Shared Values: Diverse perspectives – engaging engineering educators in integrating Indigenous engineering knowledge into current curricula

Elyssebeth Leigh[a], Tom Goldfinch[a], Juliana Kaya Prpic[c], Les Dawes[b], Jade Kennedy[a], Tim McCarthy[a]

University of Wollongong[a]; Queensland University of Technology[b]; University of Melbourne[c]

Corresponding Author's Email: eleigh@uow.edu.au

BACKGROUND

Engineering is a problem-based practically oriented discipline, whose practitioners aim to find effective solutions to engineering challenges, technically and economically. Engineering educators operate within a mandate to ensure that graduate engineers understand the practicalities and realities of good engineering practice. While this is a vital goal for the discipline, emerging influences are challenging the focus on 'hard practicalities' and requiring recognition of the cultural and social aspects of engineering. Expecting graduate engineers to possess communication skills essential for negotiating satisfactory outcomes in contexts of complex social beliefs about the impact of their work can be an unsettling and challenging prospect for engineering educators. This project identifies and addresses Indigenous engineering practices and principles, and their relevance to future engineering practices.

PURPOSE

This Office of Learning and Teaching (OLT) project proposes that what is known/discoverable about indigenous engineering knowledge and practices must be integrated into engineering curricula. This is an important aspect of ensuring that engineering as a profession responds competently to increasing demands for socially and environmentally responsible activity across all aspects of engineering activity.

DESIGN/METHOD

The project addresses i) means for appropriate inclusion of Indigenous students into usual teaching activities ii) assuring engineering educators have access to knowledge of Indigenous practices and skills relevant to particular engineering courses and topics iii) means for preparing all students to negotiate their way through issues of indigenous relationships with the land where engineering projects are planned. The project is undertaking wide-ranging research to collate knowledge about indigenous engineering principles and practices and develop relevant resource materials.

RESULTS

It is common to hear that such social issues as 'Indigenous concerns' are only of concern to environmental engineers. We challenge that perspective, and make the case that Indigenous knowledge is an important issue for all engineering educators in relation to effective integration of indigenous students and preparation of all engineering graduates to engage with indigenous communities. At the time of first contact, a rich and varied, technically literate, Indigenous social framework possessed knowledge of the environment that is not yet fully acknowledged in Australian society. A core outcome of the work will be development of resources relating to Indigenous engineering practices for inclusion in engineering core curricula.

CONCLUSIONS

A large body of technical knowledge was needed to survive and sustain human society in the complex environment that was Australia before 1788. This project is developing resource materials, and supporting documentation, about that knowledge to enable engineering educators to more easily integrate it into current curricula. The project also aims to demonstrate the importance for graduating engineers to appreciate the existence of diverse perspectives on engineering tasks and learn how to value - and employ - multiple paths to possible solutions.

KEYWORDS

Indigenous engineering, curriculum materials, socio-cultural contexts, ways of knowing

Introduction

Engineering is considered to be a problem-based practically oriented discipline, whose practitioners are concerned with finding technical and economically effective solutions to concrete challenges. Engineering Educators operate under a mandate to ensure that graduate engineers understand the practicalities and realities of good engineering practice. Alongside this there is an increasingly urgent societal (employer and community) expectation that students will be able to address these practicalities within the context of socio-cultural requirements. This paper addresses one specific aspect of such expectations – namely that of ensuring graduates:

> *…. take responsibility for …. all interactions between the technical system and the context within which it functions. The latter includes understanding the requirements of clients, wide ranging stakeholders and of society as a whole. (Engineers Australia, 2014)*

In the case of the work reported here, those requirements involve conceptualising engineering activity as based on abstracting useful information, making judgments and solving problems *with the aid of* certain important principles. What those principles are, and the way they influence judgments, is dependent on the engineer's worldview, and/or the worldview of their client. We illustrate how those worldviews can be so different as to produce engineering solutions that overtly appear to bear little or no resemblance to each other. In doing so we aim to demonstrate the importance of appreciating the existence of diverse perspectives about engineering tasks and solutions. For instance, learning to consider multiple paths to achieving desired goals may show how to incorporate sustainability principles into civil engineering projects. Consider these solutions to the problem of moving ochre from Wilga Mai in Western Australia to Sandon Point in NSW. The indigenous engineering solution used songlines and petroglyphs to map the route and guide travellers. The equivalent western solution built the Indian Pacific railroad and miles of paved road. The scope of the transport problem addressed by each solution is undoubtedly different, however the nature of the Indigenous solution suggests why Indigenous nations could survive and prosper in the same country in which Burke and Wills died.

The authors are members of an Office for Learning and Teaching (OLT, 2014) project addressing the task of *Integrating Indigenous Student Support Through Indigenous Perspectives Embedded in Engineering Curricula*. The project goal is to foster greater uptake of the profession of engineering by Indigenous students, and increase general awareness of Indigenous engineering concepts and principles. The paper provides a background to the goals and context of the project, presents results of our work to date, and identifies the scope of work ahead, including implications for engineering education. It begins with present perceptions about the topic of 'Indigenous engineering' and how these might have arisen.

What is 'Indigenous Engineering'?

We noted above that *engineering is a problem-based practically oriented discipline, whose practitioners are concerned with finding the most technically and economically effective solutions to practical challenges*. Described this way the practice of 'engineering' is as integral to Indigenous communities as to any other form of human society.

To many the concept of 'engineering' is more usually associated with activities of 'developed nations' such as Britain was, when Captain Phillip's convoy arrived in Botany Bay in January 1788 (*first contact*). It therefore comes as a surprising revelation to many that Aboriginal people had been using highly developed, sustainability-based engineering principles and practices, honed over thousands of years of close relationship with the land and 'country' (*pre-contact*). In the centuries since that first contact (*post contact*) much knowledge about Indigenous engineering has been lost. A frequent response to the term 'Indigenous engineering' received by the first author is 'what's that?' or (more often) 'what engineering did they have?' suggesting the term is somehow invalid or implausible. In reality, evidence for sophisticated Indigenous engineering practices indicates that any difference between Indigenous and non-indigenous engineering resides in the way that philosophical and

societal beliefs influence and shape the achievements and technical skills and attributes of both groups of engineers.

In a paper on this subject Jordan (2012) supplied an interesting definition of engineering, drawn up by the founders of the Institute of Civil Engineers. At the time of establishing their Institute they described

> *" . . . the profession of a civil engineer,* [as] *directing the great sources of power in Nature for the use and convenience of man."*

Our current work has led to the drafting of a comparable definition of Indigenous engineering practices along the lines of

> *"… working with Country to develop and sustain safe and healthy living for the group, in a manner that enacts a custodial role for humans of caring for Country, including minimally disturbing the land".* (NB - thus far we have not found a comparable published definition)

Of the many potential differences between these two characterizations of engineering, we are primarily concerned with two. The first concerns the sense of relationship with, and consequent conceptualising of, the physical character of what is being referred to. The Institute of Civil Engineers was explicit about 'Nature" as existing for humanity's '*use and convenience'*. How their humanity then responded to Nature – as engineers – is evident in the constructions, reshaping and reworking of the landscape and its physicality, for human purposes. Land is there to be owned, worked and used as convenient. This sense of 'using Nature for man's purposes' is vastly different from Indigenous concepts of relationship with Nature, which reflect a set of expectations about human custodianship of, and caring for, Nature.

Mary Graham's 2008 article on "Thoughts about the Philosophical Underpinnings of Aboriginal Worldviews" highlights these contrasting perspectives -

> *The land is a sacred entity, not property or real estate; it is the great mother of all humanity. The Dreaming is a combination of meaning (about life and all reality), and an action guide to living. The two most important kinds of relationship in life are, firstly, those between land and people and, secondly, those amongst people themselves, the second being always contingent upon the first.*

This does not mean that Indigenous people did not construct, mine, harvest or otherwise disturb the course of Nature. In fact it was quite the contrary. Indigenous engineers used stone to build extensive fish traps at Budj Bim in Victoria and Brewarrina in NSW, (two of may such sites Jenkins, 2012), conducted extensive mining operations across Australia (DPI 2007), and regularly undertook intensive agricultural activity (Goonrey, 2012). However the considerations that were established, and strictly adhered to, in regard to managing such sites drew on custodial principles, rather than ownership based ones.

Indigenous engineers faced the same kinds of problems as any other engineers, about transport, housing, health and the generation and preparation of food - they simply chose to address them in quite a different manner. In doing so they caused less harm to Nature, while also appearing to be 'less developed' in their thinking as assessed by those early European arrivals, and later generations, when observing Indigenous lifestyles through the lens of Western conditions and expectations. Indigenous engineering creates desired outcomes (safety, comfort, sustenance etc.) similar to other forms of engineering, in quite different ways, leading to misperceptions about both the quality of the work and the apparent paucity of the thinking behind it. The philosophical stance influencing Indigenous engineering does not separate 'humanity' and 'country' – considering them as indivisible – when framing actions for problem-solving to deliver sustainable solutions. Sveiby and Skuthorpe (2006) demonstrate that it does this in ways that 21st century engineering is only just beginning to appreciate.

Framing the Connections

Bringing this to general consciousness and achieving acceptance is clearly going to be a complex process. Seeking to frame this project in a manner that acknowledges barriers, values different perspectives and provides for diversity of thinking, and thus represents our approach to working on the issues, we developed the Venn diagram shown in Figure 1. It represents three crucial aspects of the wider picture, as we understand it. We have identified these as 'Western ways of knowing', 'Engineering ways of knowing' and 'Indigenous ways of knowing'. The convention in drawing a Venn diagram is to represent the circles as having equal dimensions, but this is only a convention not a fact. Appreciating that 'essentially all models are wrong and some are useful' (Box and Draper, 1987) we emphasise that our image is about conceptualising a way of describing relationships among different ways of thinking. It is not a way of quantifying anything. Further it is important to identify and share basic assumptions underpinning this representation. These include -

- Engineers learn to deal with the world and with human problems in a manner that uniquely creates an 'Engineering way of knowing'. Non-engineering team members in the project testify to its difference from their own disciplinary training.
- Western social constructs, built on a particular way of knowing, inform such diverse aspects as language formation, social relationships and connection to the physical world. This is, of course, manifested differently in specific sub-groups called (for example) English, German, Romanian, etc.
- Indigenous social constructs, built on a particular way of knowing, inform the language, relationships and connections of more than 200 Indigenous (pre contact) Australian nations. (NB - There is no exact set of details about these nations. Horton's (1996) map of language groupings indicates *only the general location of larger groupings of people, which may include smaller groups within them*).

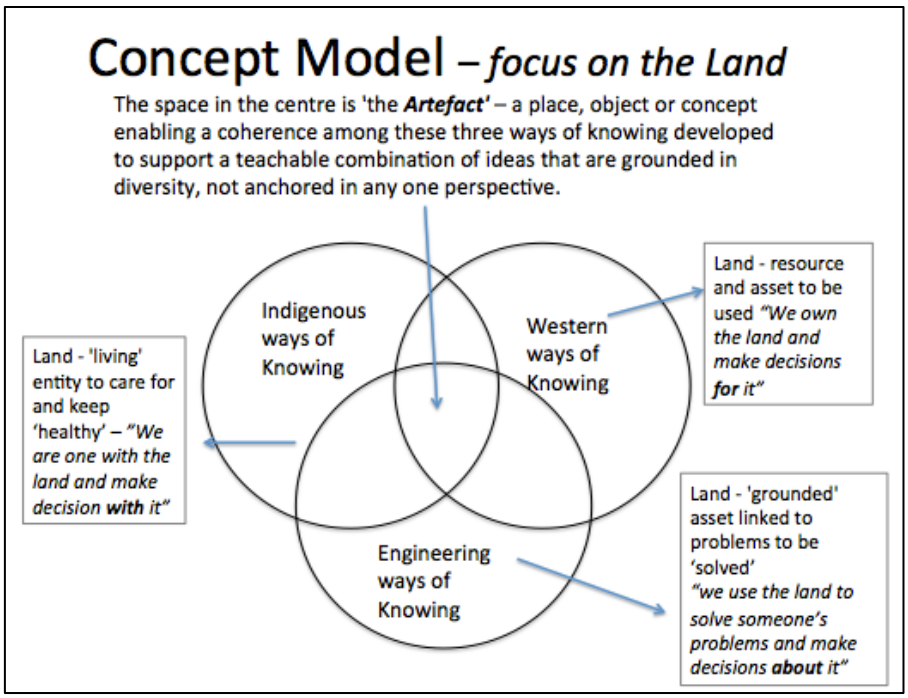


Figure 1 The Artefact space - developing knowledge of Indigenous Engineering

- 'Western knowing' and 'Engineering knowing' overlap to create the buildings, roads, mines and technical processes etc. that we occupy and see around us.

- 'Western knowing' and 'Indigenous knowing' share features including creation and use of language and social relationships (albeit with different outcomes).
- 'Indigenous knowing' and 'Engineering knowing' overlap to create buildings, structures, transport routes and processes of an elegant sufficiency, often quite unlike similar products of Western thinking.

Finally in that crucial space where all three ways of knowing intersect and overlap we locate the central focus of this project's activity, and have named this **'the Artefact Space'.** We explain below how it is shaping our work.

(En)Countering Resistance

This project is linked to an earlier OLT project (Goldfinch et al, 2012) that sought to introduce engineering students to the importance of understanding the role of 'culture' in their work and career plans. In developing that work the team members (some of whom are also engaged in this project) became acutely aware of how such a notion might be resisted in a discipline that is largely practical and outcomes focused. That experience helped us orient our thinking towards seeking understanding of the kinds of resistances we might encounter and to prepare for them. While we acknowledge these resistances may exist at many different levels, we are particularly aware of the following two factors -

1. post-contact reporting of events in the history of Australia has been heavily weighted towards denigrating Aboriginal civilisations in comparison with western society. Moreover this led to unseemly and deadly encounters which render difficult the task of reinstating into general awareness the quality and validity of Indigenous culture and principles;
2. a (more than) 50 years long struggle to redress the balance has, in many places, taken on a highly adversarial nature with claims for possession of 'rights' to knowledge made by various claimants and actual owners, such that navigating the content of the 'knowledge field' can be fraught with difficulty.

The first of these two factors appears to underlie a frequently encountered reluctance to consider an alternate perspective on the achievements of Indigenous engineers and Indigenous society more generally. One very evident outcome of this is the highly dispersed nature of information about Indigenous achievements and the comparative absence of reference to relevant engineering practices in current texts. In developing a catalogue of information about Indigenous engineering practices and principles we have explored literature from fields as diverse as astrophysics and linguistics, anthropology, archaeology and history. Thus far, few resources have been found in engineering literature, although the search is not yet over. For example a widely used textbook for undergraduate courses in Australia (Dowling, Carew, Hadgraft, 2010) has – at present – no coherent acknowledgement of the scale and complexity of Indigenous engineering solutions to provide for common human needs. We are aware this is being addressed in the next edition, so our point here is that the absence of information is endemic, requires sustained effort to redress, and will continue to be the norm for some time. Such an absence of information, as the norm in Australia, means that sustained effort is required to make visible that which has been present but unacknowledged and therefore invisible for so long.

The second factor influencing resistance to the goals of this project concerns claims about 'ownership' of (particularly) Indigenous knowledge and ways of knowing. This is rooted in current understanding of how Indigenous knowledge was developed and shared. It is likely to be a recurring difficulty for engineering educators because there are no clear and widely agreed guidelines about how to manage this factor. For example a recent media item reports on the opinion of a high profile Indigenous activist who apparently considers the kind of information we are developing as irrelevant to achieving equality for young Indigenous school students (Karvelas, 2014). While others apparently question this view, (see for example the UniSA symposium at http://unisa.edu.au/mathssymposium). Non-Indigenous observers

(including relevant members of this team) become uncertain about how to proceed. We acknowledge that this experience is likely to be encountered by academics interested in including our materials to their own teaching. So we add this factor to our deliberations, and continue working.

The Artefact Space

The key outcomes and deliverables as proposed in the OLT application remain constant but have been rearranged in terms of priority as follows:

1. A set of guidelines detailing Indigenous cultural values and their relationship to engineering education and engineering epistemology and design.
2. An elective subject that links Indigenous perspectives on country and connectedness to local engineering projects *(this may be increased to two or three subject packages)*
3. A model for the development and implementation of elective course content focusing on Indigenous cultural appreciation that is applicable to other design oriented fields.
4. Strategies for teaching STEM related content that will accommodate different ways of perceiving and valuing ideas, objects and contexts.
5. Strategies for restructuring highly technical subjects to incorporate deliverable 4.

This rearrangement arose from our own deepening awareness of the complexity of the task as a whole. The Venn diagram is a product of this awareness, and has led to both the rearrangement of priorities and the creation of the notion of 'the Artefact space' as both a concept and a tool for practical application.

The Artefact Space – as concept

At the intersection of all three 'ways of knowing' is a centre point representing shared knowledges and opportunities for agreement about how to operate within a conscious awareness of the (overlapping and sometimes contradictory) impact of all three on behaviour and outcomes. We designated this space the 'Artefact space' after long consideration of how it could best be applied to engineering project activity. We initially considered the term applied only to physical environments, until we researched Indigenous ways of knowing and came to appreciate that in that context the term equally applies to intangible notions as much as to tangible items. Artefacts can, therefore, also be environments, beliefs and ideas, providing a powerful concept with which to explore ways of reconciling divergent and even opposing worldviews.

From an engineering perspective, an Artefact (infrastructure development, housing, community facilities, locked filing cabinet etc.) is a problem to be solved or a design to be optimised and the absorbing concern is ***what to do*** about it. Our current understanding of an Indigenous worldview indicates that the absorbing concern is for **relationship** with the artefact. From a Western worldview the absorbing concern is about how to engage with the **opportunity** it offers. At this point in the project this phrasing of all three conceptualisations is tentative and subject to amendment as our understanding improves, however the emphasis here is the centrality of **relationship** to Indigenous thinking. The artefact is not separate or 'other than' the thinker – it is part of them – and must be managed with that in mind at all times. Mary Graham (2008) expresses this concept in this way –

> *The Land is the Law*
>
> *[It] is, not property or real estate . .. The Dreaming is a combination of meaning (about life and all reality), and an action guide to living. … The land, and how we treat it, is what determines our human-ness. … the relation between people and land becomes the template for society and social relations. Therefore all meaning comes from land.*
>
> *You are not alone in the world*
>
> *Aboriginal people have a kinship system which extends into land … One's first loyalty is to one's own clan group. … Every clan group has its own Dreaming or explanation of existence. .. a person finds their individuality within the group. To behave as if you are a discrete entity or a*

conscious isolate is to limit yourself to being an observer in an observed world.

From a Western worldview based on hundreds of years of science which has fostered exactly that kind of 'observer in an observed world' stance, this can be very hard to grasp, and may even be considered to be merely an affectation without substance, and therefore easily ignored. We accept that developing appropriate ways and means of sharing our understanding of the implications of what Graham describes is simultaneously central to achievement of project outcomes and very, very complex.

The Artefact Space – as tool for practical application

This is easier to tackle and is the area where we have made most progress. Once we had grasped how to work with the Artefact as tool it became clear that some previous work undertaken by project team members could validly be recycled into this space. This is because the goal of developing a suitable context within which to introduce such concepts had been emerging in a parallel context and we could begin to discern how the current situation had forecast our arrival at the idea of the Artefact. Perhaps we were also engaging with an Indigenous worldview of our situation and spotting the interconnectedness of current work with the emerging conceptualization.

In 2013 two team members incorporated Indigenous perspectives into an existing first year subject at Wollongong University. *Engineering Design and Innovation* (ENGG154) merges theory and practice using an assessment task whereby students design and model an innovative approach to engineering problems. Material incorporated into the subject introduced students to indigenous precepts, asking them to apply these to develop innovative solutions to engineering problems at Sandon Point, a designated Aboriginal place (see OEH, 2011) in the Illawarra region.

Writing an opinion piece in the local newspaper, Colin Salter (2014) a local academic not associated with our project, recently noted that -

> *Developing protocols to support [Wollongong City Council and the broader community] in deciding what facilities are most appropriate [for Sandon point] is key [to development of a co-management agreement for the area]. This includes their form, design and location. Implicit in such an approach is respect for culture … practical recognition of their history, connections to the land and struggles to protect it. Most of all, it is acknowledgement of country*.

This resonates with feedback received from students (see comments below), who at the close of the subject had created original solutions to such problems as erecting a large meeting place on the site without in any way 'breaking into' the surface of the land! As we reflected on the outcomes of this approach we realised that Sandon Point was an Artefact in all the meanings of the word that we were exploring. It is a physical space, with deeply important and intangible spiritual significance to the members of the tent embassy who have occupied the site since 2000. The controversy engendered by this occupation represents enactment of the kinds of conflict often to be found when Western and Indigenous thinking collide rather than connect.

Non-Indigenous students, completing the subject, commented on how the experience had opened their eyes to the different perspectives associated with Indigenous thinking. They expressed, in their designs and their writing, a new regard for the complex nature of reconciling Western and Indigenous attitudes to the land. Two articulate responses, among others received, expressed team-based insights in this way

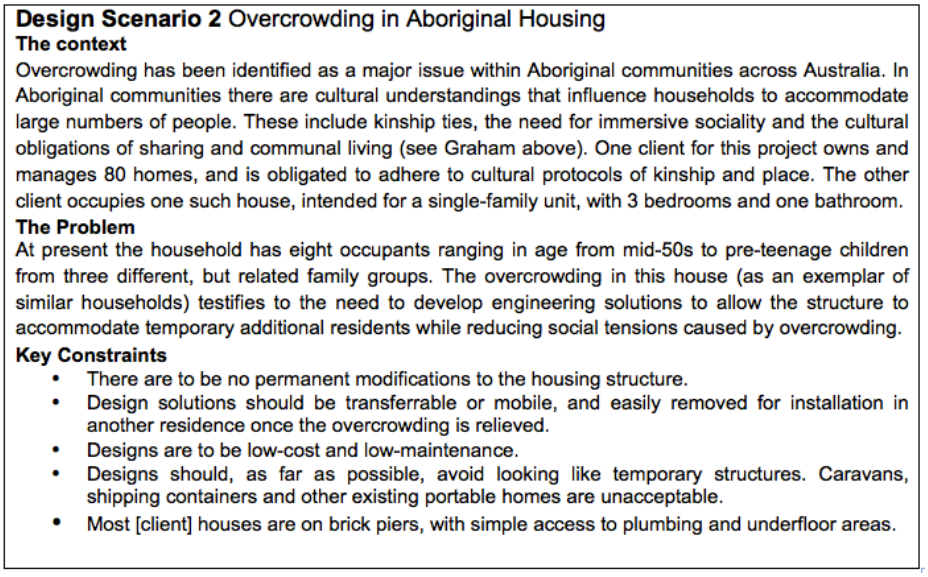
> *The team comprised four members brought up within western culture and it is therefore difficult to truly understand and empathise with aboriginal culture and innovate designs without unconsciously applying western bias in regards to structural design and construction methods.*

> *Connections* [that] *the Indigenous people have with the site is understood to run deeper than a mere form of respect, instead tying them to their ancestors and to the land itself and as such the conservation of this connection needs to be at the forefront of any development.*

Next Steps

We are re-developing the approach used in ENGG154 into a free-standing elective subject which will have as its centre piece a focus on uncovering, addressing and reconciling the three ways of knowing represented in the Venn diagram. When completed, the subject documentation will provide potential future users with a range of examples of how to discover and address relationship building with the community in which the Artefact is located. Since this first trial, a second iteration of the same subject has presented students with the task shown in Figure 2. The results of this work will be available at the end of 2014, and contribute to expanding both the conceptualization of 'the Artefact' as engineering context and tool, and to ways of identifying relevant and appropriate 'Artefacts'.

Examples of contexts in which an engineered solution to an existing problem may be affected by concurrently applying Western, Engineering and Indigenous perspectives, will be developed and explored. For example when the worldview sees human and Nature as equal *contributors* to an environmental loop rather than locating the human at the top of the pyramid, supplying fish to a large population will engender different solutions. Consider fishing trawlers and fish traps - one solution supports the growth of human populations at the expense of compromising fish stocks and biodiversity, the other solution sustains both populations while placing limits on the growth of each. They are carefully engineered solutions to the same problem, caring about the issues from different worldviews.



Design Scenario 2 Overcrowding in Aboriginal Housing

The context

Overcrowding has been identified as a major issue within Aboriginal communities across Australia. In Aboriginal communities there are cultural understandings that influence households to accommodate large numbers of people. These include kinship ties, the need for immersive sociality and the cultural obligations of sharing and communal living (see Graham above). One client for this project owns and manages 80 homes, and is obligated to adhere to cultural protocols of kinship and place. The other client occupies one such house, intended for a single-family unit, with 3 bedrooms and one bathroom.

The Problem

At present the household has eight occupants ranging in age from mid-50s to pre-teenage children from three different, but related family groups. The overcrowding in this house (as an exemplar of similar households) testifies to the need to develop engineering solutions to allow the structure to accommodate temporary additional residents while reducing social tensions caused by overcrowding.

Key Constraints

- There are to be no permanent modifications to the housing structure.
- Design solutions should be transferrable or mobile, and easily removed for installation in another residence once the overcrowding is relieved.
- Designs are to be low-cost and low-maintenance.
- Designs should, as far as possible, avoid looking like temporary structures. Caravans, shipping containers and other existing portable homes are unacceptable.
- Most [client] houses are on brick piers, with simple access to plumbing and underfloor areas.

Figure 2 Assessment task incorporating Indigenous knowing into design subject

Summary

Returning to the three worldviews it is clear that pre-contact indigenous decision-making processes were based on a values system that considered the whole environment - human, animal, plant, country, the spirits sharing the landscape. An indigenous 'way of being' is minimalist ('*only take what you need from the environment*'). While colonisation has had significant and geographically diverse effects on Indigenous life, strong connections to country, culture and kinship are maintained and deep-rooted 'ways of being' resonate in current Indigenous culture. The project is also identifying applications of indigenous concepts to modern engineering problems, as seen in the work of the brilliant Indigenous engineer David Uniapon (Jones, 1990) and the more recent activities of the inventive bush mechanics (Warlpiri Media Association, 2002).

Western ways of thinking are also diverse, formed by a long history of differentiating and compartmentalising knowledge. Centuries ago western science divorced itself from religion, while retaining powerful vestiges of religious ways of thinking. This form of science drove the industrial revolution at cost to the environment. Today many of its practitioners are realising that humanity is taking too much from its support structure and seek global responses to this issue. While there is still significant resistance to this reality, perhaps because it undermines the dominant western paradigm, there are valuable insights and suggestions for action to be gained by acknowledging the value of alternative ways of thinking like those of Indigenous Australian engineering.

This project regards engineering judgment as an application of a high level conceptual framework to a real world problem, and involves demonstrating how Indigenous design and engineering activity also applies high level conceptual frameworks to real world problems. This is where Indigenous and Western engineering principles and practices overlap.

References

Box, G. E. P., and Draper, N. R., (1987), *Empirical Model Building and Response Surfaces*, John Wiley & Sons, New York, NY.

Dowling, D. Carew, A. Hadgraft, R. (2010) E*ngineering Your Future: an Australasian Guide*, John Wiley & Sons Aust. Ltd, Australia

DPI (2007) *Mining by Aborigines – Australia's first miners*, Department of Primary Industry NSW PrimeFact 572

ENGG154 https://sols.uow.edu.au/owa/sid/CAL.SUBJECTINFO?p_subcode=ENGG154&p_year=2014&p_source=WebCMS

Engineers Australia (2014) *Stage 1 Competency Standard For Professional Engineers*, Retrieved 22/8/2014 from http://www.engineersaustralia.org.au/ on 21/8/2014

Goldfinch, T. Leigh E, Dawes, L. Gardner, A. McCarthy, T. (2012) *Engineering Across Cultures: New learning resources for intercultural competency in engineering, AAEE 2012 Conference, Melbourne*

Goonrey, C (2012) Report on an Aboriginal Land Management Workshop led by Rod Mason a respected Ngarigo elder from the Monaro region of NSW held at Garuwanga via Nimmitabelle NSW – report prepared for National Parks Australia

Graham, Mary (2008) *Thoughts about the Philosophical Underpinnings of Aboriginal Worldviews* in Australian Humanities Review, Issue 4, ANU E Press Retrieved 22/8/2014 from http://www.australianhumanitiesreview.org/archive/Issue-November-2008/graham.html

Horton, D (1996) Map of Aboriginal Australia - based on language data gathered by Aboriginal Studies Press, AIATSIS and Auslig/Sinclair, Knight, Merz. Retrieved 22/8/2014 from http://www.abc.net.au/indigenous/map/

Jones, P. (1990) David Uniapon 1872 -1967: entry in the Australian Dictionary of Biography. Retrieved 22/8/2014 from http://adb.anu.edu.au/biography/unaipon-david-8898

Jordan, J W, (2012) *The engineering of Budj Bim and the evolution of a societal structure in Aboriginal Australia* Institution of Engineers Australia, Australian Journal of Multi-Disciplinary Engineering*, Vol 9 No 1*

Karvelas, P (2014) Warren Mundine: indigenous culture in maths nonsense, Retrieved 22/8/2014 from The Australian 3/13/2014

OEH (2011) *Aboriginal Places Policy*, Office of Environment and Heritage, NSW Government

OLT (2014) Office for Learning and Teaching an entity within the Federal Department of Education which promotes and supports change in higher education institutions for the enhancement of learning and teaching, Retrieved 22/8/2014 from http://australia.gov.au/directories/australia/olt

Salter, C (2014) *Support for Sandon Point Aboriginal Tent Embassy positive for region*, Illawarra Mercury, Opinion piece published July 16, 2014

Sveiby, Karl-Erik, Skuthorpe, Tex (2006) *Treading Lightly* Allen & Unwin, Sydney

UniSA Symposium (2014) *Indigenous Content in STEM* Retrieved 22/8/2014 from http://unisa.edu.au/mathssymposium accessed 22/8/2014

Warlpiri Media Association (2002) Bush Mechanics Retrieved 22/8/2014 from http://www.bushmechanics.com/home.htm

Acknowledgements

We acknowledge the support of the Office for Learning and Teaching in funding this work, and the Universities providing in kind support by way of staff and physical resources. We also acknowledge the skills and knowledge of the Indigenous engineers of pre-contact Australia whose engineering judgment created a sustained and sustainable way of life for 40,000 years.

Copyright statement