Towards integration of the Māori world view and engineering: A case study on student design projects for the Koukourārata community, Aotearoa/New Zealand

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CONTEXT Among desired graduate engineer attributes is comprehension of the role of engineering in society and the economic, social, cultural and environmental impacts of engineering activity. The University of Canterbury, Aotearoa/New Zealand, aims for its graduates to be globally aware, engaged with the community and biculturally competent and confident. Here we present a case study on explicitly addressing the development of these attributes in a final-year undergraduate course. The key focus is the small coastal community Koukourārata, in Canterbury, for which students conducted a design project focussing on relevant water, sanitation and landscape management issues, guided by the Māori world view.

PURPOSE We present a case study that describes an inaugural design project in collaboration with the Koukourārata community, to highlight opportunities for community engagement and meaningful societal impact through the learning process.

APPROACH In previous years course design projects have been desktop studies on aspects of water, sanitation and energy systems in Pacific Island communities. With the 2017 inaugural design project in collaboration with the Koukourārata community in Aotearoa/New Zealand, students have been able to visit the area in question and meet with the community, and receive feedback on their designs. This approach aspires to respectful co-creation of sustainable and culturally relevant engineering solutions.

RESULTS Student design projects addressed aspects of domestic and agricultural/horticultural water supply, flood and sedimentation mitigation, food production, with various degrees of holistic treatment of integrated water and energy systems. These designs incorporated aspects of the Māori world views and beliefs. Designs gifted to the community provided the Koukourārata community with a diverse set of ideas and plans with which to achieve their aspirations for future development, and future years will add to the design portfolio. The course has directly addressed desired graduate attributes pertinent to societal engagement and sustainability.

CONCLUSIONS The opportunity for young engineers to engage meaningfully with indigenous peoples as part of their undergraduate programme, and the requirement for them to incorporate indigenous beliefs and world view into engineering designs to address significant water, sanitation, energy and land use issues, significantly enhances their educational experience. This approach starts to fulfil the need for students to understand the role of engineering in wider society and in developing communities in particular, in order to address complex issues of economic, social, cultural and environmental sustainability.

KEYWORDS Indigenous communities; Māori; Graduate attributes; Place; Treaty of Waitangi; Biculturalism

Introduction

In a world of continuing and increasing demographic and environmental changes, our future engineers must be sensitive to the sustainability of engineered systems in urban and rural settings. Key to this is being able to provide designed solutions tailored to the cultural expectations, needs and aspirations of particular communities. In this paper we offer a sharing of practice that presents an example of collaborating with one of Aotearoa/New Zealand's indigenous Māori communities, in order to present students opportunities to develop key insights and skills, as well as providing the community information and inspiration to meet their own development goals.

The Washington Accord is a multi-lateral agreement between international organisations responsible for accreditation or recognitions of tertiary-level engineering qualifications, and activities of the Accord signatories are meant to assist the mutual recognition of engineering qualifications among countries and regions (International Engineering Alliance, 2014). A fundamental element of the Accord is the articulation of desired engineering graduate attributes, a knowledge profile, complex problem-solving skills and attributes of complex engineering activities. These attributes are meant to reflect the skills necessary for successful engineering practice in today's modern world of complex projects, globalised work forces and the need to address environmental and socio-cultural concerns.

In the context of this paper, significant Washington Accord attributes and skills of note are: designing solutions that meet specified needs for cultural, societal and environmental considerations; reasoning informed by contextual knowledge to assess societal and cultural issues and the consequent responsibilities relevant to engineering practice; understanding and evaluating the sustainability and impact of professional engineering work in societal and environmental contexts; applying ethical principles; and functioning effectively as individual engineers and as part of teams in multi-disciplinary settings; and effective communication with the engineering community and society at large.

In addition, the graduate knowledge profile includes the need to demonstrate understanding of the role of engineering in society including the impacts of engineering activity on economic, social, cultural and environmental sustainability. When addressing complex engineering problems graduates are required to identity the range of potential conflicting requirements, and to identify diverse stakeholder groups with potentially widely-varying needs. Lastly, a key aspect of understanding complex engineering activities is to appreciate potential consequences to society and the environment in a range of contexts where prediction and mitigation may be difficult. The above aspects of graduate attributes, knowledge, problem-solving and understanding of engineering activities are intended to address important contextual factors that professional engineers must appreciate to ensure the success of their projects and teams, meeting needs of clients and other stakeholders, and ensuring sustainability in a world of growing populations, increasing urbanisation and environmental (including climate) change.

The University of Canterbury in Aotearoa/New Zealand has committed to ensuring graduates gain expertise in a core discipline, as well as developing a number of personal attributes that happen to align with many Washington Accord engineering graduate attributes. The four pillars of the University of Canterbury graduate profile personal attributes are: Bicultural Competence and Confidence; Engaged with the Community; Employable, Innovative and Enterprising; and Globally Aware (University of Canterbury, 2017a; Table 1). Elements aligning with socio-cultural emphases of the Washington Accord include: working effectively and professionally with diverse communities; analytical, critical thinking in diverse contexts; the ability to engage critically and effectively in global and multicultural contexts; and undertaking engagements, reflection and application of understanding in interactions with communities. Bicultural Competence and Confidence is given particular emphasis as a consequence of the institution's overarching obligations, as a Crown entity, to breathe life into the partnership central to the 1840 Treaty of Waitangi (signed by Crown officials & Māori

chieftains). At its heart, bicultural competence is based on understanding that Aotearoa/Zealand's bicultural society is comprised of: 1) Tangata Whenua, people of the land - Māori and; 2) Tangata Tiriti, people of the Treaty - Europeans, others and their descendants in Aotearoa/New Zealand by virtue of the Treaty of Waitangi. This framework is intended to produce graduates who are distinctive in the knowledge, skills and attributes which position them to respond in the one nation, two peoples (Indigenous and non-Indigenous), whilst still acknowledging the multicultural society that is contemporary Aotearoa/New Zealand. This Treaty relationship, or 'biculturalism', also provides distinctiveness in an international context. For students at the University of Canterbury a key learning outcome is to "be aware of and understand the relevance of biculturalism in Aotearoa/New Zealand to their area of study and/or their degree" (University of Canterbury, 2017b). Students are provided opportunities to deepen their understanding *te ao Māori* (the Māori world) through studying *te reo Māori* (Māori language), *tikanga* (customary practice) and *kawa* (protocols). The *kaupapa* (themes) contributing to Bicultural Competence and Confidence are outlined in Table 1.

Table 1: The University of Canterbury graduate profile

<table>
<tr><th colspan="2">Critically competent in a core academic discipline of their degree</th></tr>
<tr><td colspan="2">• The core business of any University. Graduates will know and can critically evaluate and, where applicable, apply this knowledge to topics/issues within their majoring subject.</td></tr>
<tr><th>Bicultural Competence and Confidence</th><th>Engaged with the Community</th></tr>
<tr><td>• A process of self-reflection on the nature of "knowledge" and "norms".
• The nature of contemporary Māori organisational structures e.g. rūnanga[1], hapū[2], iwi[3], iwi corporations.
• Traditional and contemporary realities of Māori society e.g. tikanga[4] and kawa[5], Te Reo Māori[6].
• The Treaty of Waitangi and Aotearoa New Zealand's bicultural history.
• The processes of colonisation and globalisation.
• Other indigenous models of development, knowledge and behaviours.
• Application of bicultural competence and confidence in a chosen discipline and career.</td><td>• Engagement: Gaining knowledge and understanding of a community by interacting with a community.
• Reflection: Gaining knowledge and understanding of a community through reflection on one's experiences with that community.
• Application: Understanding and articulating how the content and/or skills of the subject/programme enhances the community.</td></tr>
<tr><th>Employable, Innovative and Enterprising</th><th>Globally Aware</th></tr>
<tr><td>• Working effectively and professionally with diverse communities.
• Communication.
• Analytical, critical and problem solving in diverse contexts.
• Digital literacy.
• Innovation, enterprise and creativity.</td><td>• Self-reflection on the nature of one's culture, language, and beliefs on one's systems of knowledge.
• Understanding the global nature of one's discipline.
• The ability to engage critically and effectively in global and multicultural contexts.</td></tr>
</table>

[1] community/tribal council, [2] subtribe, [3] tribe, [4] customary practice, [5] protocol, [6] Māori language

In addition to the graduate attributes emphasised by the Washington Accord and the University of Canterbury graduate profile, professional engineering bodies in Aotearoa/New Zealand address socio-cultural and environmental issues. The latest Code of Ethical Conduct adopted by the Institute of Professional Engineers New Zealand and Chartered Professional Engineers of New Zealand, in addition to specifying obligations relating to personal conduct, also specify obligations in the public interest (IPENZ, 2016). These public interest obligations comprise taking reasonable steps to safeguard health and safety, reporting adverse consequences, and having regard to effects on the environment. The latter obligation states:

> *You must, in the course of your engineering activities, i. have regard to reasonably foreseeable effects on the environment from those activities; and ii. have regard to the need for sustainable management of the environment. In this rule, sustainable management means management that meets the needs of the present without compromising the ability of future generations (including at least the future generations within the anticipated lifetime of the end products and by-products of those activities) to meet their own reasonably foreseeable needs.*

Although no specific mention is made in the IPENZ (2016) Code of Ethical Conduct of Aotearoa/New Zealand's indigenous Māori populations, the elements of environment and sustainability mentioned above are of particular concern to these communities.

Engineering in Developing Communities Design Project 2017

Background

The course ENCN401 Engineering in Developing Communities, offered through the Department of Civil and Natural Resources Engineering at the University of Canterbury, is a final 4th-Year (3rd Professional Year) elective that was first delivered in 2009. The course provides students with a background in development engineering, with a focus on potable water and sanitation systems, hygiene and disease, and rural agricultural engineering including irrigation. Other topics address the roles of women and disadvantaged groups, and socio-cultural factors that influence understanding and uptake of engineering solutions and behavioural interventions. The course draws upon the personal and research experiences of the lecturers in countries and communities across the world, and the material is framed through global agencies and initiatives such as the United Nations Development Programme, the 2000-2015 Millennium Development Goals and the 2015-2030 Global Sustainability Goals. An important component of the course is a design project conducted by groups of students, with the occasional support of local student chapters of Engineers Without Borders.

In 2016 new course material was introduced that addressed the history of Aotearoa/New Zealand and the impacts of humans on the environment. Two guest lectures also presented material on issues around marae (courtyard where formal greetings and discussions take place, and associated building complex) infrastructure (Te Puni Kōkiri, 2012), Māori as client, and the statutory role that Te Waipounamu/South Island iwi (tribe) Ngāi Tahu play in the rebuild of Ōtautahi/Christchurch following the 2010-2011 Canterbury Earthquake Sequence. The 2016 design project was a desktop exercise in which groups developed water, sanitation and energy solutions for a high school in Tonga, with information provided by the student Engineers Without Borders chapter at the University of Canterbury. Soon after delivery of the guest lectures, featuring Māori content, discussions began on 'how' the 2017 design project could be based in the Canterbury region and work closely with a local Māori community, with a specific focus on marae issues. This would give meaningful effect to the principle of 'partnership' central to the Crown's (1989-) 'principles for action on the Treaty of Waitangi' (Hayward, 2009).

The coastal community of Koukourārata/Port Levy was identified and one of the authors, M. Cunningham, a member the community, was engaged to determine local interest and

potential collaboration. The concept was embraced enthusiastically, as the objectives of the wider course and the design project aligned with community aspirations. As a result, the course was now underpinned by an Indigenous place-based pedagogical framework similar to the curriculum design, delivery, assessment and evaluation processes recommended by Manning (2011; 2016).

Preparatory Curriculum Material

Preparatory lecture sessions focussed on three areas: 1) elements of community engagement; 2) design thinking and empathy with stakeholders; and 3) an overview of Māori history and the importance of marae, and Māori as client.

Initial lectures and exercises focussed on engaging community stakeholders through interviewing, observing and participation, drawing upon international experiences in the African and South Asian continents. The importance of information gathering was emphasised through triangulation – obtaining information from more than one source in a community and doing comparative assessments. In anticipation of the upcoming Koukourārata community visit, a place-conscious structure was presented in which to define the nature of engagement in comparison to strict ethnographic study, and market research to inform product/system design processes (Table 2). Information was presented on effective and respectful information in communities, including; explaining the type of interaction sought; gaining permission for any recordings whether visual or audio; in interviews, starting with easy open questions to gain trust, and asking for specific details, examples and stories.

Table 2: Defining the nature of engagement with the Koukourārata community (ENCN401 visits) in comparison with ethnographic and market research approaches

	Ethnographic Study	*ENCN401 Visits*	Market Research
Focus	Observe and record	*Involve and innovate*	Define and quantify
Outcomes	Extensive description	*Empathy and inspiration; Ideas; Prototypes*	Quantitative information; Feasibility
Type of Interaction	Long; Unstructured; In-depth	*Short; Unstructured; In-depth*	Short; Structured; Broad
Community Involvement	Everyone	*Cross-section of community; Local innovators*	Targeted market segments

A second set of preparatory lectures and exercises focussed on the design process and empathy with stakeholders. Students were introduced to the Design Spiral concept to emphasise that the path to solutions is not simple and linear. This framework begins with Stage 1 – Information and Insight (Learn), followed by Stage 2 – Ideas and Approaches (Ideate) and then Stage 3 – Implementation and Validation (Experiment); the process then returns to Stage 1 for further research and refinement and continuation of the spiral. The steps in this process were linked explicitly with community engagement and design output milestones throughout the course. Other material presented to the class included: definitions of human-centred and user-centred design, co-creation, and user-created design; and users' motivations and needs as framed by Maslow's Hierarchy of Needs (Maslow, 1943). To further be able to distil information into a statement of user needs the concept of a PATH Statement (Problem, Approach, Target, Heart) was introduced, in which the problem is stated clearly with sufficient contextual detail to demonstrate its importance, the approach to problem framing is described, targets are defined (especially quantitative ones), and that the anticipated outcome shows heart, or is sensitive to communities' needs, wishes and aspirations. Different approaches were presented for framing problems. Subsequent to the initial community engagement (see next Section), further material and exercises focused on

better stakeholder characterisation. This was explored through the development of "personas" – representations of individuals based on researcher/designer experience of the community, and created as tools for empathy. Personas included: descriptions of individuals' demographics and cultural and social environments; characterising their world through imagining their social, economic and infrastructure constraints; and imagining a day-in-the-life narrative. Final topics comprised different approaches to brainstorming design solutions including convergent and divergent processes in concept generation (Liu et al., 2003), and discussing the roles of team composition and attitudes in creative design generation (Toh and Miller, 2016a; 2016b). Concept selection methods including Pugh Charts and Quality Function Deployment/House of Quality assessments (Okudan and Tauhid, 2008) were addressed, as were design sustainability and life cycle assessments (Devanathan et al., 2010).

The final preparatory session, to raise students' cultural awareness and place-consciousness levels, was an overview of the history of Māori in Aotearoa/New Zealand, the 1840 Treaty of Waitangi and colonisation impacts, the importance of marae in the Māori world, and the roles of Māori as clients and environmental guardians. The importance of marae was emphasised as a community centre, the pū manawa (beating heart or pulse) of the people who live around it; because important discussion and decisions take place on the marae they are viewed as politically significant. Discussion centred on the fact that ⅓ of marae have inadequate and unfit-for-purpose infrastructure (Te Puni Kōkiri, 2012), due to lack of funding and investment, rural communities not prioritised by local and central government, and issues around communal land ownership. The state of marae presented clear opportunities for the students to envision potential contributions to potable water, waste water, and energy systems. The importance of marae in disaster contexts was also highlighted further demonstrating their essential roles in communities (e.g. Lambert, 2014). Also explored was that due to the demonstration of Māori autonomy and resourcefulness in developing support networks during the 2010-2011 Canterbury Earthquake Sequence, the Ngāi Tahu iwi (tribe) have for several years been a statutory partner with local and central government in the rebuild of Christchurch City. Accordingly there has been significant Māori input into architectural design of buildings and their surrounding open spaces that tell of the ancestral ties to landscape from before European colonisation and construction of Christchurch's built environment. Newly designed features echo locations and lifeways associated with seasonal movements, food sources, water bodies and significant events in Ngāi Tahu's history.

Another significant preparation for community engagement at Koukourārata was an overview of marae protocol during the traditional welcome ceremony (pōwhiri). Preparation involved presenting written material and verbal instructions about what to expect, and what was expected of them (e.g. to wear formal attire as they represented themselves, their families and their ancestors), the manner of entering the marae, speeches and singing. A well-known Māori folk song originating from the early 20th century called *Tū Tira Mai Ngā Iwi* (Line Up Together People; a song exhorting community solidarity) was first practiced in the course's introductory lecture and again in the lecture session immediately prior to the marae visit. It should be noted that the actual pōwhiri process during the community engagements was conducted in te reo Māori, but the ensuing discussions were in English. Students were presented English translations of the pōwhiri visitor response speech delivered by M.W. Hughes so they could understand what was being said.

The Koukourārata Design Project

Koukourārata (Port Levy in English), is a local Ngāi Tahu rūnanga (community) situated on Banks Peninsula, on the southern margins of Lyttelton Harbour on Banks Peninsula, Canterbury, Aotearoa/New Zealand. Koukourārata has a long history of Ngāi Tahu, Kāti Māmoe and Waitaha land use and occupancy and holds a significant place in tribal history and traditions. The settlement and marae are located on the ancient pā (fortified settlement) site Puari. Koukourārata was the largest Māori settlement in Canterbury in the mid-

1800s with a population of around 400 and a reputation for its abundance of kai (food) – both māra kai (cultivated food crops) and kaimoana (seafood). The focal point of the modern community is Tūtehuarewa Marae, whose whare tipuna (ancestral/meeting house) was built in 1923 and named Tūtehuarewa after an ancestor. In 2004 a whare kai (dining hall) was added to the marae buildings, and was named Te Pātaka o Huikai (the storehouse of Huikai) after the eponymous ancestor Huikai. See Mahaanui Kurataiao Ltd (2017) for more details. The community is developing a successful project in conjunction with Lincoln University, Canterbury, to establish organic horticulture in line with the four Koukourārata strategic pou (pillars): 1) matauranga (knowledge/wisdom), including education and research; 2) economic development; 3) employment opportunities; and 4) bringing whānau (family) home/papakainga (original home/communal Māori land). The Koukourārata Development Company was established to give effect to the 2025 vision for the community: to protect and restore the mauri (life spirit) of the land and its water, and to engage and reconnect whānau with Koukourārata through creating employment, education enterprise and other opportunities. See Hapai (2017) for more information.

ENCN401 was invited to Koukourārata to meet with the community, learn about their history and values and to start working with them to address issues around provision of water for domestic use, agriculture and ecological restoration. There was also opportunity to address concerns around sanitation and energy. An essential element of the project was to spend time with community representatives to understand their issues and world views, to better enable sustainable and resilient community-centric designs.

The learning objective was to apply knowledge and skills to the design of an engineering solution for a well-defined problem related to water, sanitation or energy needs at Koukourārata, with the problem definition done in consultation with members of the Koukourārata rūnanga. Another key objective was to raise students' awareness of the social, economic and environmental issues that engineers must account for while working with developing communities. The class (total 37 students) was comprised mostly of students studying Civil and Natural Resources Engineering, with some studying in Forestry and Mechanical Engineering. Most students were from Aotearoa/New Zealand, but several were from North America and Europe. The class formed groups of 3-4 tasked with designing a practical and sustainable technology-based solution to a water, sanitation and/or energy problem. Although the focus was primarily on engineering solutions, groups had to consider social, cultural and economic factors impacting on successful design implementation.

Based on the preparatory lecture material and exercises groups were to first analyse the context and situation of the Koukourārata rūnanga, then define a particular issue to be addressed. This was followed by generating a suite of potential solutions, then narrowing these through concept selection. The project was executed via a series of milestones and community engagements described in Table 3. A valuable experience was the presentation of draft design solutions during a second day-visit to Tūtehuarewa Marae, providing students with valuable feedback from the rūnanga, and providing confidence that their designs were incorporating elements that directly addressed the community's aspirations.

The titles of submitted final projects are presented in Table 4. Projects addressed aspects of domestic and agricultural/horticultural water supply, flood and sedimentation mitigation, food production, with various degrees of holistic treatment of integrated water and energy systems. The final project reports and project posters/maps have been compiled, bound and gifted to the Koukourārata rūnanga. The intention is to over time build a library/portfolio of ENCN401 student designs for the community's reference, which may inform later detailed scoping and implementation to support local development initiatives.

Table 3: Koukourārata Design project milestones (M) and community engagements (CE)

M, CE	Task/Activity
M1	Identify team members
CE1	Spend weekend at Koukourārata and stay the Saturday night at Tūtehuarewa Marae. On the Saturday arrive and be welcomed in traditional pōwhiri, followed by education and orientation sessions run by the rūnanga. Sunday explore the area and speak to locals about relevant issues.
M2	*Problem definition report* that: 1) Clearly expresses underpinning values and approaches of the rūnanga towards the environment, natural resource utilisation, water and waste, and future development; 2) Identifies a water, sanitation or energy issue that groups wish to address, and qualitatively describe the problem, identify any potential for an integrated water-sanitation-energy solution; 3) Outlines proposal to define quantitatively characteristics of the issue and proposed solutions, identify further types of information needed; 4) Identifies necessary resources and constraints for project based on the information gained from visit and other sources. Constraints may include: terrain and climate characteristics, available construction materials, local labour skills, financial aspects, and local legislation.
M3	*Progress report* describing in more detail issue(s) addressed and potential solutions evaluated. Rationale presented for selecting a solution the project team will further develop. In addition to technical issues, attention paid to non-technical aspects as mentioned before.
CE2/M4	Spend Saturday at Koukourārata and Tūtehuarewa Marae. Each group to present a "mature" design to the rūnanga. Opportunity to showcase ideas and receive feedback to be incorporated into final project submission.
M5	*Final report* with detailed description of engineering solution to identified problem, supported by diagrams and calculations as appropriate. Emphasise role of technical (physical/engineering and scientific) and non-technical (economic, social, cultural) issues with respect to their interaction and how they shape technological implementation. Analyse how the technology meets the goal of sustainability. In-depth analysis of the technology using principles discussed in class. Describe how community feedback at the second marae visit was incorporated into final design.
M6	Reflection of evidence of student effort to engage with project, reflecting participation in activity. Garnered from students via a system allowing assessment of each other's relative contribution.

Table 4: Submitted Koukourārata design projects

Group	Design Project Title
1	Proposed irrigation and domestic water supply for Koukourārata
2	Proposal of a suitable potable water supply for the Koukourārata community
3	Flood mitigation for the Koukourārata community
4	Koukourārata olive grove proposition
5	Domestic water supply for Koukourārata
6	Taewa (Māori Potato) production through a hydroponics alternative for Koukourārata Marae
7	Sedimentation solutions in Koukourārata
8	Developing Koukourārata into an eco-community
9	Silt retention and economic stimulus package
10	Koukourārata Water Supply - A sustainable approach to a holistic water system

The ENCN401 class was surveyed to elucidate their experiences of the design project and engagement with the Koukourārata rūnanga. The survey was not part of the formal University of Canterbury course and teaching assessments, and response rate was poor. However, some useful and insightful comments were received.

Below are selected responses to the question: *The first part of [ENCN401's] lectures focussed on design thinking and idea generation, to arrive at culturally appropriate design solutions. Was this useful for the Koukourārata design project? If so, how?*

> *I did find this incredibly helpful as it made us take a step back and think more about what they want and need as they need to take ownership. It would have been even better if we had even more interaction with more people in the community while we were there.*
>
> *Yes some of [it] was helpful – I think it could be better applied in a [harsher] environment where there are significant language, cultural, social barriers – with more limited resources. The people from Koukourārata being from [New Zealand] were very open to help us achieve our goals*.
>
> *This was very useful, in the way that [it taught] us how to approach the community, and to expect that is would not be as easy as one may think. The members of the community may have a clear opinion of what is culturally acceptable, and how things work in the community, but this may be difficult to explain to us [who] have no knowledge. We experienced this in practice when we had both the meeting with [M. Cunningham at the University of Canterbury] and after our presentation at the Marae, that what we had understood [was] not totally correct.*

Below are selected responses to the question: *Having completed the Koukourārata design project, do you feel your understanding of Māori history/culture/worldview has changed? If so, how?*

> *Yes I definitely think I gained a much greater appreciation for Māori culture and I also really felt I understood why cultural diversity is so important in the world. I always knew it was the case but I had never been so confronted with it I suppose.*
>
> *Yes, I have a more exact understanding of especially their views of water and waterways, and what is culturally accepted in different situations. After personally interacting with the community I also feel more home and want to help the people and the area.*
>
> *Yes I have a more well-rounded perspective of how the Māori were previously treated and also how those effects have flowed on to the present day.*

Below are selected responses to the question: *In future, how do you think you might apply your Koukourārata design project experience?*

> *I think I will make sure to emphasise the importance of making people feel valued (I feel our idea achieved this), whilst also really listening to the [root] of the problem and trying to avoid preconceived ideas. I hope to do some entrepreneurial work to solve global problems, and I think a lot of the skills from the design project will be able to be applied. I also hope to work in developing countries and so it will be particularly relevant.*
>
> *The process and [technical] approach [are] experiences I for sure can use if I am working on a project in a developing community, but also when working with all kinds of stakeholders in project design and building projects. The [technical approach] will always have to be adjusted to the situation.*
>
> *If I am required to work with a particular Māori group it will be very helpful as I already know quite a lot of their core values and how to treat their culture. It was also good practice for dealing with potential clients. I do understand how the Māori are a developing community but compared to those in developing countries I think there is quite a big difference – it was still a valuable experience.*

We acknowledge the low survey response rate means that these student comments are not generalisable to the wider class. In future years class-wide assessments will be undertaken, and analytical frameworks will be developed with which to interpret them, such as the bicultural competencies presented in Table 1.

Taking stock, and the journey ahead

The 2017 inaugural Design Project in collaboration with the Koukourārata rūnanga has proven to be an interesting challenge for the teaching team and students, and will become a keystone in the course ENCN401 in years ahead. Although the sharing of practice presented in this paper cannot address metrics of success in a rigorous manner, future years will afford opportunities to develop appropriate metrics of students' bicultural competence, and wider failings and limitations from student and community perspectives that will be used to improve the course. The course incorporates aspects of design thinking, concept generation and selection, collaborative work, sustainability, and engaging with Aotearoa/New Zealand's indigenous Māori communities in the spirit of respectful co-creation. This approach serves two important purposes. First, the collaboration is helping provide the Koukourārata rūnanga with a diverse set of ideas and plans with which to achieve their aspirations for future development, and may serve as inspiration for their own youth to engage in Science, Technology, Engineering and Mathematics subjects throughout their education. It is hoped that aspects of student projects developed over time may be deemed sufficiently applicable to be scoped professionally and implemented to support Koukourārata's infrastructure and development. Second, the course ENCN401 and its Design Project directly address desired graduate attributes articulated by the Washington Accord (International Engineering Alliance, 2014) and the University of Canterbury (University of Canterbury, 2017a; 2017b), as well as addressing obligations in the public interest under the Code of Ethical Conduct adopted by the Institute of Professional Engineers New Zealand and Chartered Professional Engineers of New Zealand (IPENZ, 2016).

Looking ahead to 2018, the following will be done:

- The overall approach and structure of ENCN401 and its Design Project will be retained, but with some modifications made at the suggestion of students and teaching staff. These will include including more opportunities for environmental sampling and monitoring.
- Discussion will be had with representatives of the Koukourārata rūnanga on whether next year's projects should address particular themes e.g. impacts of natural hazards, climate change, aquaculture/marine farming, and sustainable energy. There is ample opportunity for this because this project is the first of many years of collaboration.
- In the preparatory curriculum materials more lectures will be devoted to developing place-based approaches to teaching about Māori histories in Aotearoa/New Zealand and Māori worldviews pertaining to their relationships with a diverse range of landscapes, water and the wider environment. Material on the 1840 Treaty of Waitangi and its ramifications will be included, including what this means for Aotearoa/New Zealand's bicultural society and its peoples i.e. Tangata Whenua (people of the land, Māori) and Tangata Tiriti (people of the Treaty, Europeans, others and their descendants in Aotearoa/New Zealand by virtue of the Treaty of Waitangi).
- Assessments will be made of students' cultural competence. This will involve written self-reflection exercises prompted by specific questions at the beginning and end of the course.
- In the final 4th Year (3rd Professional Year) of the undergraduate programme in the College of Engineering at the University of Canterbury, students are required to undertake a research project equivalent to ¼ of their year's course load. In 2018 two of these research projects will be dedicated to Koukourārata in addition to the design projects of ENCN401.

Beyond 2018, the following is intended:

- Continue over time to build a library/portfolio of ENCN401 student designs for the community's reference and inspiration;
- Continue to dedicate final-year research projects to complement ENCN401.

- Broadening the assessments of students' bicultural competence. In collaborative co-creation with the rūnanga, approaches including qualitative observation will be explored, as will the potential to apply participant-observer ethnographic research.
- Within the wider College of Engineering and Department of Civil and Natural Resources Engineering at the University of Canterbury, introduce more Māori content earlier in the undergraduate programme. Over time this will allow courses such as ENCN401 to build on this introductory material, and begin to address more complex and subtle issues of policy and legislation that impact on design implementation and sustainability.
- Engaging other rūnanga in the Canterbury region to see if the approaches being developed here can also be applied to other marae.

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