Embedding Indigenous Perspectives into Engineering Education

Final report 2016

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https://Indigenousengineering.wordpress.com/

Acknowledgements

It is with respect that we firstly acknowledge the Country of the Yuin, the Country of the Wurundjeri and the Country of the Turrbal. It is on these traditional Aboriginal lands that the learning institutions committed to this project to teach and engage their students. It is hereafter that we extend this respect to the Aboriginal peoples and communities of these Countries who have been consulted and contributed to the knowledges we share throughout this report. We particularly thank the Illawarra Local Aboriginal Lands Council and Sandon Point Aboriginal Tent Embassy and acknowledge their continuing support of this project and the intimate sharing of Aboriginal values, knowledges and principles they have privileged us with along this journey.

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Definition of Terms

EAC – Engineering Across Cultures

MOU – Memorandum of Understanding

NSW – New South Wales

NT – Northern Territory

OLT – Australian Government Office for Learning and Teaching

QLD – Queensland

QUT – Queensland University of Technology

SA – South Australia

STEM – Science, Technology, Engineering, Mathematics

TAS – Tasmania

UniMelb – The University of Melbourne

UOW – University of Wollongong

VIC – Victoria

WA – Western Australia

This report uses both the terms 'Indigenous' and 'Aboriginal' to refer to descendants of the original inhabitants of this land. The term 'Aboriginal' is used to describe activities and outputs of the project which engaged only Indigenous people from mainland Australia. The term 'Indigenous' is used where discussing wider applications of project outputs or broader matters. This approach has been taken on advice from the many Aboriginal stakeholders consulted over the course of the project. Use of either term is not intended to exclude or marginalise any Aboriginal and/or Torres Strait Islander peoples of Australia.

Executive summary

The project *Embedding Indigenous Perspectives into Engineering Education* commenced in August 2013 with the intention of developing an approach to Indigenous student support that is integrated within existing engineering curricula. The project has delivered:

1. A model for the development and implementation of engineering and technology oriented curricula that accommodates different ways of perceiving and valuing ideas, objects and contexts.
2. A set of guidelines detailing Aboriginal cultural values and their relationship to engineering education and engineering epistemology for the purpose of integrating Aboriginal perspectives.
3. An elective subject at the lead institution that links Aboriginal perspectives on country and connectedness to local engineering projects.
4. A model for continuing engagement between Engineering Faculty and Aboriginal Community.

The project involved three dimensions: a culturally sensitive exploration of Aboriginal values, perspectives and their meaning in engineering practice and the classroom; a constructivist approach to revising curriculum design for existing engineering subjects to accommodate different ways of perceiving and valuing ideas, objects and contexts; and, an innovative approach to course content design to introduce Aboriginal cultural appreciation for both Indigenous and non-Indigenous students.

An interdisciplinary approach was taken, with the team itself consisting of academics from engineering, education, archaeological, business, science and anthropological backgrounds, and Indigenous and non-Indigenous members. Input was also actively sought from individuals outside higher education including practicing engineers, heads of industry, and Aboriginal community leaders. Over the project's duration, the project team worked closely with Aboriginal communities, academic and teaching staff involved with engineering education, and undergraduate engineering students. The team placed a high priority on engaging with 'grass-roots' communities to understand the challenges that students may face in entering and completing engineering studies.

The work undertaken through the project resulted in a range of complex issues to be addressed in the embedding Aboriginal perspectives. Engineering education, in comparison to other fields, is in the early stages of considering the relevance of Indigenous Australian cultures and knowledge to its body of knowledge. Similarly, the implications for staff and students in providing effective student support are not yet well understood. Workshops held over the course of the project, and interviews with engineering academics, have identified that, at this time, the key need is to 'start' the conversation, rather than progress or refine it. Through workshopping with Indigenous and non-Indigenous academics and extensive

collaboration with Aboriginal communities in the Illawarra and South Coast of NSW, five elements were identified as critical for establishing any new initiatives. These were:

1. Redefining the purpose of embarking on the process of embedding Aboriginal Perspectives.
2. Understanding and articulating the relationship between Aboriginal world-views and the engineering method.
3. Exploring and appreciating Aboriginal worldviews.
4. Engaging Aboriginal stakeholders in the process in a meaningful and respectful way.
5. Developing the educational experience for students.

The vital importance of accommodating local contextual factors became very apparent. Various definitions and models for articulating Indigenous worldviews highlight the importance of place and relationships (between people, and between people and place). The project team came to appreciate that this means all initiatives seeking to incorporate an Indigenous worldview must pay respect to local issues, priorities and leadership structures. With input from Yuin community local to the lead institution, the team developed a visual representation of how these five elements fit together in the context of curriculum development and creation of educational experiences (Figure 1)
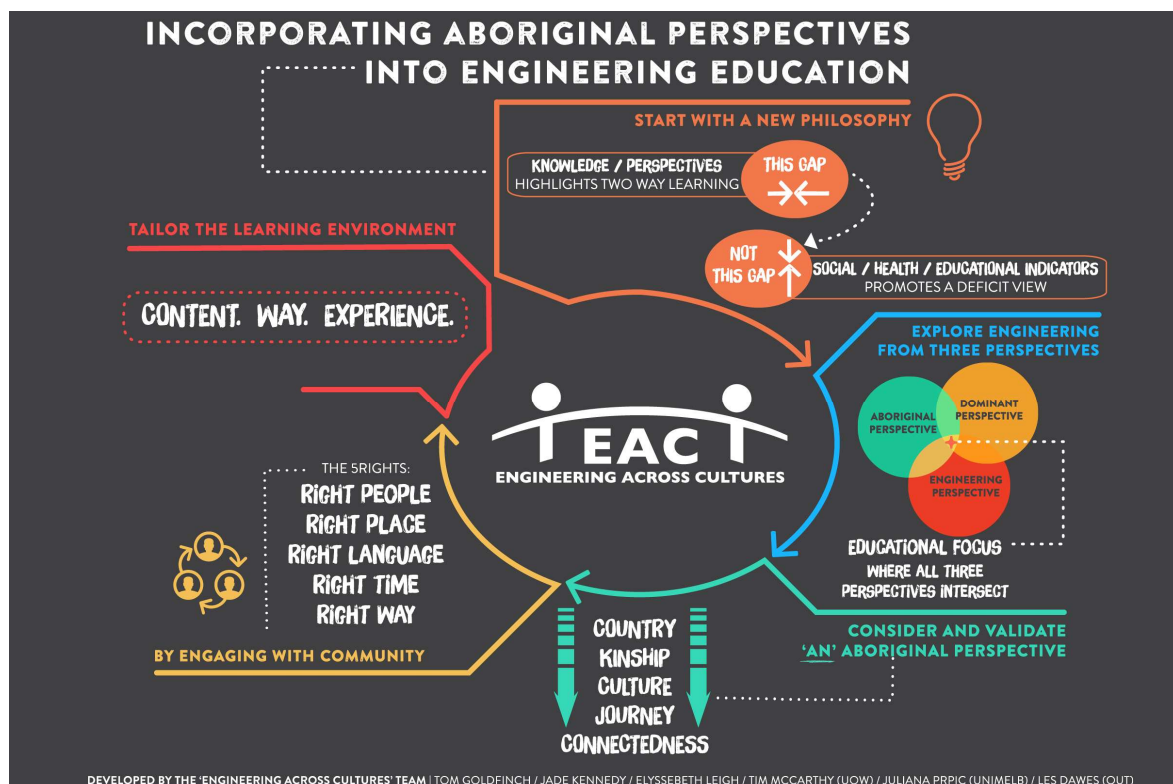
Figure 1 Visual 'map' for guiding curriculum development and creation of educational experiences

Each component is described in 'A Beginners Guide to Incorporating Aboriginal Perspectives into Engineering Curricula' (see Appendix C). This guide has been written for an engineering academic audience to assist them in starting the conversation. The full guide and an

annotated version of the model in Figure 1 is also available at the website indigenousengineering.wordpress.com. The model, the guide, and the underpinning principles have informed the implementation of student learning experiences that have so far been delivered to over 700 undergraduate engineering students from August 2013 to December 2015.

This project has set about reshaping the conversation around Indigenous inclusion in engineering education by focusing on the embedding of Aboriginal perspectives in curricula. Close engagement with Aboriginal communities in the Illawarra and South Coast of NSW has seen a strong positive response from continued consultation. This project has shown that there are benefits to all students' preparation for practice through careful exploration of culture, heritage and priorities in the context of engineering projects. Focus must remain on valuing the contribution to be made to engineering education and the profession to better position engineering as a viable career path for Indigenous students in the future. The project team strongly believes that ongoing collaboration between engineering faculties and schools and Indigenous community groups is the key to meaningful embedding of Indigenous perspectives into curricula.

At the completion of this project, the following recommendations are made to focus ongoing work and to capitalise on outcomes of the project.

Recommendation 1
That Engineering Faculties and schools work towards formalised, long term engagements with Indigenous groups, particularly those involved in consultation processes in engineering projects. This must be viewed as a shared responsibility of academic staff and faculty and school leadership.

Recommendation 2
That leadership bodies within engineering education and practice support Engineering Schools and Faculties to build links with Indigenous community groups through formal commitments, position statements, and facilitating connections with existing corporate-community partnerships in industry.

Recommendation 3
That peak bodies involved in engineering education, including The Australian Council of Engineering Deans, Engineers Australia, and the Australasian Association for Engineering Education move beyond participation targets and actively promote the need to incorporate Indigenous perspectives into engineering education for the benefit of all students.

Recommendation 4
That a central online hub be established to share and showcase successful examples of embedding of Indigenous perspectives in Engineering, Science, and Technology related fields in both educational and industry contexts.

Recommendation 5

That further research be undertaken to explore the nature and extent of Indigenous Engineering pre and post-colonisation to better understand how Indigenous perspectives shape practices and influence outcomes of engineering.

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1. Project Overview

The project *Embedding Indigenous Perspectives into Engineering Education* commenced in August 2013 with the intention of developing an approach to Indigenous student support that is integrated within existing engineering curricula. The project has delivered:

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2. A set of guidelines detailing Aboriginal cultural values and their relationship to engineering education and engineering epistemology for the purpose of integrating Aboriginal perspectives.
3. An elective subject at the lead institution that links Aboriginal perspectives on country and connectedness to local engineering projects.
4. A model for continuing engagement between Engineering Faculty and Aboriginal Community through a formal Memorandum of Understanding.

The project was premised on the fact that despite numerous outreach initiatives, financial support opportunities, and industry drivers, Indigenous participation in Australian engineering degree courses remains persistently low. 2011 Census data indicate that just 0.13% of professionals with a Bachelor degree in engineering and related technologies identify as Aboriginal and/or Torres Strait Islander (ABS, 2011). Furthermore, there was little evidence to suggest that Indigenous perspectives had been explored with respect to engineering.

In terms of Engineering Education, there are unique challenges faced by Indigenous students in engaging with STEM curricula (Appanna, 2011). Western cultures which have shaped engineering education in Australia emphasise facts and concepts in a decontexualised manner. In contrast, Indigenous worldviews tend to emphasises value, spirituality and holistic understandings (NTDEET, 2006, in Apanna, 2011). The clash of cultures can create significant challenges in education when these differing values and worldviews are not recognised and accommodated (Prpic & Kanjanapanyakom, 2004). There have been previous efforts to revise engineering curricula to accommodate and/or value different cultural perspectives. However, much of this work has focused on globalization and the international nature of the engineering profession (Abuodha, Layton, & Goldfinch, 2011; Becker, 2006; Goldfinch, Layton, & McCarthy, 2010; Lohmann, Rollins, & Hoey, 2006; Rhamdhani, Salehi, Wong, Kapoor, & Vakhguelt, 2009).

This project was also driven by recommendations from the Review of Higher Education Access and Outcomes for Aboriginal and Torres Strait Islander People Final Report (Behrendt, Larkin, Griew, & Kelly, 2012). The first of these was Recommendation 18:

That universities develop and implement an Aboriginal and Torres Strait Islander teaching and learning strategy across a range of curriculums, focused on standards of excellence as applied to other curriculum content and feeding into descriptions of graduate attributes, with an initial focus on priority disciplines to close the gap such as teaching and health professions.

This project focused on engineering as a priority discipline, developing curriculum design strategies and examples for incorporating Indigenous perspectives in teaching and learning approaches. The project also progressed towards Recommendation 32:

That universities continue to develop and implement a range of strategies to improve the cultural understanding and awareness of staff, students and researchers within their institution, including the provision of cultural competency training.

This was achieved through the production of a guide for educators to incorporate Aboriginal perspectives in engineering education.

1.1 Project approach

To achieve the stated deliverables the project involved three dimensions: a culturally sensitive exploration of Aboriginal values, perspectives and their meaning in engineering practice and the classroom; a constructivist approach to revising curriculum design for existing engineering subjects to accommodate different ways of perceiving and valuing ideas, objects and contexts; and, an innovative approach to course content design to introduce Aboriginal cultural appreciation for both Indigenous and non-Indigenous students.

As Indigenous student enrolments in engineering remain low, the approach sought to develop an engineering education experience that is supportive of non-Indigenous students developing their understanding and appreciation of Indigenous Australia and Indigenous students exploring their identity within the engineering profession. The development of inclusive curricula was intended to lay the foundations for closer engagement between engineering education and Indigenous Communities, leading to improved access and retention for Indigenous students in the years ahead.

The project aimed to identify ways to help both engineering educators and students build their own understanding of concepts pertinent to notions of Aboriginal engagement with engineering. Thus the design of relevant materials and strategies was highly focused on active engagement rather than transmission of information. This choice grew out of the project team's emerging awareness that Aboriginal learning strategies are more active than passive. Examples modelling this approach in education areas other than tertiary level study were identified (Department of Education, 2016), but few in tertiary contexts, and no specific engineering examples. In academic contexts research on similar topics is more usually confined to theoretical and abstract level of attention to related issues (Universities Australia, 2011). For example the Review of Higher Education Access and Outcomes for Aboriginal and

Torres Strait Islander People (Behrendt et al., 2012) provides a clear and detailed policy document with excellent and wide ranging policies for implementation. However it does not attend to detailing how policies can be translated to classroom contexts where all such policies encounter the reality of teaching and learning. The application of constructivist principles in this project led to a focus on education for all students – and a shift away from focusing only why there are so few Aboriginal and Torres Strait Islander students in engineering classrooms.

1.2 Stakeholder Engagement

The project team took an interdisciplinary approach to the project. The team itself consisted of academics from Engineering, Education, Archaeological, Business and Anthropological backgrounds and met weekly to ensure the project was guided by a diversity of perspectives and methodologies. Input was also actively sought from individuals outside higher education and academia. This included practicing engineers, heads of industry, and Aboriginal community leaders. Over the project's duration, the project team worked closely with Aboriginal Communities outside Higher education, Academic and teaching staff involved with engineering education, and undergraduate engineering students.

1.2.1 Aboriginal Communities

The team placed a high priority on engaging with 'grass-roots' Aboriginal community to understand the challenges that students may face in entering and completing engineering studies. This approach also allowed the team to learn how to effectively engage with Aboriginal Community. A process of continuous consultation with Aboriginal elders and community of Yuin Country (Illawarra and South East coast of NSW) was employed throughout the project. Informally, this was carried out through community and familial relationships held by the project leaders. This continuous, informal engagement led to a series of more formal meetings with members of the project team, and Faculty leaders at the lead institution. Community Leaders and Elders from this region advised on project activities, contributed directly to teaching at the lead institution, and instigated a process for signing a Memorandum of Understanding with the University of Wollongong.

Importantly, key community organisations engaged in the project were the Illawarra Local Aboriginal Lands Council and the Sandon Point Aboriginal Tent Embassy. Both of these organisations have been heavily involved in negotiations with government and private sector organisations around development of engineering projects. This provided the project team with an important perspective on Community priorities that project engineers and site engineers are required to deal with.

Efforts were also made to engage Community groups and Indigenous academics at partner institutions and other universities. Again, particular focus was on engaging groups who have direct involvement in large engineering projects. However, without prior established relationships, turning these engagements into outcomes has been difficult within the funding

period. Reflections on the projects' successes in engaging with Aboriginal community at the lead institution have been documented in the creation of 'A Beginners Guide to Incorporating Aboriginal Perspectives into Engineering Curricula', available at Indigenousengineering.wordpress.com. Engagement with Communities and key individuals at partner institutions is continuing, and has highlighted the need for a long term commitment to establishing productive partnerships.

1.2.2 Engineering Educators

Engineering academics, teaching and curriculum support staff were engaged in the project through workshops, seminars, academic publications, direct communications and a public blog. Workshops and seminars were held in Sydney, Wollongong, Melbourne, Brisbane, Perth, Wellington (NZ), and Torquay. Interim findings, ideas and draft models for curriculum design were presented and developed at these events. Table 1 presents a breakdown of the location, timing, and representation at these events.

Table 1 National Engagement with Engineering Educators (workshops)

Location	Date	Representation
Sydney, UOW Sydney Business School	October, 2014	14 Academics – UNSW, UTS, UWS, UOW, USYD
Melbourne, The University of Melbourne, Parkville	October, 2014	9 Academic Staff – UniMelb, Swinburne, RMIT
Brisbane, Queensland University of Technology	October, 2014	10 Academic Staff – QUT, UQ
AAEE Annual Conference, Wellington NZ	December, 2014	21 Academic Staff – 14 institutions
Perth, The University of Western Australia	February, 2015	22 UWA Academic Staff, 2 external individuals
Wollongong, University of Wollongong	April, 2015	14 Academic and professional staff
AAEE Annual Conference, Torquay, VIC	December, 2015	25 Academic Staff – 15 institutions

The Curriculum Model developed in the project was also tabled at the 2015 National Indigenous Engineering Summit hosted by the University of Melbourne in June 2015. This event was attended by over 100 delegates from higher education, government, not-for-profit organisations and Industry.

Project outputs were also communicated to the engineering education and broader academic community through paper presentations at four national conferences. These presentations were typically to audiences of 20-30 individuals from various institutions. Details of these papers are presented in Table 2.

Table 2 National Engagement with Engineering Educators (Conference Presentations)

Location	Date	Paper Title
Australasian Association for Engineering Education Annual Conference, Gold Coast, QLD	December, 2013	Understanding Indigenous consultation and engagement in engineering education
Australasian Association for Engineering Education Annual Conference, Wellington, NZ	December, 2014	Paper 1: Australian Indigenous Culture and Heritage in Engineering Project Planning and the Implications for Engineering Education Paper 2: Shared Values: Diverse perspectives – engaging engineering educators in integrating Indigenous engineering knowledge into current curricula
Indigenous Content in Education Symposium, Adelaide, SA	September, 2015	Beginning from a knowledge perspective - re-thinking Aboriginal engineering
Australasian Association for Engineering Education Annual Conference	December, 2015	Shifting the Focus. Incorporating Knowledge about Aboriginal Engineering into Main stream Content

A public blog, Indigenousengineering.wordpress.com, was maintained throughout the project. Posts presented interim updates on the project team's development of a model for Incorporating Aboriginal perspectives into engineering curricula, as well as outcomes of project events.

1.2.3 Engineering students

Students were engaged in the development of project outputs primarily through for-credit student projects. Projects focused on the intersection of Aboriginal goals and priorities and contemporary engineering practice (further details in 2.2 and 2.5 below). This enabled the team to observe student responses to various approaches and informed the development of the curriculum development model.

1.2.4 External Stakeholders

Opportunities arose throughout the project to engage with other parties involved in consideration of Indigenous perspectives from and engineering design and project management perspective. Feedback on project directions was sought from practicing engineers, community liaison staff, and engineering managers.

2. Project Findings

The work undertaken through the project resulted in a range of complex issues to be addressed in the embedding of Indigenous perspectives. Engineering Education, in comparison to other fields, is in the very early stages of considering the relevance to its body of knowledge, of information about Indigenous cultures and knowledge. Similarly, the implications for staff and students in providing effective student support are not yet well understood. Workshops held over the course of the project, and interviews with engineering academics, have identified that, at this time, the key need is to 'start' the conversation, rather than progress or refine it. Through workshopping with Indigenous and Non-Indigenous academics and extensive collaboration with Aboriginal Community in the Illawarra and South Coast of NSW, five elements were identified as critical for establishing any new initiatives. These were:

1. Redefining the purpose of embarking on the process of embedding Aboriginal Perspectives.
2. Understanding and articulating the relationship between Aboriginal world-views and the engineering method.
3. Exploring and appreciating Aboriginal Worldviews.
4. Engaging Aboriginal stakeholders in the process in a meaningful and respectful way.
5. Developing the educational experience for students.

Overall, the vital importance of accommodating local contextual factors became very apparent. Various definitions and models for articulating Indigenous worldviews highlight the importance of place and relationships (between people, and between people and place). The project team came to appreciate, and emphasise in all project outcomes, that this means all initiatives seeking to incorporate an Indigenous worldview must pay respect to local issues, priorities and leadership structures. With input from Community, the team developed a visual representation of how these five elements can usefully be fitted together for the kinds of academic purposes that engineering educators will be seeking to implement (see Figure 1).

Each component is described in full in 'A Beginners Guide to Incorporating Aboriginal Perspectives into Engineering Curricula' (see Appendix D). This guide has been written for an engineering academic audience to assist them in starting the conversation. A summarised version of the model underpinning this guide is also available at Indigenousengineering.wordpress.com. Below is a detailed overview of how each of these five elements were explored and refined.
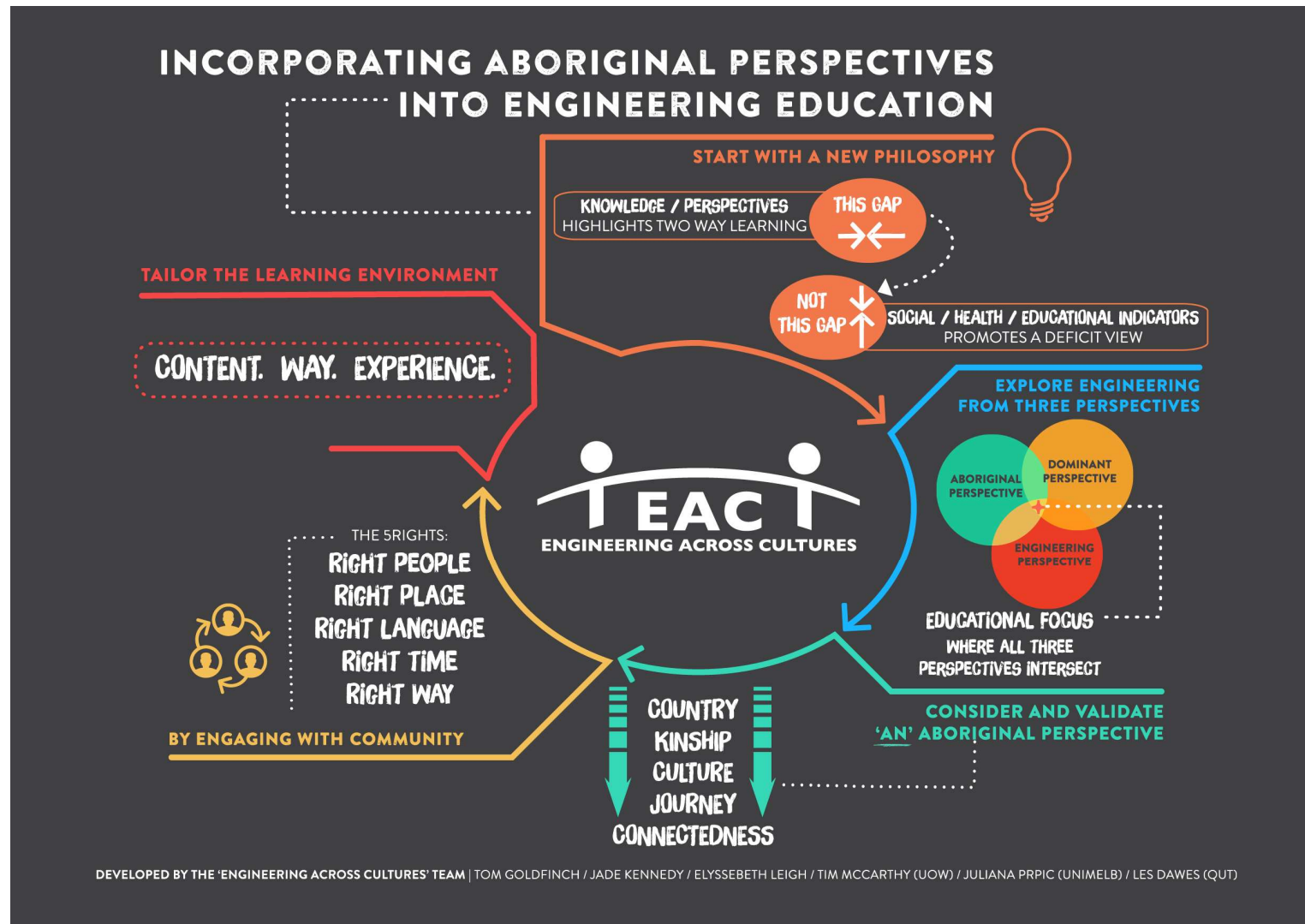
Figure 1 Curriculum design model for incorporating Aboriginal perspectives

2.1 Redefining the purpose of embarking on the process of embedding Aboriginal Perspectives

A review of existing work in this area revealed that within Engineering Education, initiatives to engage with Indigenous Communities have tended to focus on outreach, student recruitment, and the provision of scholarships (Engineers Australia, 2015b; Eineering Aid Australia, 2013; Goldfinch & Kennedy, 2013). While some evidence is offered on the effectiveness of these approaches, no reports on further impacts on curricula-embedded support were located by the project team.

Investigation of related work in other fields – health, mathematics, and science – revealed an interesting array of ways of paying attention to Indigenous knowledge of natural phenomena and how this may inform western scientific understandings. One of the most pertinent was found in the work of Michael Cooke (1990) who emphasised that:

> *by removing words, concepts, and structures from their Aboriginal context and putting them into a European box called 'mathematics', I have inevitably lost much of the full significance of their meaning and have certainly not done justice to the intricacy and complexity of the Yolngu world.*

This has been developed quite extensively in work about Ethnomathematics as documented on the Australian Institution of Aboriginal and Torres Island Studies web site (Rudder, 2016), noting that:

> *Early Western researchers were concerned primarily with quantities and studied Indigenous Australians' use or lack of use of numbers. Rarely was the question asked as to whether the Indigenous terms being spoken about were actually numbers or even part of a number system. The general assumption of researchers from the eighteenth century until the mid-twentieth century was that they belonged to an impoverished version of a number system.*

In effect mathematics researchers exploring the issue of Aboriginal knowledge of maths principles have been reconfiguring their thinking about such concepts. However such work has not yet widely influenced related disciplines, including engineering. There has not yet been enough effort to move perceptions beyond that 'impoverished version' to a more accurate view of the real nature of Aboriginal mathematics. This is typified by the way in which Jared Diamond, a highly respected researcher and author, could mistakenly represent Australian Aboriginal society as unable to develop 'writing or politically complex societies' (Diamond, 1997, p311). As the team worked to address this lack of knowledge about Aboriginal engineering, it became clear that a new perspective was overdue and led to exploration of what such a term might encompass.

Archaeologically identified engineering sites

Australian archaeologists, and other researchers, have mapped numerous Indigenous sites across Australia demonstrating extensive and sustained knowledge of architecture and a range of engineering knowledges, among other disciplines. For example there are more than 200 known Aboriginal mining sites in NSW and, at Wilgie Mia in Western Australia, is one of the oldest known mines, which was still operating in the 1920's after almost 8,000 years of operation. At the site known as Budj Bim, in the region of Lake Condah, Western Victoria is an extensive example of water management which was recognised in 2011 as an Australian Engineering heritage site by Engineers Australia (Jordan & Corporation, 2011). This is now being considered for nomination as a World Heritage site (Engineers Australia, 2015a). At a similar water management site near Brewarrina, NSW (Department of the Environment, 2015), indications are that the engineering knowledge required for such large constructions was shared across great distances around the continent and applied to local conditions with care for the environment. More recently than such constructions, the work of prominent Aboriginal engineer David Uniapon has become widely acknowledged for his contributions to Australian Engineering Innovation.

Further exploration of Indigenous industry and technologies revealed many examples which, viewed through an engineering perspective, represent complex, and often large scale examples of pre and colonial engineering, much of which continued for some time after the arrival of Europeans. These have been publicised recently by Pascoe (2014) and Gammage (2011) in their respective explorations of Aboriginal agriculture and the continent wide use of fire for land management.

As all this information was gathered, it became apparent that any attempt to explore Indigenous perspectives in engineering curricula must recognise the potential contributions of Indigenous knowledge to the discipline. Rather than focus on incorporating Indigenous perspectives as a means of providing socioeconomic benefit to Indigenous Australians, the project shifted focus to exploring the benefits to the engineering profession of having greater participation by Indigenous Australia. Thus the work of the team concentrated on reducing, as least somewhat, the knowledge gap within the engineering profession about Aboriginal engineering accomplishments. The hope is to lead to cessation of regarding the 'Gap' as something to be remedied by means currently prescribed in government policy (Altman, 2009; Department of Families, 2010; Department of Prime Minister and Cabinet, 2015). This represents a significant change in direction from previous efforts in engineering education, and brought with it a new understanding of the paucity of knowledge on the part of Australian engineers about the achievements of the civilisation that pre-dated European arrival by millennia (Leigh, 2015; Leigh et al., 2014).

2.2 Understanding and articulating the relationship between Aboriginal world-views and the engineering method.

Exploration of Aboriginal engineering examples raised two key considerations, the first concerns the need to consider how Aboriginal engineering is derived from an Aboriginal worldview, and second how this is, and can be, related to modern Australian engineering practice. Concurrently, the projects' close engagement with Aboriginal Community in the Illawarra, and the Illawarra Local Aboriginal Lands Council (ILALC) brought attention to a number of contemporary engineering projects where challenging negotiations and occasionally tense standoffs between community and proponents of development had occurred. These scenarios frequently involved engineers working on the project directly. These cases brought attention to the way in which underlying tensions in contemporary interactions between modern engineering projects and Aboriginal communities were embedded in the very different worldviews held by members of each party. This awareness contributed to development of an approach to designing an engineering course unit through which engineering students can explore the intersection between engineering practices and Aboriginal worldviews.

This emerging awareness also helped form the orientation of first year and final year engineering student projects. A first year project strategy required students to develop designs for technologies and infrastructure for use on an existing Aboriginal Community-run site. Students were introduced to the nature of the issues described above, and then required to consider Aboriginal priorities for the site, as these were articulated by members of the community. This also involved working out how to do so while complying with concurrent requirements established by the relevant local council, and engaged them in considering, and working out how to balance, the competing demands placed on them as engineers (Goldfinch & Kennedy, 2013). Final year projects pushed students to consider and critique current practices in engineering industry in the preservation and management of Aboriginal Cultural Heritage impacted upon by projects (Goldfinch, Ilango, Roland, & Willis, 2014). Feedback from students suggested that this approach to introducing Aboriginal perspectives was seen as relevant, and a valuable addition to their preparation for practice.

Consideration of how to articulate the approaches described above in terms of a curriculum model initially focused on what were later defined as 'dominant' and 'Aboriginal' perspectives. This established an 'either/or' false dichotomy with the potential to create a dead-end of mutually exclusive positions, particularly in the context of engineering education where there is little current influence from any Aboriginal perspective. Further investigation identified that professions tend to acquire a distinctive point of view as a result of their training, and that an Engineer's perspective cannot simply be subsumed under either one or other of the 'dominant' or 'Aboriginal' perspectives. Engineers are problem solvers, utilising scientific principles and the engineering method to develop technical solutions for particular purposes (Engineers Australia, 2011). An Engineering Perspective is distinct from both

'Aboriginal' and 'dominant' perspectives in that those who acquire it view things differently from those who do not have it. This led to an exploration of perspectives as having 'both/and' characteristics. It is possible to have a 'dominant' perspective and also an 'engineering' perspective; and it was equally evident that an 'Aboriginal' perspective and an 'Engineering' perspective will co-exist.

This led to identification of the fact that three different perspectives must be considered in unison for engineering educators to establish the value and usefulness of incorporating Aboriginal perspectives into their curricula. A simple Venn diagram was employed as a means of developing a useful conceptualisation of the relationships among these three perspectives (see Figure 1).

To validate this approach, five workshops were held with engineering educators in Sydney, Melbourne, Brisbane, Perth, and Wellington (NZ) to explore this Venn diagram concept. Participants were asked to consider an artefact (an object or project) from one of three perspectives. Outcomes from these workshops suggested that this model was useful in helping participants to recognise Aboriginal perspectives has engineering merit, and also to unpack dominant cultural influences on the process and outcomes of engineering endeavour. These workshops also highlighted engineering academics willingness to explore and seek guidance on Aboriginal perspectives once the relevance to contemporary engineering practice was established.

2.3 Frameworks for exploring and appreciating Aboriginal Worldviews

Once the need to value an Aboriginal perspective in relation to contemporary engineering had been established, the issue of how to adequately define an Aboriginal Perspective for educational purposed arose. Defining and Aboriginal worldview is complicated by the diversity of traditional and contemporary culture. Various expressions of an Indigenous worldview have been published elsewhere, and while they each present similar fundamental principles, they differ in their subtleties and applicability to different Indigenous nations (Graham, 2008; Kennedy & Hoynes, 2010; Kennedy, Hoynes, & Pratt, 2010; Nakata, 2010). Early on it was emphasised by Aboriginal Community engaged in the process that such matters are rarely captured in writing. In fact, phrases such as 'that's not written in any book' are often used to emphasise the truth and authenticity of a fact, signalling that the fact in question has not been subject to reinterpretation by non-Indigenous people.

The project team recognised that any written articulation of an Aboriginal worldview produced as part of this project could only be used as a guide and a starting point. For this purpose, a written articulation of an Aboriginal worldview previously developed by the project Co-leader in consultation with Yuin Elders (Kennedy et al., 2010) was adopted and further developed. This framework is structured around five key concepts: Country, Kinship, Culture, Journey and Connectedness. It is presented in more detail 'A Beginners Guide to

Incorporating Aboriginal Perspectives into Engineering Curricula'. It is emphasised in this guide that this is 'An' Aboriginal worldview, and only to be used as a starting point to inform further engagement with Aboriginal people with knowledge and status relevant to the educational context. Those seeking to embed Indigenous perspectives will need to build relationships to inform their own understanding and valuing of an Indigenous worldview.

2.4 Strategies for engaging Aboriginal stakeholders in the process in a meaningful and respectful way

Building the necessary relationships with Aboriginal Community is the most challenging aspect of embedding Aboriginal perspectives. As the project team discovered in trying to build ties at partner institutions QUT and UniMelb, identifying the right people, building trust, and establishing mutually beneficial goals is a long term process. The project was able to build on pre-existing relationships at the lead Institution, UOW, a factor critical to the outputs of the project. Analysis of how these relationships at the lead institution were built and converted into productive outcomes led to the articulation of a simple checklist-type framework. This framework is intended to assist others on the same journey to understand the opportunities and roadblocks to building working relationships, and provides a reflective tool to understand why things are or are not progressing. The framework is called the 'five rights': right people, right place, right language, right time, and right way. The framework has the endorsement of a number Yuin elders, and as with other aspects of the project is articulated using the term 'Aboriginal', rather than 'Indigenous' on their advice. Each element is described in brief below, with further detail in Appendix D.

Right People

All consultation efforts require the right people. Aboriginal hierarchal structures are unlike those of the dominant Australian culture, and are not necessarily consistent from community to community. Although there is a decent understanding that Eldership within Aboriginal communities defines decision-making power, Elders are not necessarily the right people to approach when first considering how to begin. Possessing a clear understanding of what is to be achieved is essential for identifying the right people to engage with. As this project focused on the intersection between Engineering and Aboriginal Communities, the project team sought to work closely with Community groups engaged in land use negotiations in large engineering projects, such as Lands Councils and groups registered in community consultation processes.

Right Place

Place is one of the most significant physical and spiritual ideologies for Aboriginal people since it is related to *Country*. Successful engagement with the 'Right' Aboriginal people must be built on an appreciation of the extent to which *place* is a significant contributor to building positive relationships. For this project, engaging in the 'right place' meant frequent trips to

locations of importance to the purpose of the engagement, eg. Sites to be considered in student projects, significant Aboriginal places, Community centres, and Lands Council offices. Meetings were also arranged on-campus where the primary purpose of engagement concerned the University itself. As was observed, 'place' had an important influence on the tone and direction of meetings, and meeting off-campus was critical to the learning experience of non-Indigenous project team members and students.

Right Language

All engagement requires a diplomatic approach to ensure success. Aboriginal people emphasise the importance of oral history, so using the *Right Language* is a principal tool of diplomacy. Many Aboriginal community members engaged in this project, expressed frustration from talking to representatives from government and other institutions. In the academic setting, concerns were expressed about misrepresentation and appropriation of stories, knowledges and communities by academia. The history of engagement with formal education also meant that in some instances individuals may have been uncomfortable as a result of their own experiences. Using the right language requires careful attention to others conversation, and a lot more listening that talking. As explained in 2.1, learning the right language so as not to present as 'all-knowing' or 'keen-to-help' requires recognition by academic staff that they have much to learn, much more than they might expect at the outset.

Right Time

For Aboriginal people there is a strong understanding that knowledge and learning are handed down through time. Consideration of when is the *Right Time* is more than a process of ascertaining the best day or hour to engage. It includes acknowledging that 'time' equals showing respect. Time is valuable to all people and it must be acknowledged that that there may be a different value placed on time for Aboriginal people when engagement or consultation is taking place. It is also important to consider that whatever the reason you are seeking to engage people's time, they are likely to have other competing priorities that emerge at any time. Patience, and a long term view are essential. Right time is both a consideration of the right moment to do something, and the commitment to seeing it through, regardless of timeframes. To express this concept in a sharp, but blunt form for Academics and Higher Education leaders:

Aboriginal people, their priorities, their knowledge, do not cease to be because your funding period ended…

Right Way

The Right Way acknowledges that -

- the Right People have been consulted
- in the Right Place

- with the Right Language
- at the Right Time

It is a term widely used by Aboriginal people to recognise the appropriateness of one's behaviour. The term is often expressed in an off-the-cuff manner, not formally applied, but delivered humbly through conversation with respect and appreciation. As the project team experienced, hearing this phrase is the strongest suggestion that the right approach to engagement is being undertaken.

2.5 Developing the educational experience for students

An important aspect of the project was to demonstrate how the elements above could be incorporated into engineering education. Given the importance of respecting the 'right way', this involves a shift in the modes of teaching required to authentically model Aboriginal forms of knowledge and methods of guiding learning. These teaching and learning modes equate more closely to what is now called 'discovery learning', and immersive engagement with Aboriginal forms of learning does not begin with knowledge content. It starts with practice and exploration. As learned from the project's ongoing engagement with Aboriginal community, these modes of teaching and learning are about leading by example, providing ways for students to figure things out for themselves and allowing learning to evolve within the individual student. As such any authentic engagement with Aboriginal perspectives involves an approach quite different from the teaching modes familiar to many engineering educators. Thus the focus is less about providing new knowledge than it is about encouraging skill and awareness development through first-hand experience. The general approach presented from the project is detailed in 'A Beginners Guide to Incorporating Aboriginal Perspectives into Engineering Curricula'. In summary, the approach involves three aspects, Content, Way, and Experience:

Content

Knowledge about Aboriginal perspectives has been included in academic disciplines such as education, health and law for several years now; and there is a general trend within the higher education sector to increase the emphasis on Aboriginal perspectives in all disciplines. However in many cases this has meant finding appropriate case studies and information about examples of Aboriginal culture in the form of content to be added into conventionally structured subjects, without substantially altering the mode of delivery. It was emphasised to the project team by community that such an approach can result in misappropriation and misrepresentation, especially when there is no local engagement with the people about whom information is being presented. This can be offensive (however unaware and unintentional) and contribute to a further disparity between Aboriginal and non-Aboriginal communities. The General principle recommended in the guide is that content, is limited to contextual information that aides engagement with a curriculum design more closely aligned with the Aboriginal ways communicated to the project team.

Way

Modern theories of learning and teaching have various names including 'constructivist', 'participatory', and 'action-oriented'. Collectively they draw attention to the learner as the essential focus of educational activity. Their theme is described by users as '*teach the student not the subject' (McComb, 2016)* and by researchers as requiring attention to *Aligning assessment with long-term learning* (Boud & Falchikov, 2006). In effect the proposition is that ways of engaging with learning must involve more active modes of engagement including story-telling, exploration (guided and unguided), and use of puzzles with known solutions as well as problems with no known answers. The role of the academic educator shifts towards facilitation of learning and relationships with Aboriginal community such that the approach:

- Involves local Aboriginal people as both learners and educators, by enabling students and community members to work collaboratively on student projects.
- Respects the three perspectives (Dominant, Engineering, Aboriginal) in order to assist all parties gain insights into each others' basic thinking parameters and the impact of those on actions.
- Assists students to learn how future workplaces will require them to balance decision-making among the demands of multiple stakeholders.

Such an approach reverses the purpose of many current engagements between higher education and Indigenous community by positioning community members as student mentors.

Experiences

Students' journeys in the academic learning space will be varied and are always highly individual. Their experiences will shape their approach to learning as well as their relationships with others – staff, students and Community members. Providing students with direct experiences of engaging with Aboriginal community partners allows these journeys to evolve in diverse and unique ways. While this means that academic staff may be less able to predict events as they unfold, it also means that students can learn the outcomes of their own actions in a supportive environment. It also creates space for student to develop relationships that may continue to guide their approach to engaging with Aboriginal communities in a future professional setting.

3. Major Project Outputs

3.1 A model for incorporation of Aboriginal perspectives in engineering education

The Infographic presented in figure one is seen as a major output of the project. The model represents an accessible one-pager, acting as a roadmap to the complex range of considerations required to go about embedding Aboriginal perspectives in curricula. The model has been distributed widely within the Australian Engineering Education community, through conference presentations and workshops, and the 2015 National Indigenous Engineering Summit hosted by The University of Melbourne.

Project evaluator, Dr. Lesley Jolly, used this model as a focus for evaluation of the potential impact of the project. Dr. Jolly's report is included in Appendix C. Outcomes of the evaluation, as well as the consultation conducted by the project team indicate that the model is successful as a tool to highlight the complexity of what needs to be done. As expected, further detail is required to explain each of the elements of the model, which is the purpose of the 'Beginners Guide to Incorporating Aboriginal Perspectives into Engineering Curricula'. Further support is also likely to be required to help engineering educators to put this model into action.

3.2 'A Beginners Guide to Incorporating Aboriginal Perspectives into Engineering Curricula'

As one of the key project deliverables, this guide has been created to assist engineering educators in beginning the process of embedding Aboriginal perspectives into engineering curricula see https://indigenousengineering.wordpress.com/ the guide is an outcome of the project team's engagement with Illawarra and South Coast NSW communities, and has drawn heavily from their input.

The Guide has been written to capture both an Aboriginal and an Academic voice. It represents a lengthy process of mutual learning to define terms, link ideas and ideals, and present these in a manner that is acceptable to Community as well as accessible to Engineering Academics in particular. While the primary focus of the guide is on engineering, reconsideration of the intersection between Engineering, Aboriginal, and Dominant perspectives for other related fields like mathematics based disciplines, science, technology, and design fields is possible.

A draft form of the guide was tabled at a workshop comprised of individuals responsible for the design and delivery of undergraduate engineering education. Feedback to date indicates that this has prompted some individuals to try different approaches to incorporating Indigenous perspectives in their curricula at at least three institutions outside partners in this project.

Subsequent to its release and beyond the funding period, the project team have committed to monitoring and supporting the use of the guide by engineering educators. The team is keen to ensure that it is used appropriately, and that the core message emphasising the importance of working directly with Indigenous Communities has been heard.

3.3 Student experiences

Engineering students were key stakeholders as the ultimate beneficiaries of the project. Table 3 presents a summary of learning opportunities provided to students over the course of the project. In the case of the lead institution, each of these learning opportunities involved close support from the Project co-leader and active member of the Illawarra Aboriginal Community Jade Kennedy, plus other members of community as opportunity arose. In most cases, Mr Kennedy would act as an intermediary between students, staff and the Community to relay questions from students and priorities of the Community.

Table 3 Summary of learning opportunities

Subject	Years run	Overview	No. of students
ENGG154 Engineering Design and Innovation	2013, 2014	Design project partnered with Community	Approx. 700 over 2 years
ENGG456 Engineering Project	2014-2016	Final year project – Investigation of current Industry practices in managing Aboriginal Cultural Heritage in Engineering projects	16
ENGG456 Engineering Project	Spring 2015	Simulated tender process for design and build contract involving Indigenous, Non-Indigenous and Government stakeholders.	6
ENGG452 Thesis	2015-2016	Honours Thesis investigation of current Industry practices in managing Aboriginal Cultural Heritage in Engineering projects	3
ISIT351 Information Technology Project	2015	Final year IT project on the appropriate representation of Aboriginal engineering sites	3

3.4 Elective subject

An elective subject was developed as originally proposed, and is currently on offer at the lead institution as an elective for Bachelor of Engineering students majoring in civil engineering, mining engineering, environmental engineering, mechanical engineering, materials engineering, mechatronics engineering, or electrical engineering.

The subject is named ENGG321 Community Stakeholder Engagement in Engineering Projects. It is intended that upon completion of the subject, students will have:
1. Demonstrated understanding of the complex nature of contexts where social and engineering goals may be contentious.
2. Analysed engineering projects in terms of multiple perspectives on preferred outcomes.
3. Presented information successfully to a variety of audiences.
4. Prepared documentation relating to negotiation processes and protocols.
5. Recommended processes and protocols for negotiating outcomes for engineering projects involving Indigenous community stakeholders.

Students undertake a project to develop a protocol for managing Aboriginal Cultural Heritage that falls within the bounds of a proposed engineering project. Students must balance the time, budgetary and technical constraints of the project (engineering perspective), legislative requirements and local government priorities (dominant perspective), and Aboriginal community interests (Aboriginal perspective). The subject uses hypothetical scenarios on real locations, enabling it to draw in individuals from Community who have knowledge of the area to work with students.

The subject has been run in pilot form within a final year project unit, with students undertaking a project to put forward a proposal for community consultation and engineering design of a heritage walk which captures the Aboriginal, Industrial, and Migrant heritage of the area. Materials are available for others to base a similar approach on by request from the project leaders.

3.5 Indigenousengineering.wordpress.com

The project's public blog captures in detail the work underpinning the curriculum design model shown in Figure 1. While the site serves mostly as an easily accessible public archive for the project it has received over 400 views from over 200 individual users. Given the very targeted nature of the content this is seen as encouraging. The blog will continue to be updated and will host the Guide described in 3.1 and other published materials.

4. Project Outcomes

This project has sought to redirect the conversation about Indigenous inclusion in engineering education from one of increasing enrolments of Indigenous students to a conversation about what it means to value greater Indigenous participation in engineering education. Identifying outcomes (or impact) of a project of this nature within the funding period is challenging. However, a number of indicators of wider impact have been identified. Further pursuit of these early signs of broader impact inform the recommendations presented in 5.1.

4.1 Bringing focus to the curriculum

This project is the first to bring significant attention to the issues surrounding meaningful embedding of Indigenous perspectives in engineering curricula. Most importantly, the project has refocused conversation from benefits for Indigenous students and people, to benefits for Non-Indigenous students and the profession itself.

Student led projects have highlighted the challenges practicing engineers face with respect to managing Aboriginal Cultural Heritage appropriately. This includes:

- Awareness of relevant legislative requirements for proponents of engineering projects

- Familiarity with guidelines and examples of industry best practice

- Respecting the importance and value of Aboriginal Cultural sites, artefacts and associations with place.

This student research has led to ongoing research into the issue for the purpose of further informing the design of engineering education.

The focus on educating engineering academics and students has also brought to the fore the need for action and recognition that embedding Indigenous perspectives in curricula is about far more than supporting Indigenous students. Since the project commenced, members of the project team have been invited to contribute to several initiatives, including:

- Contributing to efforts to embed Indigenous perspectives in engineering curricula at three Universities outside the project partners.

- Clean Air and Urban Landscapes (CAUL) Hub Indigenous Advisory Committee

- 2015 National Indigenous Engineering Summit

- Indigenous Engineering Winter School

- 2016 Aboriginal and Torres Strait Islander Mathematics Alliance Symposium organising committee

Most importantly, interviews with participants of a December 2015 workshop where draft outputs of the project were presented indicated that the materials produced were successful in prompting educators to recognise the importance of building the necessary relationships with Indigenous people to inform curriculum development and delivery. It is important that this focus is not lost, and recognition of the long term commitment required is promoted.

4.2 Memorandum of Understanding

As a result of the extended consultation undertaken in the development of the curriculum model and the guide for engineering educators, the project team was approached by a newly formalised Aboriginal group to initiate a process for signing a Memorandum of Understanding. The group is a large, family based organisation from Yuin Country in South-East NSW, with many politically active members. The group has sought a Memorandum of Understanding with the Faculty of Engineering and Information Sciences at the University of Wollongong to, among other goals:

- Ensure authentic representation of Aboriginal perspectives.

- Provide guidance to the Faculty on engaging with Aboriginal Community

- Provide improved opportunities for Aboriginal participation in engineering and other higher studies.

A statement of intent was co-signed by delegates of the group and the Dean of the Faculty in September 2015. The UOW senior executive has supported the transition of the statement of intent to a formal Memorandum of Understanding. A copy of the wording of the signed statement of intent is available by request from the report authors.

This outcome is seen as a very positive response to the way in which the project has been undertaken, with strong regard for Aboriginal Community input. It is hoped that as this formal agreement is enacted, it will serve as a model for other Engineering Schools and Faculties to follow in building and sustaining links with Indigenous Communities.

4.3 Institutional recognition

Several outcomes have emerged as either direct outcomes from project activities, or indirect outcomes from individuals involved in the project. These particular outcomes signal growing recognition of the need to focus on curriculum design and involvement of Indigenous people.

Since beginning her involvement in the project, Dr Juliana Kaya Prpic has been drawn in to contribute substantially to parallel initiatives at the University of Melbourne. These include inspiring Indigenous students to enrol in engineering, through the establishment of the Victorian Indigenous Engineering Winter School, inclusion of Indigenous cultural sensitivity heritage for professional practice in the engineering curriculum, and building connection with between the Melbourne School of Engineering and Indigenous communities to integrate Indigenous knowledge systems, values and philosophies into their teaching. A direct

consequence of her involvement in this OLT project is that the Melbourne School of Engineering has acknowledged the importance of integrating Indigenous perspectives in the engineering curriculum. As a result, several initiatives are currently underway to expand on the OLT project's outcomes. Further, the University of Melbourne is taking a lead role in developing a proposal for a National Indigenous Engineering Resource Hub.

At the University of Wollongong, the model for Incorporating Indigenous Perspectives into Engineering Curricula has been included in the University's Aboriginal and Torres Strait Islander Education, Research and Engagement Strategy. The project's co-leader, Jade Kennedy has also since been appointed as an Indigenous Curriculum Developer within the Faculty of Engineering and Information Sciences to continue the work started by this project. So far this has resulted in contributions to two additional subjects in mining engineering, and a request by the School of Civil, Mining, and Environmental Engineering to contribute to design and management subjects in all its Engineering degree programs.

5. Conclusion and Recommendations

This project has set about reshaping the conversation around Indigenous inclusion in engineering education by focusing on the embedding of Indigenous perspectives in curricula. Close engagement with Aboriginal Communities in the Illawarra and South Coast of NSW has seen a strong positive response from continued consultation, and an interest in contributing to the appropriate preparation for practice of new engineers. The project team strongly believes that ongoing collaboration between engineering faculties and schools and Indigenous community groups is the key to meaningful embedding of Indigenous perspectives into curricula.

While much attention has been paid to outreach and recruitment strategies to the 'benefit' of Indigenous students in the past, this project has shown that there are benefits to all students' preparation for practice through careful exploration of Indigenous culture, heritage and priorities in the context of engineering projects. Focus must remain on valuing the contribution to be made to engineering education and the profession to better position engineering as a viable career path for Indigenous students in the future.

At the completion of this project, the following recommendations are made to focus ongoing work and to capitalise on early outcomes of the project.

Recommendation 1
That Engineering Faculties and schools work towards formalised, long term engagements with Indigenous groups, particularly those involved in consultation processes in engineering projects. This must be viewed as a shared responsibility of academic staff and faculty and school leadership.

Recommendation 2
That leadership bodies within engineering education and practice support Engineering Schools and Faculties to build links with Indigenous community groups through formal commitments, position statements, and facilitating connections with existing corporate-community partnerships in industry.

Recommendation 3
That peak bodies involved in engineering education, including The Australian Council of Engineering Deans, Engineers Australia, and the Australasian Association for Engineering Education move beyond participation targets and actively promote the need to incorporate Indigenous perspectives into engineering education for the benefit of all students.

Recommendation 4
That a central online hub be established to share and showcase successful examples of embedding of Indigenous perspectives in Engineering, Science, and Technology related fields in both educational and industry contexts.

Recommendation 5

That further research be undertaken to explore the nature and extent of Indigenous Engineering pre and post-colonisation to better understand how Indigenous perspectives shape practices and influence outcomes of engineering.

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Appendix A

Certification by Deputy Vice-Chancellor (or equivalent)

I certify that all parts of the final report for this OLT grant/fellowship (remove as appropriate) provide an accurate representation of the implementation, impact and findings of the project, and that the report is of publishable quality.

Name: Date: 29 March 2019

Appendix B External Evaluator's Report

INTEGRATING INDIGENOUS STUDENT SUPPORT THROUGH INDIGENOUS PERSPECTIVES EMBEDDED IN ENGINEERING CURRICULA - Evaluation Report

February 2016

Dr Lesley Jolly
Strategic Partnerships

This is the final report of the evaluation of the OLT-funded project *Integrating Indigenous student support through Indigenous perspectives embedded in engineering curricula* (ID13-2899). OLT describes the evaluator role as: "*a sounding board for the team, asking questions that will enable greater clarity and precision to be attached to planned processes and outcomes*". In this case the project was intended to have two evaluators – an Indigenous one to address issues of authenticity and community involvement and an academic one to review the academic merit of the project and its value to the sector. This report is the work of the academic evaluator only.

A meeting was attended in August 2014 to plan the monitoring and evaluation framework for the rest of the project. That plan was reported on in September 2014 but, as is often the case, the project has taken some unexpected turns so that the original plan became inappropriate. The original intention to set up course with an Indigenous focus was always going to be difficult within the time frame of the grant, although it is work that will happen in the future. As the project developed it became obvious that, while there is considerable interest from a number of institutions and academics around the country, the gap between where people are now and where they need to be to begin embedding Indigenous perspectives in their courses is highly various but generally substantial. As a result, this project has focused on developing a model of what it is to understand and embed such perspectives as a necessary preliminary. The model was trialled at a National Indigenous Engineering Summit hosted by the University of Melbourne on June 18-19, 2015. The very existence of this summit indicates the level of interest in the topic and this team's success in getting their message across. After further work on the model it was used again in a workshop at the annual conference of the Australasian Association for Engineering Education (AAEE) in December 2015. This report relies on observations and exit surveys from the Melbourne and AAEE events and interviews subsequently undertaken with ten of the participants from the AAEE workshop.

Key questions

The project proposal describes key outcomes and deliverables thus:

1. A set of guidelines detailing Indigenous cultural values and their relationship to engineering education and engineering epistemology and design.

2. Strategies for teaching STEM related content that will accommodate different ways of perceiving and valuing ideas, objects and contexts

3. Strategies for restructuring highly technical subjects to incorporate deliverable 2, above.

4. A model for the development and implementation of elective course content focusing on Indigenous cultural appreciation that is applicable to other design oriented fields.

5. An elective subject that links Indigenous perspectives on country and connectedness to local engineering projects.

As noted above, the scope of the project shifted to concentrate on objectives 1 and 4. One of the issues that emerged over the course of the project turned on the perception and valuing of ideas, objects and contexts mentioned in objective 2. Without a clear appreciation of such perceptions no progress can be made and so much of the work needed to concentrate on that issue. As a result some of the evaluation questions contained in the original plan had to be modified or ignored. For instance no opportunity arose to examine student reaction since the work remained at an abstract and institutional level.

Evaluation Questions (modified)

This list reproduces the evaluation questions from the original evaluation plan with modifications noted in brackets.

QUESTIONS
APPROPRIATENESS   How well did academics (~~and students~~) respond to the Indigenous focus – were they able to (see how they would) incorporate it into an engineering worldview   How appropriate were the models and guidelines across a variety of universities?
OUTCOMES   How well did academics within and outside the project team understand the model and guidelines?   What kinds of changes did participants foresee could be possible as a result of the guidelines?
IMPACT   Did academics feel they could use the guidelines?   Did professional bodies see benefit in the guidelines?   ~~(What permanent embedding (such as in accreditation measures) has happened or can be expected?)~~
EFFICIENCY   To what extent were resources (time etc) a barrier to implementation?   How were resource problems (to be) overcome?   ~~(Do participants feel that the model provides return on their investment of effort?)~~
SUSTAINABILITY   What needs to be done to foster implementation in particular institutions?   ~~(Are there review processes which will maintain quality control?)~~   What resources would be necessary to widen the impact of the guidelines?

Workshops and interviews

National Indigenous Engineering Summit

The aim of this forum was to "develop strategies to create and support pathways into engineering professions for Indigenous Australians". Speakers included prominent Indigenous and non-Indigenous scholars and representatives of organisations such as Engineers Australia (EA) and Engineers Without Borders (EWB). Preliminary work had been done on policy statements in four areas, Pathways and Accreditations, Student Support, Adaptations and STEM Education. Two of the four working groups responsible were headed by members of this project team so their thinking was highly influential in preliminary statements of policy and discussions over the two day event. There were over 130 attendees including Deans, DVCs, government ministers and students.

While the focus was on Aboriginal participation in engineering education, from the first plenary session discussion also included broader issues. For instance there was support for the view that inclusion of Aboriginal perspectives in engineering, that is the inclusion of more diverse understandings of the world, would lead to a more agile and appropriate practice for engineers, a claim that has often been made for increased gender inclusivity as well. In this case it was further argued that meaningful incorporation of Aboriginal people and perspectives in engineering projects is likely to lead to greater respect for Aboriginal people and communities. It was also suggested several times that a different way of talking about engineering, what was called a different narrative, was needed so as to create better balance between the human and technical aspects of the profession. Some of the engineering Deans present appeared to be a bit resistant to any suggestion that engineering could be understood differently but most other participants, including those from EA appeared to be well-disposed to the idea.

A number of propositions had been prepared by each of the four working groups and participants were invited to join in workshopping these statements for suitability and improvement. The ideas of this project group had been very influential in the original articulation of propositions, not only through the presence of project embers in the groups but through the project blog which several people had found independently and adopted aspects such as definitions of Indigenous engineering. The whole summit could therefore be said to be heavily influenced by this project. Workshopping of the proposals produced mainly minor changes to the wording of the propositions. While it was noted that there were some overlaps between this initiative and other such as Humanitarian Engineering, discussion emphasised that while Humanitarian Engineering and others were mainly content-driven solutions to a perceived problem, the present case had to emphasise process- a new way of doing things. This is likely to be the most important impact of this project if it can be achieved.

AAEE Workshop

22 people attended this workshop (a high number for workshops at this conference) of whom 21 filled out the exit survey (one participant had to leave early). After introducing the project model (Appendix A) and having a short ice-breaker activity at the various small groups, participants were asked to generate an expression of interest for an Indigenous

related project. Project team members circulated around the room to help the small groups with their discussions.

The discussions at each table varied in their scope and focus. While one group took a quite 'engineering' approach by trying to identify priority areas and types of funding, others were able to draw on personal experience to explore underlying issues. The interventions of the project team prompted participants to start using the concepts and language of the model, such as the 5 Rights. The debriefing discussion amongst the whole group emphasised the necessity to gain understanding of Indigenous issue through authentic relationships with Indigenous people, and that this will take a long time. For those unsure how to start, the team suggested they make contact initially with the Indigenous unit at their institution.

21 people filled out the exit survey (Appendix B). One of the questions (Q6) turned out to be irrelevant since the workshop plan was changed and the other scaled questions are repeated here for convenience.

1. The workshop helped me think effectively about the possible connections between Indigenous knowledge and engineering knowledge.
2. The workshop helped me think about the way I personally work with Indigenous students and clients.
3. The workshop allowed me to articulate the implications for me of considering Indigenous points of view.
4. The workshop gave me the chance to see how other people and places handle this issue.
5. I can see how at least some of the principles described in the model may be used in my institution.
6. I am interested in learning more about the model.
7. The project team did a good job of facilitating the workshop.

Average response to each question was as follows:
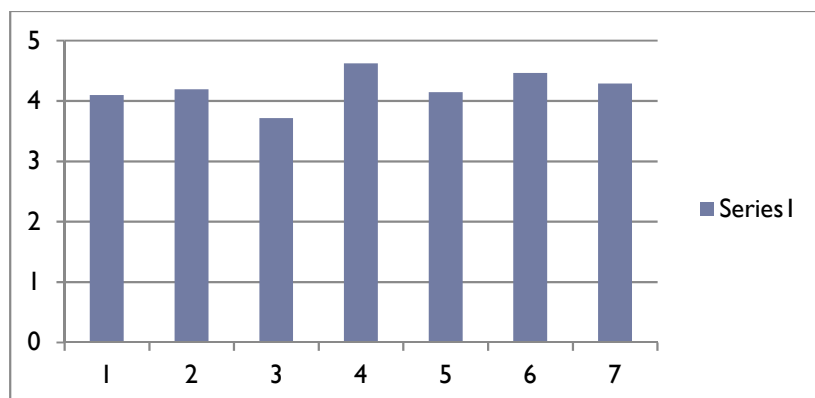
There was thus a high degree of satisfaction with the workshop. The slightly lower score on number 3 probably reflects the fact that people feel they have little experience in this area and are just finding their way forward. In the open-ended questions, participants indicated that they most enjoyed the chance to talk to other people about how they understood the issue. Three people specifically indicated that they would like to see more specific strategies for getting started.

20 participants at the AAEE workshop indicated they would be willing to be interviewed as part of this evaluation. When contacted some time later, in February 2016, 10 of them agreed to interview. These 10 represented all levels from Associate Dean T&L down to tutor and included one person from outside the university sector. They came from ten different institutions around the country and had a variety of previous experience with Indigenous people or communities. Topics for discussion included their motivation for going to the workshop and their responses to it, their experience with Indigenous people and issues, their intentions re embedding Indigenous perspectives in engineering education and any barriers they perceived to accomplishing that.

Motivations

At least two of the universities represented here have recently included an awareness of Indigenous perspectives into their list of graduate attributes and this high level support was important for academics who wanted to do this to be able to argue for resources. In principle support does not translate to effective strategies, however, without understanding of what Indigenous perspectives relevant to engineering might be and developing strategies to change the curriculum appropriately. Most of the interviewees were at very early stages in the process and had come to the workshop to find out what others thought and what strategies they might be using. All of the interviewees could relate to the model as a model of what needed to be understood but most were still at sea about how to put it into practice. As one person said "the 5 rights are great BUT they need introduction…and they need practice".

In terms of general motivations for why they were interested in this topic at all, most people were vague. Some saw it as a social justice issue, making the experience of engineering education more inclusive for some and more broadening for others. One said "Aboriginal heritage is an important part of Australia and we mustn't forget it" as though Aboriginal people had somehow ceased to be. Another commented that a lot of white people felt uncomfortable about contact history and current Aboriginal issues and ideas such as this one make a space to make connections. No-one discussed the potential for Indigenous perspectives to add anything to engineering.

Experience

Participants' previous experience of Indigenous people and communities or even of Indigenous issues ranged from nil to some years' experience embedding Indigenous perspectives in other disciplines. More interesting than this fact is the way people spoke about their level of experience. One person who claimed to be experienced in remote communities turned out to have only been there as a tourist. Another who had project experience in three different Indigenous communities said he had done "not a lot" of work in this area. Direct Indigenous experience is still rare for most Australians and those who get some experience realise how complex the issues are and rate their experience accordingly. As another interviewee noted, perceptions and preconceptions of Indigenous

people and issues tend to the stereotypical, media-derived view of underprivileged and dysfunctional communities in remote parts of the country. Even for one person with some experience of working with Indigenous people and having an Indigenous person in the family, the tendency was sometimes to think in terms of stereotypes when thinking about possible engineering projects.

Intentions

None of the interviewees could name any curriculum change they were involved in or were about to start that was relevant to this project. Two people did mention in emails later that the interview had prompted them to think about the issue again and start developing and Indigenous project in one of their projects. A third mentioned tentative intentions to ask this project team to run a workshop with their students.

There were two main ways in which people envisaged an appropriate embedding of Indigenous perspectives; talking about them, and using an 'Indigenous project' as a teaching tool. Both approaches tended to see the relevance of Indigenous perspectives as something akin to a specialized and particularly delicate instance of community consultation rather than a potential redefinition of classic problems. Whatever the interviewee's vision of what embedding Indigenous perspectives might imply, they all agreed that it would be necessary to have an Indigenous person do the talking or act as intermediary in any project. Local university Indigenous units were named as the first port of call to find such a person. In some instances the clear preference was to devolve responsibility for any 'Indigenous module' completely to someone else.

Barriers

The building of relationships, be it with Indigenous communities, Indigenous studies units or individuals, is necessary for a meaningful attempt to embed Indigenous perspectives in the curriculum, and that takes time and dedication. It cannot be done by checklist. All of the participants here recognised that and found it a significant barrier to progress. This was particularly true in the majority of cases where people had no previous relationships to begin with. All academics are time poor and some participants thought it unlikely that they would get higher level support that would allow them to divert some of their time into this activity. However, all but two participants admitted they did not know how to begin setting up relationships. Those two also had mixed experience with working through Indigenous units who sometimes have been helpful but at other times have played politics with the opportunity to get involved in such a mainstream discipline as engineering.

Once again, this dependency on other people's expertise came in many varieties. For some it was acknowledging the need to get in touch with the local Indigenous unit and work with them. In other cases it amounted to a desire to hand the whole project over to someone else, be it Indigenous representatives, the team associated with this project or outside organisations such as Engineers Without Borders. One participant who was with EWB pointed out that that they couldn't do it for anyone, that each project had to be approached in its own context to avoid 'lumping all Aboriginal people into one bucket'. It might also be

said that innovations which are delegated completely to non-engineers are unlikely to be sustainable. The challenge, then, is to develop practical strategies by which the manifest goodwill demonstrated by many in engineering education can be translated into curriculum changes.

The reach of this team's ideas demonstrated at the National Summit demonstrates that they have raised an important issue at the right time and in a way that others in the engineering and educational community can understand and use. Those engineering educators who have had greater opportunity to consider and work with the team's model are inclined to think positively of it and think it could be useful but a lack of relevant experience, time and contacts makes them a little hesitant to begin work with it.

In terms of the evaluation questions listed above, it seems appropriate to come to the following conclusions.

APPROPRIATENESS
How well did academics (and students) respond to the Indigenous focus – were they able to (see how they would) incorporate it into an engineering worldview
How appropriate were the models and guidelines across a variety of universities?

The model seemed to work equally well across institutions. There was a variety of understandings of what an Indigenous focus might be, whether it was a matter of talking about Indigenous concerns, using the Indigenous case as an exemplar of community consultation, or seeking to understand Indigenous views of what the problems are and how they might be solved that would require changes to engineering practice. This variety of possibilities is a strength rather than a drawback since it allows for those just beginning on the journey as well as the more ambitious. It could perhaps be made more explicit in future work.

OUTCOMES AND IMPACT
How well did academics within and outside the project team understand the model and guidelines?
What kinds of changes did participants foresee could be possible as a result of the guidelines?
Did academics feel they could use the guidelines?
Did professional bodies see benefit in the guidelines?

As noted there was enthusiasm for the model and guidelines. Professional bodies have not yet been formally approached about the project but the adoption of much of the thinking behind it by members of Engineers Australia who were present at the Summit bodes well.

EFFICIENCY AND SUSTAINABILITY
To what extent were resources (time etc) a barrier to implementation?
How were resource problems (to be) overcome?
What needs to be done to foster implementation in particular institutions?
What resources would be necessary to widen the impact of the guidelines?

Time and commitment have been identified as the major barriers to implementation and sustainability. While commitment is strong for many people, there will always be the need for extra support, whether that comes from local Indigenous units, other departments such as the social sciences or external organisations such as EWB. None of these can be asked to take on the whole initiative so work needs to be done in each university where this is to be pursued building strong networks and processes that will progress through something like these steps:

1. Raise awareness of both Indigenous and engineering issues.
2. Adapt model and guidelines to local circumstance and need, to help build appropriate relationships.
3. In concert with other centres undertaking similar initiatives, articulate a suite of strategies, teaching materials, potential project approaches and lessons learned.
4. Evaluate, share and repeat.

It would be ideal to have some suitably qualified person whose job it was to go around such centres, not in order to set things up for others but to facilitate each university's articulation of their own needs and strategies. A positions such as OLT Fellow or something supported by Engineers Australia would seem to be ideal to widen the impact of this important and timely project.

Model developed by project team
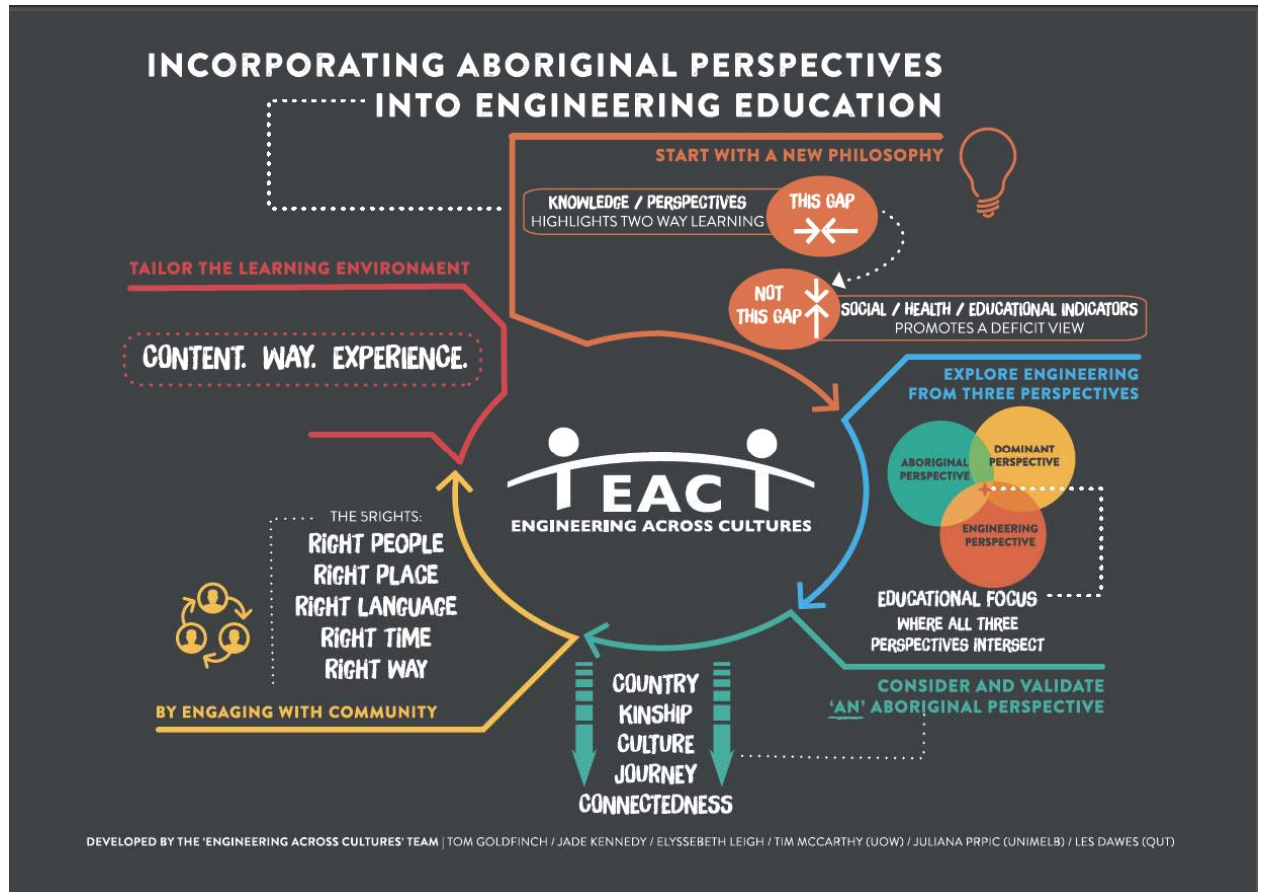
Workshop Evaluation

Thank you for attending the Indigenous Engineering Project workshop at AAEE. We would appreciate it if you take the time to evaluate the workshop by answering the following questions. Your feedback will assist the Project Team to maximise dissemination and feed into the official evaluation of the OLT project.

For the following questions please indicate your preference by selecting one of the following statements:
Strongly Disagree; Disagree; Neutral/Undecided; Agree; Strongly Agree.

Question	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
8. The workshop helped me think effectively about the possible connections between Indigenous knowledge and engineering knowledge.					
9. The workshop helped me think about the way I personally work with Indigenous students and clients.					
10. The workshop allowed me to articulate the implications for me of considering Indigenous points of view.					
11. The workshop gave me the chance to see how other people and places handle this issue.					
12. I can see how at least some of the principles described in the model may be used in my institution.					
13. The use of prompt photos worked well for me.					
14. I am interested in learning more about the model.					
15. The project team did a good job of facilitating the workshop.					

Other feedback

What aspects of the workshop did you find most interesting? ....
....

What aspects of the workshop did you least enjoy? ....
....

What was the most important issue raised by the workshop, in your opinion? ....
....

Any other comments? ....
....