Queensland University of Technology
Brisbane Australia

This is the author's version of a work that was submitted/accepted for publication in the following source:

Desha, Cheryl & Senadji, Bouchra
(2014)
Holistically approaching curriculum renewal: A case study of the Queensland University of Technology. In
AAEE 2014: Australasian Association for Engineering Education Annual Conference, 8-10 December 2014, Te Papa Tongarewa National Museum of New Zealand, Wellington, New Zealand.

This file was downloaded from: http://eprints.qut.edu.au/87063/

© Copyright 2014 [please consult the authors]

Notice: *Changes introduced as a result of publishing processes such as copy-editing and formatting may not be reflected in this document. For a definitive version of this work, please refer to the published source:*

Holistically approaching curriculum renewal: A case study of the Queensland University of Technology

Cheryl Desha[a] and Bouchra Senadji[b]
School of Earth, Environment and Biological Sciences, Science and Engineering Faculty (SEF), QUT[a]
School of Electrical Engineering, Computer Science, Networks and Communications, SEF, QUT[b]
Corresponding Author's Email: cheryl.desha@qut.edu.au

Structured Abstract

BACKGROUND

There are still many programs in Australia and overseas where curricula comprise largely 20th Century-relevant graduate outcomes, framed in 20th Century learning and teaching approaches. A 'Dynamic and Deliberative Model for Curriculum Renewal' (DDMCR) model exists for undertaking such curriculum renewal that draws on the experiences of educators around the world, however there are few experiences to date in applying this model. At the Queensland University of Technology, the 2012 accreditation by Engineers Australia observed that, despite being exposed to relevant discipline-specific engineering curriculum and practice, students did not seem to be aware of the relevance of sustainable development to their degree, beyond first year exposure. In addressing this feedback, level 8 Australian Qualifications Framework, and drawing ideas from the DDMCR model, faculty senior management undertook a full review of the engineering curriculum.

PURPOSE

This paper considers QUT's experience in embracing whole of course (i.e. program-level) rapid and sustained curriculum renewal to cater for 21st Century engineering graduate outcomes.

DESIGN/ METHOD

The authors of this paper consider how the curriculum renewal process applied insights from the DDMCR, through the lived experience of curriculum renewal at QUT (2013-2014). The authors conclude that this enquiry-based approach to problem solving also 'walks the talk' with regard to the type of real-world problem solving expected of students at QUT.

RESULTS

This paper documents the experiences of the authors in applying the DDMCR, identifying several priorities including sustainability for the design streams of all major disciplines, and creating unit outlines that embed the Course Learning Objectives (i.e. graduate attributes) related to these priorities. The paper includes a journey of stakeholder engagement, committee activities, workshops and peer-review led collaborative unit-design, highlighting lessons for others considering how to efficiently and effectively review programs. These lessons span pedagogical, organisational and logistical considerations, and latent and emergent academic, industry and student needs.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

This initiative provided the authors with an opportunity to apply the model for deliberative and dynamic curriculum renewal in a time and budget-constrained faculty environment. This paper provides lessons learned from the design phase of the initiative, up to the point of university approval of the renewed program and its components. As the program is rolled out, the lived experience will continue to be reflected upon and documented for the benefit of QUT and other interested institutions.

KEYWORDS

Whole of curriculum approach, Education for sustainable development, Curriculum renewal

Introduction

Considering knowledge and skill needs for 21st Century engineering graduates, there are still many programs in Australia and overseas where curricula comprise largely 20th Century-relevant graduate outcomes, framed in 20th Century learning and teaching approaches (Davidson *et al*, 2010; Byrne *et al*, 2013; Karatzoglou, 2013; Desha and Hargroves, 2014). Furthermore, despite the rapidly changing technological and social conditions around the planet, higher education providers continue to struggle with preparing graduates with 21st Century knowledge and skills in timeframes that meet the needs of society, resulting in a 'time lag dilemma' where there is a gap between employer needs and graduate capabilities (Desha *et al*, 2009).

Within this context, there is an emergent community of education researchers asking how higher education institutions can develop graduates to meet (or exceed) industry needs, in a highly dynamic societal context. A 'Dynamic and Deliberative Model for Curriculum Renewal' model (Figure 1) exists for undertaking such curriculum renewal that draws on the experiences of educators around the world (Desha and Hargroves, 2011:2014), however there are few experiences to date in applying this model (See for example Rose *et al*, In Press, discussing Monash University; Sheehan *et al*, 2012, discussing James Cook University) or other systematic processes (Svanstrom *et al*, 2012, discussing Chalmers University).

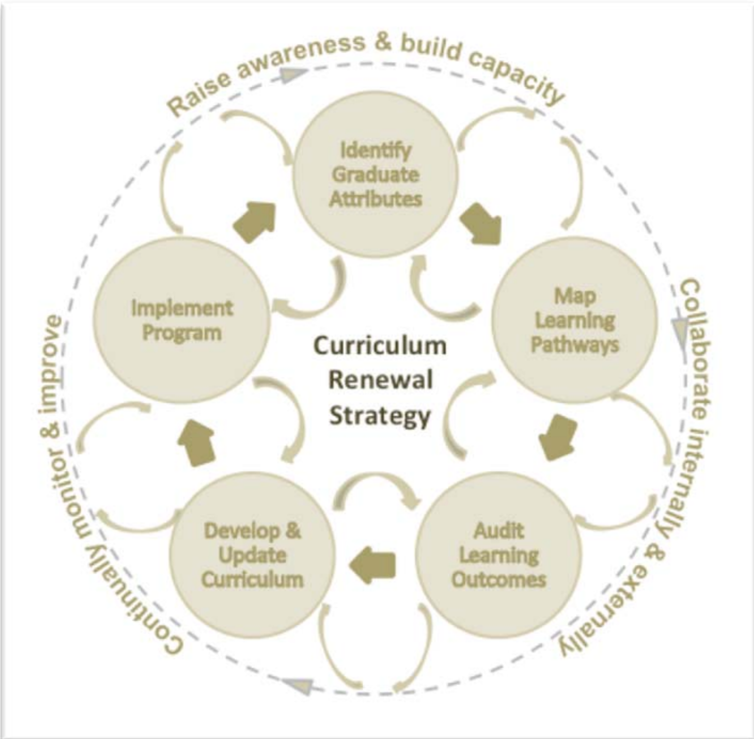

Figure 1: Deliberative and Dynamic Model for Curriculum Renewal
Source: Desha and Hargroves (2010)

The Queensland University of Technology has a strong engineering undergraduate program, with over 3000 students enrolled in 10 different majors of engineering. It also has strong a history of work integrated learning (WIL), education and industry collaboration, and mapping graduate outcomes to unit-level learning outcomes. Different format of WIL have been implemented and reviewed, from a single subject teaching all about WIL to the most recent, industry–informed format of WIL embedded in the whole curriculum.

Within this context, there were several aspects of the 2012 accreditation round by Engineers Australia, which were considered to be areas of potential improvement. This included that, despite being exposed to relevant discipline-specific engineering curriculum and practice, students did not seem to be aware of the relevance of sustainable development to their degree, beyond first year exposure. In addressing this feedback, level 8 Australian Qualifications Framework, and drawing ideas from the conceptual model in Figure 1, faculty management decided to undertake a full review of the engineering curriculum before the next accreditation round.

Moving beyond the many documented examples of champion-based ad hoc curriculum renewal to address such challenges in individual units, year levels and disciplines, this paper uses an action research approach (Benn and Dunphy, 2008) to consider QUT's experience in embracing whole of course (i.e. program-level) rapid and sustained curriculum renewal to cater for 21st Century engineering graduate outcomes. The authors of this paper consider how the curriculum renewal process applied insights from the DDMCR, through the lived experience of curriculum renewal at QUT (2013-2014).

A summary of curriculum renewal engagement

The following paragraphs provide an overview of the curriculum renewal process, drawing on the first four major steps outlined in the conceptual model for dynamic and deliberative curriculum renewal. Figure 2 summarises the organisational map for the curriculum renewal process, including internal and external stakeholders.

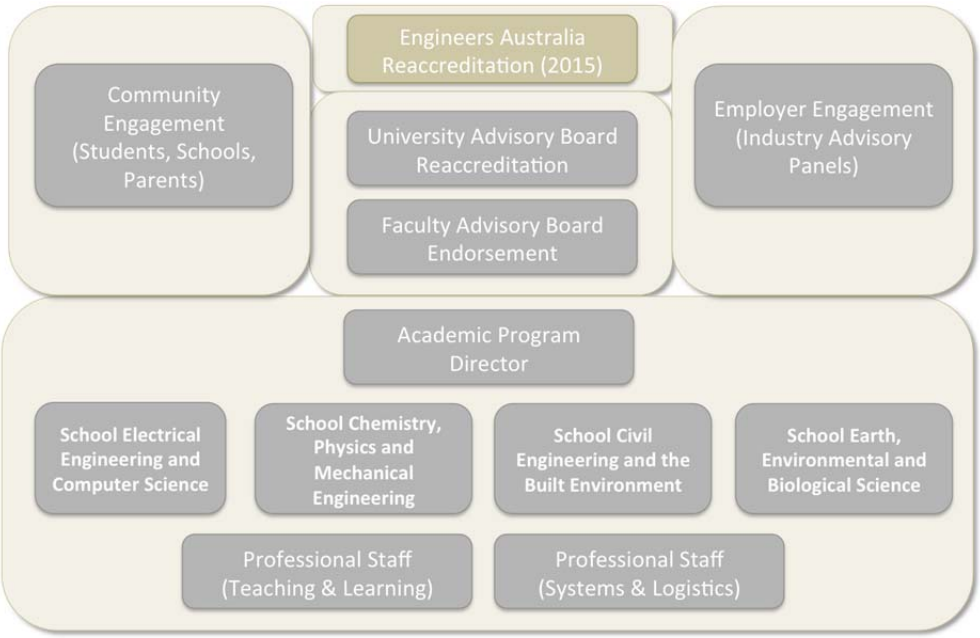

Figure 2: Organisational map of curriculum renewal engagement

In Figure 3, the authors summarise the university's experience of the curriculum renewal experience that unfolded. It is immediately apparent that several steps in the conceptual model involved quite complex interactions between various groups in the organisation. It is also apparent that two of the critical steps (i.e. creating a curriculum strategy and defining graduate attributes) occurred quite early on in the process, relying heavily on the curriculum renewal chair (in this case the Academic Program Director) to steer and articulate these outcomes.

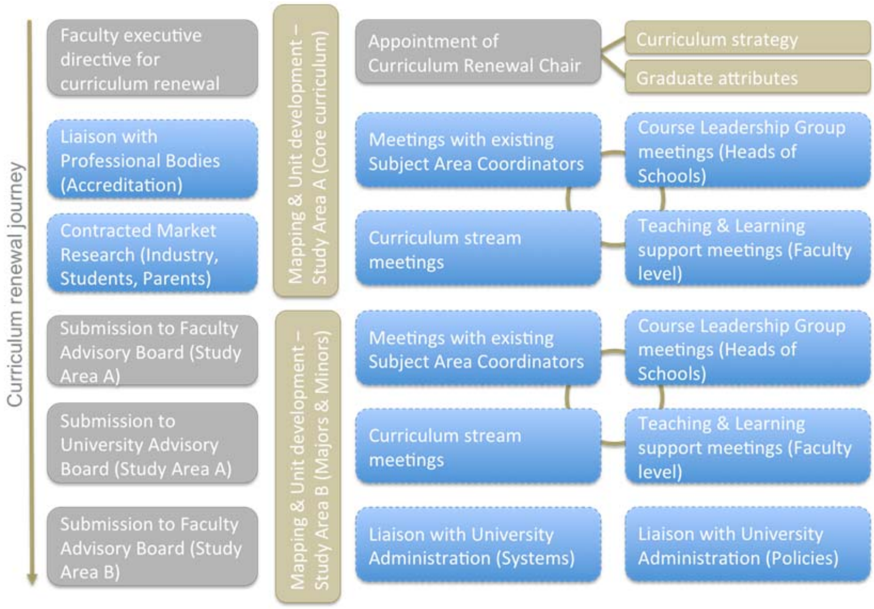

Figure 3: Summary of curriculum renewal process

Articulating the curriculum renewal strategy

The Academic Program Director led the scoping of the curriculum renewal initiative, drawing on university-level documentation regarding curricula priorities, the requirements of the Australian Quality Framework, and Engineers Australia communications from the previous accreditation round. In summary, it was identified that the new curriculum needed to produce graduates ready for the real world, competent in addressing 21st Century challenges. Subsequently the following strategic directions were set for the initiative:

- There would be three key disciplines (Civil, Electrical, Mechanical), continuing the existing program's disciplinary focus, with opportunities to expand into related areas through major and minor streams within the curricula.
- Creating a common first year program, addressing foundation knowledge and skill needs as a priority, in addition to creating and sustaining enthusiasm for engineering.
- Including clearly articulated design streams for each key discipline area, which would host priority learning areas including sustainability education, ethics and professionalism.

Identifying the preferred graduate attributes

The Academic Program Director led the identification of graduate attributes using a primarily desk-based approach, informed by discussions with the Course Leadership Group members and Engineers Australia. Drawing on the Engineers Australia Stage 1 competency standard (Engineers Australia, undated), in addition to the World Federation of Engineering Organisations expectations, and the Australian Quality Framework requirements, the program aims as follows (QUT, 2014),

'Students … will demonstrate advanced knowledge, based on contemporary, evidence-based, sustainable engineering practices, in at least one engineering discipline. They will have developed significant real-world project-based experience that allows them to design innovative solutions to familiar and unfamiliar complex problems whilst applying high order cognitive strategies through the evaluation and synthesis of multiple sources of information. Graduates will be proficient at engaging in professional and scholarly communication and responsible work practices with the interpersonal and teamwork attributes to engage with a broad range of stakeholders, individually, and in teams. They will manage their time effectively and will critically reflect on personal performance and professional development taking into account the broader ethical, cultural, social and multi-disciplinary contexts of engineering practice.'

This overarching statement was distilled into five clusters of graduate attributes, in the form of ‘Course Learning Outcomes’, each with ‘elements’ that specify essential dimensions:

1. ***Knowledge and applications***: Evidence of coherent and advanced knowledge in a selected discipline field.
2. ***Cognitive skills and applications***: Evidence of review, analysis and synthesis of knowledge in research and project contexts including critical, creative and innovative solutions to complex problems.
3. ***Communication skills and applications***: Evidence of advanced knowledge, concepts and ideas in written, spoken, modelled and graphic forms, for a variety of audiences
4. ***Collaborative and independent behaviours***: Evidence of independent and collaborative strategies in teams/groupwork contexts, including reflective practice, to manage projects in a timely manner, with a focus on delivering outcomes.
5. ***Context and systems***: Evidence of awareness and understanding of socio-cultural factors in engineering practice, and evidence of ethical behaviour.

Mapping the learning pathways

The process of mapping learning pathways was undertaken by each of the three discipline teams, focused on content requirements that would develop the attributes listed above. At times this was particularly challenging, where teams could verbally communicate the pathways, but documentation was missing. A series of ‘tree diagrams’ emerged from this process over several months, as shown by example in Figure 4, including acknowledgement of units that were ‘foundation’, ‘introductory’, ‘intermediate’, and ‘advanced’ in nature. This includes a research informed capstone project as well as a Foundation of Research unit.

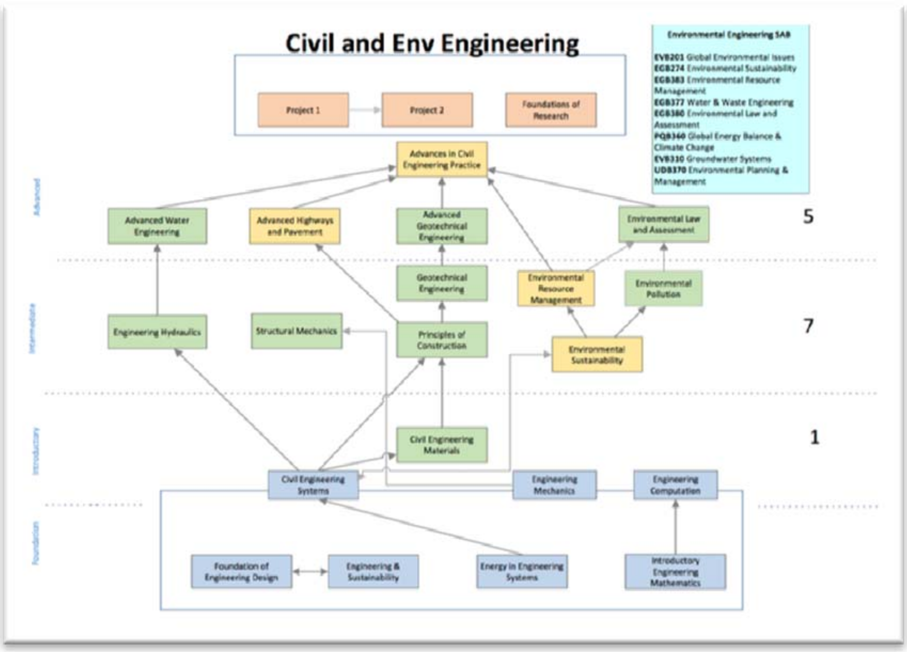

Figure 4: Example tree-diagram of a curriculum scaffold for the civil engineering discipline

Learning pathways were also informed by five preferred learning strategies, which were developed in consultation with the learning and teaching team within the university, including:

- Experiential, inquiry-based learning.
- Reflective learning experiences.

- Peer to peer, collaborative learning experiences.
- Demonstration-style lectures.
- Blended learning.

With these strategies in mind, design of the degree subsequently considered student progression and the types of learning strategies and assessment that are introduced to ensure an appropriate developmental sequence in which students are provided with additional scaffolding and support (e.g., for peer-to-peer and project-oriented learning) in units that form the foundations for later more advanced unit experiences.

Reviewing the curricuum for learning outcomes

This step involved unit level review of existing and proposed curricula, working out where existing units could be adjusted, where they should be removed and/or replaced, or where new units should be developed. As noted in Figure 3, this comprised a two-stage process:

1. 'Study Area A' units (i.e. one set for each of Civil, Electrical and Mechanical Engineering) were considered for coverage of critical core knowledge and skills. Eight SAAs are offered including Electrical, Electrical and Aerospace, Computer and Software Systems, Mechatronics, Mechanical, Medical, Process, and Civil engineering.
2. 'Study Area B' units (i.e. varying sets within each of Civil, Electrical and Mechanical Engineering) were considered for coverage of additional knowledge and skills that build on the Study Area A units in the form of majors or minors. SABs are offered in either 8-unit blocks (i.e. second majors) or two 4-unit blocks (i.e. minors), allowing for either breadth or depth, relevant to the engineering discipline.

Engaging with internal and External stakeholders

Engaging with both internal and external stakeholders constituted a big part in curriculum renewal. Focus groups conducted with academics and QUT students provided a solid background into the positives and negatives of the current engineering degree, particularly in terms of gaps, assessment, and learning and teaching approaches.

Focus groups with Industry and professional Bodies, particularly through QUT's Industry Course Advisory Group and CEO's forum provided invaluable feedback in terms of where industry was heading and about the best ways to form industry-ready graduates.

Focus groups outside QUT were also conducted with high-school teachers and students, parents, and students from other universities provided insights into the best ways to make ours programs attractive to the outside world.

Curriculum outcomes

The new Bachelor of Engineering (Honours) has been endorsed and reaccredited as a well-structured, cohesive and flexible course providing active, engaging and practical learning opportunities; equipping students with the knowledge, skills and experience required to take on a professional engineering role or further studies and research. It is anticipated that graduates will be attractive to employers by being grounded in theoretical, practical and professional aspects of engineering with the self-awareness and skills to adapt and be lifelong learners in a dynamic and competitive environment. Innovative design features of the new program include:

- Maths embedded and integrated into a selected number of units within the SAAs providing immediately relevant and applied contexts for specific mathematical knowledge.
- Discipline-specific design streams running through all the Study Area As (SAA) which build on the design experience introduced in first year, with personal and professional capabilities developed through the design streams.

- Work Integrated Learning (WIL) embedded throughout the curriculum. Assessment takes place in selected units to prepare students for their required 60-day work experience.
- Students graduating with an e-portfolio providing evidence of professional capabilities.
- Greater flexibility which allows students to choose their SAA as early as the end of their first semester if they have already decided, and more time to choose their SAA - until the end of the first year.
- Greater choice and flexibility to complement their major with breadth or depth provided by a Study Area B or a double degree.
- Active learning encouraged through reflective practice and progressive design, test and build learning cycles.

Key lessons learned – design phase

Reflecting on existing literature highlighted in the introduction and processes described in the previous section, the authors highlight several lessons learned with regard to how to efficiently and effectively review programs. These lessons span pedagogical, organisational and logistical considerations, and latent and emergent academic, industry and student needs. Indeed for QUT, the way in which these are addressed had considerable effect on how the curriculum renewal process unfolded.

Overarching criteria - “What are the hidden agendas?”

Within the process of identifying and articulating the curriculum renewal strategy, it was important to also identify the various agendas that underpin the proposed curriculum renewal process. It transpired that agendas in different schools, and within different groups in the organisation (e.g. Faculty/ School level; Academic/ Professional staff) were not the same. While some goals were explicit – for example accreditation objectives arising from previous review comments – there were others that were partially or wholly hidden. These included budgetary objectives, unit ownership and workload issues, pedagogy perspectives, philosophical and cultural backgrounds, and personality-led differences. There were several instances where these were not identified early on, resulting in unintended delays to parts of the process, and avoidable tensions among individuals involved in scoping and defining aspects of the curriculum.

Contextual leadership – “Who can navigate with vision?”

It was critical to define and delegate leadership responsibilities upfront, resulting in rapid engagement with the rest of the faculty regarding curriculum renewal requirements. Vision beyond the curriculum itself was also critical to timely implementation of the design phase. Communicating beyond academics from the start facilitated smooth progression, including teaching and learning support, and systems support (i.e. data management, testamur and transcript logistics etc). Leadership with regard to realistic expectations of staff was important in not overloading academics in the curriculum renewal process. Engaging consultants to undertake external consultation activities enabled rapid feedback and targeted advice.

Discipline-level diplomacy – “How can we ensure co-opertition?”

This process highlighted the need for clear rules of engagement, to enable various disciplines to engage in discussions regarding topics such as common first year curricula, distributing cross-disciplinary learning outcomes, and shared majors and minors. At times, when a content area overlapped with two or more disciplines of engineering, there were often competing assumptions about where the content should be located and who should be responsible for teaching. This was particularly so for cross-discpilinary content associated with maths, ethics, professionalism and sustainable development.

Clear expectations – “Where are the targets?”.

The process highlighted the benefits of creating a comprehensive agenda of actions by back casting from formal decision points (i.e. reviews and submissions) enabled clear timeframes for actions. This process also enabled consultation with industry and future students in a timely manner, capturing existing and emergent expectations regarding the types of programs to be offered and the type of content to be embedded.

Conclusions

This initiative has provided the authors with a timely opportunity to apply the model for deliberative and dynamic curriculum renewal, following publication of a textbook on the topic in 2014. Furthermore, the initiative was undertaken in a time and budget-constrained faculty environment, which is a common context for curriculum renewal activities in higher education. Within this context, the paper has communicated insights from undertaking the design phase of curriculum renewal, up to the point of university approval of the renewed program and its components. This enquiry-based approach also ‘walks the talk’ with regard to the type of real-world problem solving expected of students at QUT.

Reflecting on the QUT experience in the design phase, there are a number of implications for the curriculum renewal process in moving to the Implementation Phase:

- Having clarity with regard to leadership and expectations will be important to drive unit development that aligns with design phase intentions.
- Appreciating motivations – from individuals through to school-level – for engaging with the process may help to circumvent potential delays and obstructions to curriculum renewal activities.
- Continuing to communicate with university professional staff will be critical to timely implementation of the planned curriculum renewal, including teaching and learning support, student services, marketing and communications, and systems support services.
- The need to engage with academic staff to build capacity with regard to curriculum design (pedagogy), and assessment.

As the program is rolled out, the lived experience will continue to be reflected upon and documented for the benefit of QUT and other interested institutions.

References

Benn, S. and Dunphy, D. 2008. Action Research as an approach to integrating sustainability into MBA programs. Journal of Management Education. 33, 276-295.

Byrne, E., Desha, C., Fitzpatrick, J., & Hargroves, K. (2013). Exploring sustainability themes in engineering accreditation and curricula, *International Journal of Sustainability in Higher Education*, 14 (4), 384-403.

Davidson, C., Hendrickson, C., Matthews, H., Bridgesc, M., Allend, D., Murphy, C., Allenby, B., Crittendenf, J. and Austing, S. 2010. Preparing future engineers for challenges of the 21st century: Sustainable engineering. J. Clean. Prod. 18, 7, 698-701.

Desha, C., & Hargroves, K. (2014). *Higher Education and Sustainable Development: A Model for Curriculum Renewal*, London: Earthscan-Routledge.

Desha, C. and Hargroves, K. 2011. Informing engineering education for sustainable development using a deliberative dynamic model for curriculum renewal. Paper presented at Research in Engineering Education Symposium, Madrid, Spain.

Desha, C., Hargroves, K., & Smith, M. (2009). Addressing the time lag dilemma in curriculum renewal towards engineering education for sustainable development, *International Journal of Sustainability in Higher Education*, 10 (2), 184-199.

Engineers Australia, undated. Stage 1 Competency Standard for Professional Engineer. < http://www.engineersaustralia.org.au/sites/default/files/shado/Education/Program%20Accreditation/110318%20Stage%201%20Professional%20Engineer.pdf> Accessed 20 May 2014)

Karatzoglou, B. 2013. An in-depth literature review of the evolving roles and contributions of universities to Education for Sustainable Development. J. Clean. Prod. 49, 44-53.

Rose, G., Ryan, K., and Desha, C. (Under Review) Implementing a holistic process for embedding sustainability: a case study in first year engineering, Monash University, Australia, *Journal of Cleaner Production*.

Sheehan, M., Schneider, P., & Desha, C. (2012) Implementing a systematic process for rapidly embedding sustainability within chemical engineering education: a case study of James Cook University, Australia, *Journal of Chemistry Education Research and Practice*, 13 (2), p112-119.

Svanstrom, M., Palme, U., Wedel, M., Carlson, O., Nystrom, T., Eden, M. 2012. Embedding of ESD in Engineering Education: Experiences from Chalmers University of Technology. Int. J. Sust. Higher Ed. 13, 3, 279-292.

Acknowledgements

The authors would like to thank Associate Professor Les Dawes and Professor Doug Hargreaves for early discussions in 2013 that inspired the process of connecting insights from the conceptual model with the practicalities of implementing a whole of curriculum approach to the program review.

In addition to referring to the breadth and depth of experiences of colleagues in Australia and overseas in whole of course curriculum renewal (for which there are numerous conference and journal publications), the authors will build on their own experiences and publications in this topic area to reflect on their application of theory to practice in the QUT lived experience.

Copyright statement

The following copyright statement should be included at the end of your paper. Substitute authors' names in final (camera ready) version only.

Copyright © 2014 Names of authors: The authors assign to AAEE and educational non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full and this copyright statement is reproduced. The authors also grant a non-exclusive licence to AAEE to publish this document in full on the World Wide Web (prime sites and mirrors), on Memory Sticks, and in printed form within the AAEE 2014 conference proceedings. Any other usage is prohibited without the express permission of the authors. – TO BE INSERTED BY THE AUTHORS AFTER REVIEW AND BEFORE THE FINAL SUBMISSION