to note that this diagram is not temporal but simply proportional.

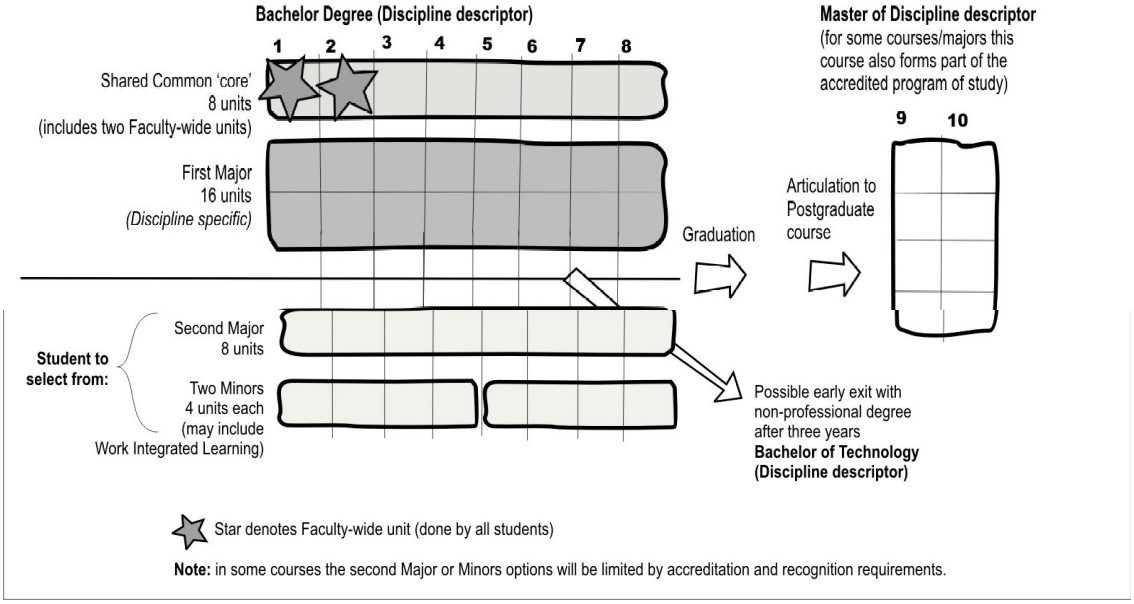


Figure 2: Design Model of the BEE Shared Course Structure (modified from Crowther and Savage 2005).

The structure for the renewed BEE courses comprised just three undergraduate degrees within the faculty, each with a number of study majors. 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 (adapted from Webb and Hayes 2006). These three degrees comprise:

— *Bachelor of Design* with majors in: Architecture, Industrial Design, Interior Design, and Landscape Architecture.

— *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.
— *Bachelor of Urban Development* with majors in: Construction Management, Property Economics, Quantity Surveying, **Spatial Science**, and Urban and Regional Planning.

Crother and Savage (2008) describe this confluence of Faculty goals along with ideas of transformative learning, such that it became possible to develop a common course structure (BEE model) that would allow for the individuality of the disciplines to prevail, while also providing, and indeed encouraging trans-disciplinary activity.

Whilst the Faculty of BEE was the first to implement this renewed course structure, other faculties within QUT have implemented a similar or variation of this model. Bennett et al (2009) outlined the radical changes in implementing the so-called Melbourne-Model applied to the Department of Geomatics new generation program. BEE teaching and learning management considered that the BEE course renewal structures and broadly based curriculum was not as drastic a structural change as the Melbourne Model. However, some course structure similarities exist between graduate attributes of academic breadth whilst maintaining strong disciplinary depth.

3. BRIEF HISTORY OF THE QUT SURVEYING COURSE

The surveying course was first offered at the Queensland University of Technology in 1974 (then Queensland Institute of Technology) as a Bachelor of Applied Science (Surveying) degree. The course was a sandwich course that combined six semesters of full time study (three years equivalent) with five semesters of industrial experience. The formal contact hours were approximately 24 hours per week. This was commonly known at the time as the"thin- sandwich" course.

The Bachelor of Applied Science (Surveying) continued in its initial form until 1986 when it was converted from a thin sandwich course (one semester of study followed by one semester of work) to a full time course with the option of a thick sandwich attendance -one year of study followed by one year of work. The thick sandwich option was never very popular with students or employers. Students completing the course in three years of full time study had to satisfy the Queensland Surveyors Board practical experience requirements after graduation. Students doing the thick sandwich course were still required to complete industrial experience before graduation and in doing so satisfied the practical experience requirements of the Surveyors Board.

Changes introduced in 1986 stemmed from recommendations made following the Commonwealth Tertiary Education Commission (CTEC) funded study "An Evaluation of Surveying and Mapping Education and Training in Queensland". At that time, the

Queensland Institute of Technology and the University of Queensland signed an agreement for the implementation of a new educational model in surveying at undergraduate and at post-graduate levels. The agreement involved rationalisation of surveying education in Queensland with the Queensland Institute of Technology focusing on undergraduate studies and the University of Queensland concentrating on postgraduate studies. The two departments coordinated their activities, shared their resources, had a common set of goals, and were generally identified as the "Queensland Centre" for Surveying and Mapping Studies.

That model had been extensively discussed with all branches of the surveying profession and had received very strong support from the Queensland Surveyors Board and the general surveying community. At that time, the Darling Downs Institute of Advanced Education (DDIAE) now the University of Southern Queensland, offered an Associate Diploma in Surveying and a bridging course by external mode. Students completing the bridging course were able to enter the final year of the Queensland Institute of Technology's Bachelor of Applied Science (Surveying) degree and complete the degree in one-year of full- time study.

3.1 Bachelor of Surveying – Four-Year Course

The course was next modified in 1993 for introduction in 1994. The primary reason for the change was to bring Queensland into line with other states. Surveyors Boards around Australia and New Zealand agree on minimum standards for registration and have reciprocal arrangements to recognise those registered in each other jurisdictions. At that time, Queensland was the only state offering a three-year degree and the Reciprocating Surveyors Boards (as they are known when agreeing to recognise each others registered surveyors) had decided not to recognise three-year surveying degrees commenced after 1993. Accordingly, the course was changed to a four-year degree and called a Bachelor of Surveying degree.

The move to a four-year degree provided an opportunity to reduce the workload on students by carrying the discipline material of the three year course over into the four year course, with appropriate updating to incorporate changing technology and professional practice. The formal contact hours for this course were around 20 hours per week.

3.2 Bachelor of Surveying – Significant Structure Change - Credit Points

The next significant change to the structure (but not content) of the Bachelor of Surveying occurred in 1999. The change occurred following direction by University management for all courses be standardised to 12 credit point units with 4 standard units per semester. The surveying program prior to 1999 comprised more than 50 units of varying credit points depending on the importance and time involved in the delivery of the unit.

From 1999, the surveying course comprised 4 standard 12 credit point units per semester for 8 semesters (4 years). At the same time the total formal contact hours was reduced from around 20 hours per week to 16 hours a week on average. An opportunity arose allowing a set of four elective unit choices to allow students to follow a particular field of interest. One of the University's aims for standardising on 12 credit point units was to allow students from across the university the opportunity to access units from outside their home discipline areas. Our

surveying students often desire to extend their education beyond traditional surveying elective units and have taken units from a wide range of discipline areas such as geography, business management, information technology, planning and property economics.

During 2002 the Head of the School of Design and Built Environment formed a surveying advisory committee drawn from the profession. Based on the committee's advice and an analysis of the course by staff some minor modifications to the course were introduced in 2003 as part of a continuous improvement program. The QUT degree known as Bachelor of Surveying was first offered in 1994 and the last intake was in early 2005 with students gradually transitioned to course completion.

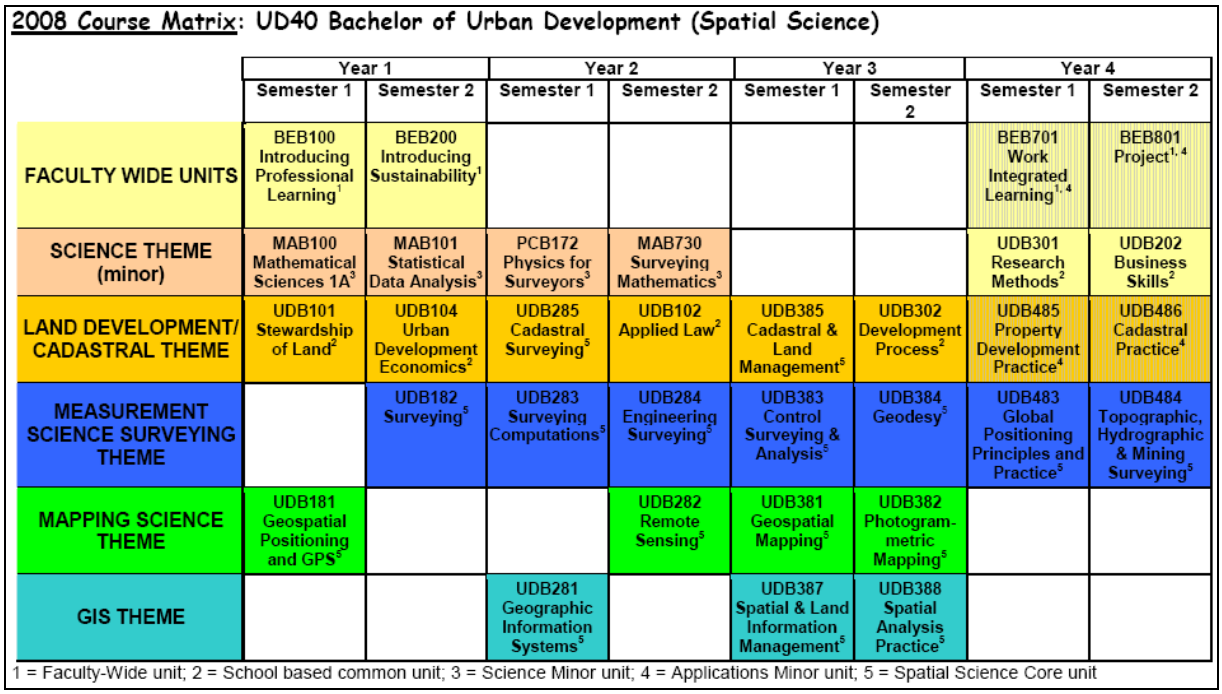
3.3 Double Degree in Bachelor of Surveying/Bachelor of Information Technology

At this junction, it is appropriate to mention the Double Degree in Surveying and Information Technology. Prior to the introduction of the four-year Bachelor of Surveying course, the double degree course was known as Bachelor of Applied Science (Surveying)/Bachelor of Information Technology. To reflect the change to the four-year surveying degree, the course became the Bachelor of Surveying/Bachelor of Information Technology. The last intake of students into the double degree was in 1998. Double degree students were highly sought after by employers but unfortunately, the course was discontinued because of low enrolment numbers. (Synthesised from unpublished report by Jones and Harris, 2004).

4. THE QUT SPATIAL SCIENCE COURSE STRUCTURE

The current Spatial Science program at QUT has three distinctive themes largely influenced by feedback from local surveying and spatial industry (private, corporate and government) and the professional representative bodies. 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 element of most final-year units is to provide the student with advanced knowledge and/or specialist experience using broad knowledge and skill base developed over the first three years of the course.

The course structure for the spatial science major (figure 3) has been aligned with the faculty model of shared course structure as previously discussed in section 2.2. 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 (four unit set) 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.



2008 Course Matrix: UD40 Bachelor of Urban Development (Spatial Science)

	Year 1		Year 2		Year 3		Year 4	
	Semester 1	Semester 2	Semester 1	Semester 2	Semester 1	Semester 2	Semester 1	Semester 2
FACULTY WIDE UNITS	BEB100 Introducing Professional Learning[1]	BEB200 Introducing Sustainability[1]					BEB701 Work Integrated Learning[1, 4]	BEB801 Project[1, 4]
SCIENCE THEME (minor)	MAB100 Mathematical Sciences 1A[3]	MAB101 Statistical Data Analysis[3]	PCB172 Physics for Surveyors[3]	MAB730 Surveying Mathematics[3]			UDB301 Research Methods[2]	UDB202 Business Skills[2]
LAND DEVELOPMENT/ CADASTRAL THEME	UDB101 Stewardship of Land[2]	UDB104 Urban Development Economics[2]	UDB285 Cadastral Surveying[5]	UDB102 Applied Law[2]	UDB385 Cadastral & Land Management[5]	UDB302 Development Process[2]	UDB485 Property Development Practice[4]	UDB486 Cadastral Practice[4]
MEASUREMENT SCIENCE SURVEYING THEME		UDB182 Surveying[5]	UDB283 Surveying Computations[5]	UDB284 Engineering Surveying[5]	UDB383 Control Surveying & Analysis[5]	UDB384 Geodesy[5]	UDB483 Global Positioning Principles and Practice[5]	UDB484 Topographic, Hydrographic & Mining Surveying[5]
MAPPING SCIENCE THEME	UDB181 Geospatial Positioning and GPS[5]			UDB282 Remote Sensing[5]	UDB381 Geospatial Mapping[5]	UDB382 Photogram-metric Mapping[5]		
GIS THEME			UDB281 Geographic Information Systems[5]		UDB387 Spatial & Land Information Management[5]	UDB388 Spatial Analysis Practice[5]		

1 = Faculty-Wide unit; 2 = School based common unit; 3 = Science Minor unit; 4 = Applications Minor unit; 5 = Spatial Science Core unit

Figure 3: Course Structure for QUT Bachelor of Urban Development (Spatial Science)

The Faculty requirement for eight shared common core units - six broad units sourced from the school 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 somewhat 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). A compulsory application minor (set of four units) consists of Work Integrated Learning, Property Development Practice, Project and Cadastral Practice. What makes this course different from other disciplines is the application minor is a compulsory minor inclusive of the recognition when mapped against the Queensland Surveyors Board Competency frameworks (2007).

These three distinct and complementary learning themes of the current spatial science program are summarized section 4.1 to 4.3 below.

4.1 Measurement Science/ Surveying Theme

The measurement science focused theme is predominantly a sequential learning pathway that relies upon some pre-requisite unit knowledge that builds from unit to unit. The later semester units rely upon successful completion of the science/maths minor (four units). The measurement science theme has seen learning and teaching improvements introduced with updating and refreshing of content and assessment methods allowing for increased unit capacity. These units typically have higher student contact hours (generally 5 or more) including field practice and dedicated small-group computer software training.

4.2 Land Development/ Cadastral Theme

The land development focused theme contains a strong cadastral surveying "flavour" influenced by negotiated input from the Queensland Surveyors Board as being able to meet educational requirements leading to registration as a surveyor. Recognition has been achieved (January 2008) for this new Spatial Science course structure when mapped against the Qld Surveyors Board Competency frameworks 2007. One requirement of the Australian/New Zealand Surveyors Registration Boards is for a significant level of land development engineering. This is primarily addressed in the 2 units Cadastral and Land Management and Development Process. Co-teaching with civil engineering students occurs. An economy of scale relating to teaching delivery and educational resources exists within the land development theme as half of the eight units are delivered school-wide across the urban development disciplines.

4.3 Mapping and GIS Theme

The mapping and GIS focused theme have contracted to an identified six and half units (twenty percent). The first year, first semester unit known as Geospatial Positioning and GPS conveniently abridges the Measurement Science and Mapping/ GIS themes and is intended as a introductory foundation unit (thus the half unit contribution to Mapping Science). Looking to the recent past, an identified Mapping/GIS theme was partially evident of the previous Bachelor of Surveying program 1994-2005. Webb (2009) has previously provided a course structure of this older surveying/ cartography program with the cartography/ mapping/ GIS related units highlighted. An obvious contraction of cartography/ mapping/ spatial information units has occurred with the 2006 implementation of the broad based BEE-model.

5. CURRICULUM MAPPING OF THE SPATIAL SCIENCE MAJOR

The current Spatial Science course at QUT is due for formal review in late 2010 with implementation to occur into 2011. To inform this formal review, a curriculum mapping approach has been undertaken to inform this impending review. One of the most common approaches to developing graduate attributes in Australia and internationally is curriculum integration or embedding. This involves facilitating students' development of graduate capabilities within the disciplinary contexts of the courses they undertake as part of their undergraduate university programs.

The central element of curriculum mapping is an exercise in which involved staffs review the learning outcomes, content, learning activities, and assessment of a given course to identify where and how graduate attributes are taught, practised, and assessed within the course. Often this exercise shows that many graduate attributes are already being developed but not in an explicit way. Therefore, mapping can reveal opportunities for new or better alignment between aspects of course design for the introduction of new learning or assessment activities, as outlined by the Learning and Teaching group at UNSW (2008).

Recognition that curriculum mapping and program review processes are most successful when based on the particular learning and teaching goals of Faculties. To this extent, curriculum mapping should not be seen as a predetermined process and a so-called "tick-the-box" approach. Identification of graduate attributes as they pertain to courses and discipline specific units, assists University teachers, faculties and schools in planning, implementing, and evaluating curricula, and helps students to know expectations, plan for their own learning and review their progress and achievements. Graduate attributes inform the wider community about the qualities, skills, knowledge and abilities developed by the University's graduates, as outlined by University of Qld, TEDI (2008).

5.1 The Curriculum Mapping Process Adopted

The process undertaken on the specific Spatial Science program review at QUT was a hybridized model between the University of Qld – mapping and embedding graduate attributes approach; University of NSW- curriculum mapping approach, and considering our own QUT teaching and learning frameworks with supportive graduate capabilities resources.

The process undertaken involved four sequential segments.

- **Program mapping** - What do the learning outcomes and graduate capabilities mean when applied to graduates of the Spatial Science program? This task involved the identification of outcomes and capabilities that the Faculty believes its graduates should or will develop after experiencing the undergraduate program of study in question.
- **Course mapping** - How does each of the units within a program support the development of discipline specific graduate attributes? The outcome of the course mapping phase was an overview of how the attributes are evident within the learning activities, and therefore, also in the learning objectives and assessment program. Several thematic layers have been applied to the fundamental course map matrix to determine strengths and/or weakness.
- **Program review** - How does the whole program contribute towards the expected graduate capabilities? This task will be undertaken at faculty level by teaching consultants as a means of synthesising the data from the course-mapping segment with comparative judgements against broader teaching and learning directions. Some work has commenced in late 2009 by BEE employed teaching and learning consultants with an expected formal review to be undertaken late 2010.
- **Evaluation and revision** - How can discipline themes and individual learning units be refined to ensure developmental and sequential support for students to develop program graduate attributes? This segment will involve faculty and school level inputs to analyse the outcomes of the previous three segments with the aim of identifying how individual units (three levels) can be enhanced. This activity is often undertaken periodically on a three to five-year cycle.

Analysis of a completed curriculum map can show gaps where attributes could be embedded or areas of over-concentration where one aspect of the course is responsible for developing several attributes. Not every unit can be expected to develop every graduate attribute.

Curriculum design at QUT has three key characteristics as briefly outlined below.

(a) Curriculum design supports student learning.

QUT courses are designed to support students in achieving the stated learning outcomes desired from the course and to achieve the graduate capabilities that should characterise every QUT graduate group. Throughout the course there will be multiple opportunities for students to master the relevant content, practise the skills and develop the dispositions desired of graduates in that field. There also will be multiple opportunities to track the student's learning progress, as mastery of the learning outcomes is assessed. To optimise student development, curriculum design incorporates consideration of diverse student needs and student engagement with the learning environment.

(b) Curriculum design embeds real world learning pedagogies

QUT values real-world learning that explicitly reveals for students the practices, culture and practical knowledge of the disciplines and the professions that its students aspire to enter. Curriculum design embeds QUT's distinctive brand of engagement and real-world learning at every stage of the course. These features include engagement with professions, engagement with research and real-world learning experiences

(c) Whole of course design

Curriculum design is scaffolded to identify and support the developmental levels of learning inherent within a course. To achieve this whole of course design, the curriculum acknowledges the needs of each level of learning and engages students with challenges appropriate to that level, while also building on the previous level and preparing students for the following level.

6. WORK INTEGRATED LEARNING

Work-integrated learning (WIL) provides opportunities for students to apply theoretical knowledge, develop and consolidate skills, reflect on practice, and develop an understanding of the relevant profession or related sectors is essential to providing real-world experiences. All undergraduate courses are expected to provide an opportunity for students to undertake various forms of work-integrated learning during their course, including work experience in industry / professional workplaces.

A distinctive feature of effective work-placement programmes (such as occurs in nursing programs) is that they involve partnerships among diverse groups: employers, students, academic teachers, higher education managers and professional bodies. Students receive instrumental 'training' and employability skills are arguably captured on the job while at the same time students gain insight into the pressures of the work environment within various organisations. In contrast, the stakeholder's emphasis is on learning (training?) and often adopts a longer-term view seeking benefits for all parties. Host organisations usually and intentionally develop teamwork, communication and interpersonal skills through a range of specific work projects.

There is increasing pressure on Australian Universities to give greater emphasis and accept more responsibility for "graduate employability". Systems currently in place hold universities accountable for their graduates' success in gaining employment. The Australian Graduate Destination Survey (GDS) and the Course Experience Questionnaire (CEQ) are two instruments used nationally to measure and report on this (Franz, 2008).

One of the main approaches universities have responded to these demands has been to include some form of work placement during or at the end of the student's course of study. Orrell (2004) describes how recent research "…illustrates that students who had undertaken a work-integrated learning experience or a skill-development component during their course of study were more likely than others to have reflected positively on their university experience and to have achieved employment within their chosen field". The way in which work-based learning has been implemented varies from university to university and course to course. Webb and Hayes, 2008, contribute more detail of the WIL scheme at QUT and the operational and implementation aspects of such a scheme specific to Spatial Science/ Surveying students.

7. SOME HIGHER EDUCATION ISSUES CONCERNING SPATIAL COURSES

Predictions for the tertiary surveying sector made by McDougall (2000) of the impacts of Dawkins' reforms and unification of higher education institutions have arguably resulted in a number of important structural and business model 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.

As Bellman et al (2006) outlined at the Trans Tasman Survey conference and additionally recognised by Australian University Heads of Departments meeting in 2007, 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 and Bennett et al 2009). Staff directly involved with the teaching and management of the spatial science program at QUT have seen these reform predictions eventuate along with a concerning climate of reduced funding and alert to increases in academic staff student ratios.

In recent times, a number of significant factors have been reported that had a major effect on the capacity of universities to develop and maintain arguably sustainable education programs in this country. (Cartwright et al 2000; Bellman et al 2006; Mishra 2008).
These factors include but are by no means limited to the following issues:

- High rate of technological change.
- Vagaries of government policy towards higher education – funding models.
- Changing systems and approaches to research quality or excellence in research.
- Stress and workload issues associated with a general reduction in staffing numbers.
- Some limited resources and difficulty with replacement and refurbishment of equipment and facilities.
- Performance based workplaces with increased complexity related to socio-economic and technological challenges.

Contemporary universities can be "rapidly changing legal, social, economic and technological environments" characterised by the conflict they are experiencing between corporate and academic cultures (Ferren 2001). With significant changes in the past decade to society's attitude to higher education, universities have changed their management structures to become more entrepreneurial, competitive, strategic and arguably more administratively bureaucratic.

In 2000, Professor Lodwick from Curtin University speculatively commented about some trends in tertiary education for tomorrows spatial scientists. One noticeable trend was …..the most significant change is corporatisation. More and more universities are beginning to be operated as independent businesses. Corporatisation can be seen in the trend to more hierarchical structures, the consolidation of teaching areas into larger business units without regard to academic issues, the widespread imposition of business systems in staff and student management, more emphases on financial reporting and accountability, the drive to outside income generation, and cost reduction strategies such as outsourcing of many support functions (Lodwick 2000).

Currently 37 federally funded universities exist in Australia and only two or three private universities. The difference between government funded and the private universities is likely to become somewhat more blurred in the next decade. Bennett et al (2009) correctly asserts that spatial science education in Australia is facing a paradox within the next decade with the demand for graduates steadily increasing yet student enrolments remain somewhat static to marginally declining.

8. CONCLUSIONS

The challenge of curriculum design at university level is adapting/renewing programmes within structural constraints to respond to the incremental theoretical and practical developments to enhance the education of tomorrow's Spatial Science professionals. The role of curriculum mapping in whole-of-course design has been shown to be a useful process to academic and unit content advisors. The process often looks at recent past reflections, is

informed by communities of best practice and attempts to manage rapidly changing technology relating to technical and professional issues.

The restructure of the Spatial Science program generally aligns to the university corporate-orientated business models to focus on high volume, low overhead programs and provide for future capacity. The WIL unit is viewed as contributing industry relevance and depth to a students learning experience. The structure of these new broadly based 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 recognisable professional competence.

9. ACKNOWLEDGEMENTS

The author would like to acknowledge the support of the School of Urban Development, Faculty of Built Environment and Engineering at QUT, Brisbane, in the preparation of this paper and the associated research. Educational directions through course re-structure and the subsequent transitional period has been successfully achieved with the professional guidance of Dr John Hayes as Course Coordinator for the Bachelor of Urban Development. Historical information relating to previous surveying course structures has been synthesis from the work of Mr Kevin Jones, former course coordinator for Surveying at QUT. However, the views expressed in this paper are those of the author and do not necessarily reflect the views of the individuals or organisational groups associated with the faculty or university.

REFERENCES

Bellman C., Williamson I., McDougall K., Rizos C. (2006) Challenges Facing Spatial Information and Geomatics Education in the Higher Education Sector. *Proceedings of Combined 5th Trans Tasman Survey Conference and 2nd Queensland Spatial Industry Conference 2006*. Spatial Science Institute of Australia. Cairns.
Bennett R., Ogleby C., Bishop I. (2009) One strategy for Repositioning Spatial Sciences Education in Australia, *Journal of Spatial Scicnce*, Vol. 54, No. 1, June 2009. pp.93-104.
Betts M. (2004) *White Paper – The Founding Principles of the New Faculty*, QUT Faculty of BEE Strategic Plan, Brisbane, Queensland University of Technology
Boyer E. (1990) *Scholarship reconsidered: priorities for the professoriate*. Princeton, NJ: Carnegie Foundation for the Advancement of Teaching.
Cartwright W., Edwards N., Fraser D., Pupedis G. (2000) From Cartography to Multimedia Cartography: the metamorphosis of an educational program. *Proceedings of Mapping Sciences Institute Australia National Conference 2000*, Sydney.
Clarke B. (1998) *Creating Entrepreneurial Universities: Organisational Pathways of Transformation.* New York: Pergamon.
Coaldrake P. (2004) *QUT Blueprint,* QUT Strategic Plan, Brisbane, Queensland University of Technology.
Cook J.S. (1998) An interpretation of current progress towards an industry model for Queensland's surveying and mapping industry', Southern Exposure, ed. Jon Osborn, *Technical*

papers of the 39th Australian Surveyors Congress held at Launceston, Tasmania (8-13 November 1998) pp.173-186
Crowther P. and Savage S. (2005) Strange Bedfellows: Collabrative Course Development across the Disciplines. *Third International Conference of the Association of Australasian Schools of Architecture,* "Drawing Together: Convergent Practices in Architectural Education".
Crowther, P., Savage, S., (2008) The changing role of universities and flexible course re-development, *Proceedings of BEAR2008; CIB W89: International Conference in Building Education and Research*, Sri Lanka.
Engineers Australia (1996) *Changing the Culture of Engineering Education*, Engineers Australia, 1996.
Ferren, A.S.(2001) Reconciling Corporate and Academic Cultures*, Peer Review: emerging trends and key debates in undergraduate education*, Vol. 3,No. 3, 9-17.
http://www.aacu.org/peerreview/pr-sp01/ (accessed November 2008)
Foxell S. (2003) *The Professional's Choice: the future of the built environment professions*, Building Futures, London, 2003.
Franz, J. (2007). Work Integrated Learning for Design: A Scholarship of Integration, Proceeding of *Connected 2007 International Conference on Design Education*, July, University of New South Wales, Sydney.
Franz, J. (2008). Faculty of BEE, QUT- Work Integrated Learning Director, *Personal Communication*, May 2008.
Jones K., Harris M.W. (2004) *QUT PS47/48 Bachelor of Surveying: Report for Surveying Course Recognition and Accreditation Procedure, October 2004* (unpublished report), School of Design and Built Environment, Faculty of Built Environment and Engineering, Queensland University of Technology
Lodwick G. (2000) Trends in Tertiary Education for Tomorrow's Spatial Scientists. *Proceedings of Mapping Sciences Institute Australia National Conference 2000*, Sydney.
McDougall K. (2000) *Surveying and Mapping Education – Designing for the Future:* Discussion paper on the Design of a Professional Level Course, Surveying and Mapping Professions Education Advisory Committee. 10pp. June 2000.
Mishra S. (2008) Accreditation criteria of engineering curriculum in Australia, USA and India: the role of non technical subjects. *Proceedings of International Conference on Global Challenges in Engineering Education and Research*. Coimbatore, India.
Orrell, J. (2004) Work-integrated Learning Programmes: Management and Educational Quality. *Proceedings of the Australian Universities Quality Forum 2004.* Available Internet http://www.auqa.edu.au/auqf/2004/program/papers/Orrell.pdf (accessed October 2008) Also Flinders University: Model of Best Practice for Work-based Learning, available Online Internet http://www.flinders.edu.au/teach/t4l/practicum/examples/bestpractice.php
Queensland University of Technology – Teaching and Learning Support Services. (2005). *QUT Teaching Capabilities Framework.*
http://www.talss.qut.edu.au/staff/awardsgrants/awards/tcf.pdf (accessed November 2008).
Queensland University of Technology. (2009). Curriculum Design Policy- Section C/4.2, *Manual of Policies and Procedures MOPP*. Intranet
http://www.mopp.qut.edu.au/C/C_04_02.jsp (accessed February 2009)

Savage S. and Betts M. (2005) Boyer reconsidered: priorities for framing academic work, *HERDSA Conference, 'Higher Education in a Changing World'*. Sydney.
Surveyors Board of Queensland (2007) *Competency Frameworks and Competency Assessment and Registration Policy*
http://www.surveyorsboard.com.au/pdfdocs/SBQ_CF_0100_Overview.pdf (accessed January 2009).
University of New South Wales- Learning & Teaching. (2008). Graduate Attributes Chapter, Curriculum Matters.
http://learningandteaching.unsw.edu.au/content/LT/course_prog_support/graduate_attributes.cfm (accessed December 3, 2008).
University of Queensland – Teaching and Learning Support. (2008). Teaching and Learning Support (TEDI) Graduate Attributes, Mapping and Embedding Graduate Attributes.
http://www.tedi.uq.edu.au/teaching/GradAttributes/index.html (accessed November 2008).
Webb R.M., Hayes J.F. (2006) Spatial Science Education Directions for QUT, *Proceedings of Combined 5th Trans Tasman Survey Conference & 2nd Queensland Spatial Industry Conference 2006,* Spatial Science Institute of Australia, Cairns.
Webb R.M., Hayes J.F. (2008) Work Integrated Learning: Will it Work for Spatial Science Wilers?, *Proceedings of Queensland Spatial Conference 2008*, Spatial Science Institute of Australia, Gold Coast.
Webb R.M., (2009) Curriculum Mapping of the Spatial Science Program, QUT: What was the Cartography Journey? *Proceedings of Australian Map Circle/Mapping Sciences Institution Australia Conference 2009* "300 years of Mapping; The past 150 years and the next 150 years" 16-18 March, 2009 Brisbane Australia.

BIOGRAPHICAL NOTES

Robert is an academic lecturer and program coordinator of the Spatial Science discipline within the School of Urban Development, Faculty of Built Environment and Engineering, Queensland University of Technology (QUT), Brisbane, Australia. Robert previously worked in hydrographic surveying and charting, engineering surveys and "early days" GPS positioning projects. In the early 1990s, he spent a few years in research project endeavours involving photogrammetry, land information structures and GIS projects, before commencing an academic career pathway with QUT.

He actively teaches in the areas of global positioning systems, hydrographic surveying, foundation surveying skills, photogrammetry and geospatial mapping. He was awarded the prestigious 2009 Asia- Pacific Spatial Excellence Award for education and professional development.

Workplace commitments have included a broad range of activities including university committee work, student recruitment activities, workplace health and safety responsibilities, academic coordination and increasingly administration contributions.

CONTACTS

Mr. Robert WEBB, Spatial Science Program Coordinator
Queensland University of Technology
2 George Street GPO Box 2434
Brisbane, Queensland
AUSTRALIA
Tel. +61 7 31382434
Fax + 61 7 31381170
Email: r.webb@qut.edu.au
Web site: www.bee.qut.edu.au