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First Peoples Engineering – Creating cultural spaces

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ABSTRACT

CONTEXT
We are starting to understand the differences across Aboriginal Australian cultures by acknowledging both the local landscape and experiences which create cultures and identities, yet from these some universal factors emerge. These commonalities are widely acknowledged, and their significance is crucial in terms of growing and improving understanding within and between Aboriginal and non-Aboriginal cultures. They impinge on engineering practices and are both a constraint and an inspirational source of sustainability.

PURPOSE OR GOAL
We are exploring ways to change western perspectives of First Peoples concepts of engineering, education, and learning. For two-way learning to occur in Australia it is essential to understand both the specific and the shared cultural features of Aboriginal peoples and ways of expressing cultural issues. This helps people understand the innovative engineering and technology within Aboriginal Australia culture, a technology that was developed with a very different form of language and educational process. Our purpose is to provide ways and means for educators to alter their understanding and teaching to incorporate Aboriginal knowledges as valid and useful resources.

APPROACH OR METHODOLOGY/METHODS
This is a theoretical exploration of how concepts from First Peoples' cultures can inform engineering practice including provision of evidence from positive outcomes. The work applies different perspectives of Western, Aboriginal, and Engineering cultures to the development of suitable comparisons for stimulating discussions and engendering new insights.

ACTUAL OR ANTICIPATED OUTCOMES
The work reported here can inform classroom practice providing uniquely personal experiences of different knowledges in action, raising key points. The examples in this paper use community experiences and use localised storytellers to illustrate different perspectives available to engineering students and community members, extending sharing of knowledge and enabling learners to learn from First Peoples narratives. The benefits are designed to carry over to all areas of professional practice and increase the incentive to listen to clients and colleagues in an ever more complex world (Mathews, 2020).

CONCLUSIONS/RECOMMENDATIONS/SUMMARY
We want to encourage all engineering lecturers to embed their work in the culture of their country, wherever they are, incorporating local First Peoples' approaches and retain their own awareness of the context in which that knowledge grew.

KEYWORDS Aboriginal engineering, curriculum development, knowledge sharing.

Introduction

The authors have been sharing knowledge across cultures for many years through simulations, role plays and live projects. Our interest is to share these experiences and encourage others to adapt these ideas to their own style and their own stories. We

acknowledge that the first factor in sharing knowledge is the importance of embedding it in place and experience. Whatever your discipline, the context you work in, and whatever narrative your engineering identity has formed, we want to encourage readers to base their teaching on expanding their work to include First Nations' engineering. Applying your skills to a new domain and encountering new perspectives will expand your understanding of other ways of thinking.

Engaging with First Peoples in your projects and your research will enable your work to retain its authenticity when moving into this new realm. This paper highlights some key areas where Aboriginal Australian engineering, both past and present, has taken us into new perspectives, leading to questions about what has been assumed and to provide new ways of thinking and working. We share examples of how this has worked for us.

Methodology

We are taking a grounded research approach as the concepts described are designed for the instructors to develop based on their own understanding of the context in which the ideas arose. The material shared here is unique and each item belongs in its own Country or space, but the ideas and processes can be adapted to your experience, once you appreciate the relationship between story and context. This is a significant aspect of working with Aboriginal people since there are multiple examples of failure arising from enforced repeats of projects across different communities. In this work we provide background, context, and contingencies as we experienced them to help and guide you to decide how best to use these examples in your own work.

We present them as narratives or vignettes that raise questions that we hope will resonate with your concerns about engineering education and assist you to create a more satisfying learning environment for yourself and your students. Where possible Aboriginal colleagues can evaluate the new approaches you create with this knowledge.

Authority to speak

When we are working in this domain the first step is always to ground our material in place and time. We are academics and project managers researching knowledge flow among disciplines that are emerging outside, although still relevant to, the formalism of technical instruction. We describe our background and culture, to explain the knowledge we carry and our perspective on the material. This is to counter the tendency to talk for other cultures, without appreciating the limitations of our knowledge of others' experiences. The case studies provided below involved the authors or close colleagues. A variety of experiences are included, and those involved in the stories are Aboriginal, or working with Aboriginal people, to integrate Aboriginal knowledge as part of engineering education.

We introduce boundary objects as foundational material for teaching key concepts of Aboriginal knowledge sharing and then provide case studies and scenarios being developed for use in ongoing on-Country projects and broader instruction.

Boundary Objects

The following are boundary objects we use to help students grasp some of the complexity of human knowledges and to start questioning their own certainty. These are not location-based knowledges. They have been developed for western classrooms, mostly first year university introduction courses, to open students to new concepts.

Exploring on-Country boundaries

It is a vital part of embedding this new knowledge that students are introduced to the name of the Country on which they/we are all standing and the names of the people who are its

custodians. This centuries old tradition is slowly seeping into Australian consciousness and taking root as a familiar courtesy to those on whose sovereign land we live.

Objective Knowledge within Oral Traditions

Discussion of similarities between oral and written methods of knowledge help students to engage with these areas of academic literacy. Table 1 compares protocols or processes of verification of oral knowledge creation and sharing with equivalent Western techniques.

Table 1 Knowledge sharing protocols

Aboriginal approach	Western methods
Collaboration with experts in storytelling to verify the knowledge shared is correct	Peer review of written work
Stories told only to those with prior knowledge to learn	Write for specialist audience in disciplinary journals
Stories told only by those who have authority	University researchers appointed based on their research expertise
Attribution of who stories belong to when re-telling	Referencing in articles
Sharing knowledge as part of a larger narrative to provide context	Narrative teaching and Memory Codes (Kelly, 2016)

Narratives as Knowledge Repositories

We all use narratives to make sense of our life, usually as a personal narrative that grows as we do, adding new experiences. Aboriginal people use narratives, or their Dreamtime stories, as the vehicle for knowledge sharing about community and environment (Sveiby & Skuthorpe, 2016). To emulate this highly effective oral learning process, students in introductory project and design courses are given an exercise to reflect on themselves and their learning. They select an area of Country to which they have strong ties, or where their experiences are set; and an animal, plant or land feature to represent their own characteristics or totem, which they place in their environment.

The students consider some aspect of their learning and their character acts out significant indicators around that learning, for example when to check in on a team member who is not responding. Then they link with other characters from their team, their friends, or teachers, to add attributes to the narrative, with which they interact to illustrate their learning. Sometimes such representations can help clarify our future. Students record this reflection as an oral narrative, which is assessed for how they emulate valuable Aboriginal storytelling features.

Case Studies

The issues we highlight for students form major factors in good project work. These are: a) Dropping our ego to provide a safe space for community engagement; b) Relationships and reciprocity that support teamwork; c) Collective approaches for better consultation; d) Truth in speech to promote trust; e) Managing complex knowledge systems for sustainability and f) Ensuring projects engage with community practice

Drop the Ego #workingwithhumility

Many people have written about the desire for humility in engineers (Lynch et al., 2020; Neilson & Maroone, 2010) and its benefits for engineers both within organisations and when working with clients. However, when dealing with First Peoples who have traditionally been treated as inferior or deficit, more effort than normal needs to be expended to overcome inherent prejudices that otherwise disrupt projects.

Location: This first project was run by Engineers Without Borders (EWB). We rely on EWB sources who facilitated the project and comments from other participants who were highly impressed by the progress of the design and the outcomes described, for our authority to speak of this.

Actions: A group of professional engineers who were not First Peoples, went to a remote First Peoples' community to participate in a design process for a training and accommodation centre. Each day, the engineers and about the same number of community members were involved in the design process. As the group prepared to present their ideas to the community elders one of the engineers offered to present. They considered themselves technically capable and experienced at presenting. After facilitated discussion, it was decided that the youth community members should present to the elders, despite their inexperience.

The engineers were uncomfortable and suddenly unsure of their role, as they were no longer the experts presenting the ideas. Some were concerned by the perceived limited experience of the youth community members. It took them time to recognise their role as supporting the actualisation of community ideas, rather than solving the design themselves. Initially they did not respect the value of such relationships, nor that relationship was more important than technical merit in this situation, time and place. When the youth presented, the elders were receptive and proud of their young people. The facilitator observed that they expected the elders would have been less receptive if engineers had presented.

Lessons: Aboriginal people have a long experience of infrastructure being provided to communities with only rare chances to consider how it works or how it may be adapted. Technology may be used in a particular way or may be thought to be inherent in the material, rather than subject to a designer's choice. Allowing communities to discuss issues and explicitly valuing the way they conceptualise a construction is an important aspect of community acceptance and taking control of the design.

Downing (1974) describes a similar experience for engineers working with community on road design. While engineers were crucial for technical planning and construction resources, the design was influenced less by road construction technology and more by the shared experience of considering different options in town planning to support the construction.

Relationships and reciprocity #PeopleBeforeProjects

We are told that Aboriginal people hold relationship to a person as a first concern, before working with the person or their knowledge. As First Peoples work with a highly interconnected view of the world, they wish to understand how new knowledge holders fit into their system before they can relate. This is reasonable given that knowledge is contextual, and trust has so often been damaged in prior communications with First Peoples.

In fact a lack of any relationship with community can be used by Aboriginal people when necessary. 'Strangers' are not subject to the strict knowledge sharing protocols. A colleague working at Batchelor Institute was collecting stories. One day an Elder began a story, and he was surprised as he knew her daughter did not know these details. He asked why she was telling him this special knowledge. The Elder explained her daughter was not ready to hear the story, but it was okay to tell him, as he was not human (pers. Comm., David Harrington UNSW 2014). In class we compare this to when Aboriginal people were not citizens.

However, many engineers find it hard to understand such a need for relationships. When we work with engineers conducting consultation in a community setting, they often have a very serious expression on their face and write furiously in a book, forgetting to smile or look at the person they are talking to. When using a translator, they often speak to the translator, rather than to the person they are interviewing, saying things like "can you ask her if the kids wash their hands after going to the toilet?"

Location: This context is a project in the remote WA desert. An engineer who had previously worked with and been accepted into a community and had a skin name (kinship relation) given them by members of the community, went to work further out west.

Action: The engineer understood kinship is important and introduced themselves with their skin name at the new community, and when meeting local Aboriginal people. The community quickly explained their new relationship to other people in the community: who were their sisters and brothers; who were their aunt and uncles; and who were their 'straights' (those they could be cheeky with). They were also told to avoid certain people, their parents-in-law in effect.

The engineer emphasises that the process eased their work in the community, since relationships were often hard to form. As they were doing short-term projects across many communities dealing with common issues like water supply, renewable energy installation and radio communication, this was helpful. Within a day the engineer had a group of people they could ask for help, knew who to consult about what, and with whom they should do their work, and who they could socialise with after work.

Lessons: When crossing cultures many assumptions are made. We need to respect Aboriginal co-workers and clients by allowing time to build relationships. When projects are based on 'fly-in-fly-out' servicing, there is scope for casual relationships based on kinship names. However, substantial projects need deep understanding of engineers' aspirations, priorities and values to help communities engage with them in line with their aspirations.

Consider collective approaches for better consultation #FirstAsCommunityThenAsIndividual

Through ongoing discussions our students become aware of the knowledge systems with which they currently view the world and the knowledge they consider 'valid'. We want to expand their perspective and appreciate the breadth and depth of knowledge held and communicated through First Peoples' knowledge systems.

Location: We use the story of Brewarrina Fish Traps, told by Aunty June Barker who is not of the Ngemba, the traditional owners of the traps, but tells a story for those who live in the area and would have shared ceremonies at the fish traps.

The traps purportedly had 4' high walls which were opened during floods to allow water and fish in, then closed to hold the fish as a fresh food source while people stayed for discussion. As the waters dropped, traps higher up the river were emptied and lower ones were filled and used, extending the period of meetings (Mathews, 1903).

Action: After the students hear the story, we ask them what they learnt and often they note the landscape features are discussed. These Dreamtime stories are shared with children from a young age, and lessons in navigation of their lands are crucial and important to learn early. We also note that this framework of Country provides the memory code (Kelly, 20016) to help the story remain memorable. Using stories with local features is a highly effective way of holding and communicating knowledge of place in an oral culture. A story can then be expanded with further stories set at these locations, as needed throughout a person's life.

We expand on the knowledge held in this story by noting that black bream lay eggs inside hollow logs and burrows which can be collected and distributed up and down the river to ensure a good spread of the fish for food. This aquaculture was practised by Aboriginal people and the knowledge shared as part of this common story. Finally, the story tells how to create rain, by creating dust clouds during intense dancing, when the dust will billow up into the atmosphere, going "as high as the moon". We know that fine particles into the stratosphere can seed clouds.

Lessons: The community stories which are shared as Dreamtime stories are a repository of collaborative wisdom about the environment and social principles. Other stories about

Brewarrina fishtraps explain that the traps were maintained by clans of Ngemba to ensure they could feed visitors during knowledge sharing ceremonies.

An understanding of how to find your way around and to the traps, how to maintain the fish stock, and how to induce rain were all part of important knowledge to be shared around the area. Managing this in an oral tradition requires ensuring those who tell the stories are well informed and do not mis-represent the complex aspects of the knowledge. This is one place where the boundary setting pre-work on oral knowledge sharing is useful.

Truth in communication #TruthDemonstratedThroughCommunication

Winschiers-Theophilus, H. et al. (2010) said of their participatory design studies that "We are also uncertain as to whether the participants really grasped the purpose of the activity." The outcome of the design differs from the designer's plans in the community eyes. More importantly, ongoing iterations of a design that occur away from the community need to be presented and evaluated by community participants.

Location: These examples are from projects in WA based around water and IT technology. The comments are observations by external engineers and project managers in the community who raise their concerns about ongoing practice that is detrimental to projects.

Action: When projects are funded through external grants with limited consultation prior to starting the project, there will be major learning on the job. Implementation is then difficult as often not funeded, so agreed project equipment may be delivered without accompanying information, or worse broken.

An alternative scenario occurs when a system is installed, and the community has a working system but its members are not well informed about maintenance or system hazards. For example, in Jigalong, a community in the WA Western Desert, there is a three-pond evaporation system for wastewater, surrounded by a fence. However, the children were breaking in, to swim in the third pond, since the "the water guy" had told them that this pond was clean. Asked if they got sick from swimming there, the children said no, but agreed "glue ear" was common, revealing that "sick from bad water" had not been well explained.

A different kind of problem occurred when an engineering consultancy was nominated without community consultation for an award for innovation on a project and then wins, again without reference to the community. By the time an award was made the equipment was not be working and the community's ongoing needs appeared irrelevant to the award process.

Lessons: Conveying the complexities of a technology, especially to the point where a community can take over maintenance, can be difficult. We often hear that when technicians go out to the field, they consider they are already paid for the work so they do not put any care into the product. We suggest that a more accurate interpretation is that the technician, removed from their familiar context, may not be clear about the significance of the regulations nor understand their application in a new setting. Thus, a broader understanding of duty of care, community engagement and careful telling of the whole story of a technology that is being imposed from outside the community, are all important factors to be included in a community engagement process.

In a water project in the Solomon Islands, it was found that some community members would not speak up when the elders were around. In such contexts the rational forms of public argument are not always suited to the way knowledge is shared in yarning, and successful transmission of ideas requires many modes of communication. Workshops organised as social events, such as around eating can be effective, with careful attention given to the after-effects of years of conflict and distrust, if discussions are to find common ground for consensus (Buchy & Hoverman, 2000).

Traditional workshop opening sessions using questions such as “Tell us who you are and what your interest is in being here” can reinforce entrenched views and recollections of previous unsatisfactory encounters. We have found it is more effective if initial discussions are focused on the collection of factual data about the situation and only later progress to issues requiring opinions, such as: prioritizing values and threats; and consideration of management systems and relationships (Hoverman et al, 2011).

Managing Sustainably #SustainableKnowledgeSystems

The strength of Aboriginal knowledge sharing around sustainability, and the depth of understanding that goes into planning environmental actions such as fire burns or food collection, resides in narratives used to store and share knowledge.

Location: Victor Steffensen has worked for years with fire burning, starting with his elders in the Cape York area around Laura, and using GIS location equipment to map the fire burns and then show that they are systematic and can reduce fire.

Action: Throughout the earlier years of living in Laura, right through to now, I have seen researchers come and go. All sorts of strangers from different universities would come and interview the Elders on whatever topic they were after, sometimes offering the old people a few hundred bucks, or most times nothing at all. They would go away with information and we’d never hear from them again. I remember times in the early 1990s when scientists would interview old people about First Peoples’ Fire Knowledge. The old people wouldn’t tell them much. Understandably, they didn’t trust them with such information (Steffensen, 2020 p.97)

This experience was mirrored in the Northern Territory when Yolngu community members were training scientists in their *worrk* or “the work of setting fire to the bush and managing that fire” (Verran, 2002). When Yolngu did share a burning ceremony, the scientists were uncomfortable when “Yolngu instructors conflated people and lands so that both had inherent relationality” and “in the *worrk* episode, scientists were able to recognize neither valid generalizing about habitats, nor justifiable strategies of burning them.” (Verron, 2002, p 16)

Often researchers would leave thinking that the Elders knew nothing about fire at all. “One scientist I met had come to the conclusion that Aboriginal fire knowledge in Australia was lost forever” (Steffensen, 2020 p.96)

Lesson: Given the history of co-option of Aboriginal knowledge, elders are often reluctant to give information to “strangers” who may wish to gain control over a community project. In fact, the knowledge exists as environmental indicators, a knowledge that is complex and hard to learn, but passed on in the narratives. Here the lesson is that we need to fund Aboriginal people to manage and maintain these skills. Thousands of ranger groups have been set up in northern Australia. Some Ranger enterprises are now built on a business model of payment for ecosystem services, funded by trading carbon credits on the open market. While such a business model is risky and the enterprise is liable if they do not burn country well, this provides a new source of independence (Ricky Archer, NAILSMA).

Engaging with community practice #HandingOverPower

We want engineers to ensure that projects engage with community practice, and to consider how to provide skills for others to take over their role (e.g. in maintenance) and ensure their skills are seen as only a part of the team. The problem when this power is not handed over, is seen in projects such as information technology which include very foreign (unfamiliar) knowledge.

Location: Language learning apps are developed, and funds are largely spent on the development phase which is quite costly. To reduce costs, efforts are sometimes made to re-use a particular system as a template for others to develop their own apps.

Action: The problem is that during community workshops participants are unclear about how to use an app when they were not involved in its development, and therefore are not ready to take control of assembling further apps from existing material.

Lessons: The issue is twofold. It arises partly around the ongoing issue of getting enough funding for implementation of a project, and from the need to encourage developers to travel to remote areas to make a positive change out of the development experiences. This raises the issue of Aboriginal knowledge being ignored and denigrated when it should be integrated into our management of the highly complicated environment in Australia.

Location: Over the last 20 or so years, Land Councils have been extending their claims to the waters of Australia, as in Aboriginal world views the land and sea are not distinct, but interdependent.

Action: In light of the importance of water in EWB projects and the value of water for Aboriginal people, we introduce Virginia Marshal's work on Aqua Nullius (2017). We highlight the flawed treatment of First Peoples water rights and interests by Australian governments in developing national water reform and describe how the early stages of the process failed to account for First Peoples' inherent rights to water, its use, management, and ownership.

In fact, Aboriginal people had industries built around aquaculture and water management (Frangos et al., 2020) so if we are to value First Peoples knowledge of water, we need to rethink our understanding of water as part of life and land. How do we fit that into our engineering, or do we let First Peoples do this, in a creative way?

Lessons: To value Aboriginal knowledge we need to re-open discussion around such spaces, in this case water rights and interests, and provide for Aboriginal people to set up the discussion on their terms. This is happening more as individuals gain positions at universities that give them time and space to share their knowledge in the format that scientific research will respect. Also, there are other more opensource forms of knowledge sharing developing online to encourage community contribution (Roberts et al, 2020)

Discussion

The research is to bring together our understanding of engineering ways of knowing in different cultural contexts so we can appreciate the different problem-solving techniques used in different societies. We want our students to understand other ways of working that include community as partners and people to be educated in technology from their different perspectives. Also, we use boundary objects to enable our engineering students to see the continuum between Aboriginal and Western perspectives in areas such as our knowledge management and learning techniques as in Figure 1.

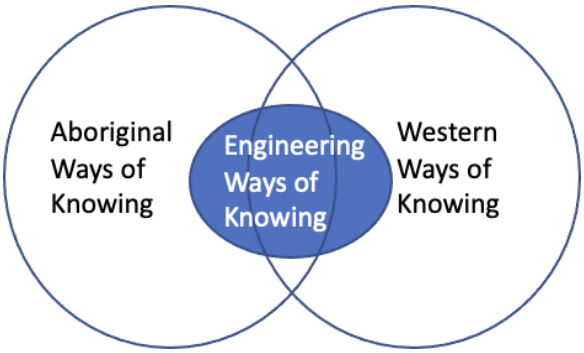

Figure 1 The Relation between Aboriginal, Western and Engineering viewpoints

Hence, we hope to see more Aboriginal people engaged with the academy either as consultants or through community projects in which our students can benefit the community and themselves through two-way learning. However, for this we need to make an environment where Aboriginal people and their knowledge systems are valued. We are

slowly developing scenarios and activities based on the key issues raised in this paper. However, to do this we need to understand how to change mindsets, what is a trigger that will help people see a new way, or what is the impediment in thinking that we can remove to enable our students to progress.

Boundary objects are supportive of preparing students for explorative discussion, though we have found that at times they need encouragement to enter such discussion where there are no right or wrong answers. We have found this to be challenging for some engineering students and so linking the activity with the skill of managing complexity in their career can be helpful, as is careful facilitation and agreements whereby students identify how they will respectfully discuss the scenario.

Other activities are designed to alert students to their current mindset, way of knowing or approaches, followed by critically analysing the efficacy of this approach, then encouraging consideration and application of alternatives. We have found role plays to be extremely effective as students are able to embody another experience “in the field”, developing empathy and understanding for the roles at play, and practice without impinging on actual communities and people as they learn.

Many activities we use are developed from the same process. We divide students into two groups to take a different approach to a theme. Each group can be told separately to take a perspective eg enact a group of Elders who are hesitant to share fire knowledge (Steffensen, 2020) and talk to a group enacting scientists seeking knowledge. Or we can have each group go through a perspective-based or fact-based consultation process, as recommended by Hoverman et al (2011), when broaching some contentious issue in class. Then the groups share reflections of their experience and how they felt about the others’ experience as they witnessed it.

We also design simulations to help students make the transition from passive to engaged learners. One or more learning outcomes is identified as are the profiles of those for whom the learning is intended. These determine the complexity of the design, the way the action is designed or restrained, and the process through which the learners will proceed. These are all woven into a structure of learning moments that can be repeated and remain stable, although each iteration will have its own unique characteristics from student response and actions. This approach enables us to draw on specific features of the wider context, to build interactive experiences that are engaging, memorable and expand learners’ awareness of themselves in context. Simulations create inbuilt opportunities to cause learners to look further and consider the further possibilities for learning arising from the experience of contributing to the action in the simulation.

Also we engage First Peoples for telling stories based around country the learners are similarly reminded of what the story had to tell them. And both groups of learners have been exposed to learning that has become embedded in their thinking, experience, and future actions. First Nations students engaging in activities should be considered, irrespective of their relationship to identity and ancestry, as having lived experience and learnt experience within the structures of colonialism to which your content is contextualised. If they wish to engage on this level they bring a greater depth to the class.

Conclusion

This is an ongoing project to develop understanding into our teaching in a way that is an authentic contribution to engineering education and provides skills that will help our students create better outcomes in their professional life with a deeper understanding of sustainability and community negotiations.

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