INDIGENOUS KNOWLEDGE, PERSPECTIVES, AND DESIGN PRINCIPLES IN THE ENGINEERING CURRICULUM

Marcia R. Friesen and Randy Herrmann
Faculty of Engineering, University of Manitoba
Corresponding Author: Marcia.Friesen@UManitoba.ca

Abstract – Canadians live with a legacy of troubled relationships between Indigenous Canadians and non-Indigenous Canadians, rooted in a history of colonialism and racism. Aligned with the Truth & Reconciliation Commission’s Calls to Action and the University of Manitoba’s Strategic Priorities 2015-2020, The Faculty of Engineering is planning curriculum initiatives to incorporate Indigenous Knowledge, perspectives and design principles.

The paper reviews the conceptual approach which encompasses both the culture of the institution as well as specific curriculum initiatives. These curriculum initiatives include redeveloping three core courses, first-year Design in Engineering, third year Engineering Economics, and third year Technology & Society for explicit inclusion of Indigenous knowledge, perspectives, and design principles; integrating Indigenous design emphases in capstone design courses, including Indigenous design principles and design application of importance to Indigenous communities, such as infrastructure development, energy independence, and food security; increasing the participation of Indigenous students in the Coop/Industrial Internship Program (IIP), and using the Coop/IIP to build authentic linkages to Manitoba Indigenous communities and environments; and, fostering linkages between teaching and existing faculty research programs.

Keywords: Indigenous Knowledge, Indigenous perspectives, Indigenous design principles, Indigenous engineering, sustainable development.

1. INTRODUCTION

Canadians live with a legacy of troubled relationships between Indigenous Canadians and non-Indigenous Canadians, rooted in a history of colonialism and racism. As part of the long road to restoration, the Truth & Reconciliation Commission’s Calls to Action [7] call for education for reconciliation, including the inclusion of Indigenous perspectives and content into post-secondary programs. One of the many goals under the University of Manitoba's Strategic Priorities 2015-2020 is also to “ensure every student graduates with a basic understanding of the importance and contributions of Indigenous peoples in Manitoba and Canada” [9].

In the Faculty of Engineering at the University of Manitoba, we are planning how we will incorporate Indigenous perspectives and content into the engineering curriculum. Moreover, how will we do it in a way that is naturalistic and meaningful, rather than as an add-on at risk of being disconnected from what is perceived to be the “real” curriculum? Many universities in Canada are at the same place, knowing this is something that needs to be done, but not quite sure how to do it. While a number of Canadian universities are unveiling Indigenous Strategy statements or documents, it is less clear how to incorporate them into curricula like engineering. At SAIT, six oil and gas pipeline courses have recently been redeveloped toward an ‘Indigeneering™’ approach – that is, combining Indigenous perspectives with engineering principles – and they will be delivered for the first time in their new form next year [1].

With more than 6% of the University of Manitoba’s undergraduate engineering students self-identifying as Indigenous, the Faculty of Engineering can safely boast to having a higher proportion of Indigenous engineering students than any other engineering program in Canada. This level of Indigenous participation is in large measure due to the success of the Engineering Access Program (ENGAP) – the premier engineering access program in Canada which provides Indigenous students with comprehensive social, personal, academic and financial support. However, this is tempered when the 6% Indigenous enrolment is compared to the 17% of Manitobans who are Indigenous, the highest percentage of any Canadian province. From 2006-2011, the First Nations population of Manitoba rose by 15%. The Indigenous population of Manitoba also tends to be young, with 51% under the age of 25 [5].

Even if there was not a single Indigenous student in the Faculty of Engineering, the need remains to Indigenize the curriculum and to create diversity in the student body including diversity of gender, cultural background, socioeconomic status, and ways of thinking and being. Engineering as a profession will be stronger with more creative artists, with more people from impoverished backgrounds, with more women, with more people of colour, and with other diversities. In particular, there is a need to educate the traditional engineering student
population of this diversity imperative by illuminating white privilege and male privilege, and the responsibilities that come with that privilege. Indigenizing the curriculum is not (only nor primarily) for the benefit of Indigenous students; it is for the benefit of the traditional student cohort.

This paper outlines the framework by which the Faculty of Engineering at the University of Manitoba is working to integrate Indigenous knowledge, perspectives, and design principles in its curriculum. It is presented to create dialogue with other engineering schools and to learn from one another for mutual benefit.

2. CURRICULUM INITIATIVES

2.1. Indigenous Knowledge, Perspectives, and Design Principles as Elements of Sustainable Development

The University of Manitoba was awarded an NSERC Chair in Design Engineering for Sustainable Development & Enhanced Design Integration focused on initiatives to enhance the undergraduate curriculum. Within this Chair and its action plan, sustainable development is defined as economic development, social inclusion, and environmental sustainability, all enacted under good governance. It can also be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Engineering design is a driver of desirable, long-term economic development and growth, and sustainable design is design aligned with sustainable development principles and includes attention to life-cycle low-impact materials, life-cycle energy efficiency, reuse and renewability, biomimicry, and new relationships between people and products (e.g. durability, moving from ownership to shared resources) across engineering disciplines [4][6][8]

Sustainable development and sustainable design inherently includes principles of accessibility and social inclusion, and in the University of Manitoba’s Design Chair Action plan, this element is explicitly directed to emphasizing Indigenous Knowledge in the proposed program. Within the framework of sustainable development, Indigenous knowledge will be framed around questions of how Indigenous Knowledge is relevant to engineering design, how engineering design is relevant to Indigenous peoples, and Indigenous design principles.

2.2. Conceptual Approach

Murray Sinclair, Canadian Senator, former judge, and Chair of the Truth and Reconciliation Commission, is known to have said, ‘It is education that got us into this mess, and it is education that will get us out.’ In taking on the act of reconciliation and education through the engineering curriculum, one has to be mindful of colonial tendencies, thought patterns, and approaches by which damage can continue to be perpetuated. An obvious risk is to oversimplify the issues and to again impose paternalistic attitudes and Western solutions to areas in need of reparation – whether relational, social, or technical.

A helpful axiom to remember is ‘nothing about us without us.’ Whether one is working toward better gender equality in the profession, the integration of foreign-trained engineers, or Indigenous Knowledge and inclusion in the profession, a key principle is to invite, listen, and respond to the voices of the key actors – in this case, Indigenous Canadians. In this, there is an important role of taking time to build trust and a sense of shared purpose.

We are also reminded that one must deconstruct before we reconstruct, and this can at times cause impatience in engineers who are eager to jump to solutions. However, “the truth of Truth & Reconciliation is that we cannot work together in a good way until we understand the story. This requires self-awareness and explicit examination of current status & structures” [1].

This can be envisioned as a three-part process. Listening and understanding is a critical first step, to consciously set aside what we all think we know about Indigenous people and be open to re-learning. This includes respecting different types of knowledge related to knowledge of communities, environments, and relationships, and for non-Indigenous Canadians to recognize one’s own lack of education in other systems of learning. Only then can one begin to focus on Knowledge, such as design integration and content knowledge, and only after Knowledge can one focus on experience, such as co-op placements and internships with Indigenous communities.

This conceptual approach outlines the institutional culture that we aim to foster at the University of Manitoba, knowing that the institutional culture is a requisite partner to specific curriculum initiatives outlined below.

2.3. Core Course Redevelopment

Indigenous Knowledge, perspectives, and design principles will be integrated into three core courses taken by all undergraduate students at the University of Manitoba: first-year Design in Engineering, third year Engineering Economics, and third year Technology & Society. These courses introduce design principles and concepts and explore the interface between engineering and other professions, the engineering profession’s role in society as a whole, and its regulatory mandate to act in the public interest.

First-year Design in Engineering provides an opportunity to highlight the history of Indigenous and non-Indigenous relationships by engaging with concepts of ingenuity and invention relative to First Peoples and to introduce Indigenous design principles to be further developed in later courses. For example, somewhat conventional examples of examining stresses in teepee
construction and buoyancy in relation to birchbark canoe in early years courses provide an avenue to link early Indigenous ingenuity with design principles, design materials, engineering concepts, and transitions to modern day development concerns of Indigenous peoples. As well, examples of design applications that open up conversations of Indigenous culture, history, and perspectives will be woven into other early-year courses to enhance students’ understanding of design and creativity.

Engineering Economics will be redeveloped to include the influence and role of funders (e.g. federal government) on infrastructure choices and the principles of valuation inherent in funding guidelines and strategies. It is also an opportunity to examine differences between Indigenous and Western perspectives on concepts like ‘ownership’ and ‘access’, the division that Western society makes between the ‘private’ and the ‘public’, and how those divisions impact land use planning, appropriation, and resource development. New content will be supported by students learning in critical writing assignments, economic valuations, and developing data sets oriented to economic decisions surrounding design and development in Indigenous communities.

Technology & Society provides an opportunity to revisit the history of Indigenous and non-Indigenous relationships, the history and structure of treaties, how treaties interact with development, the concept of social license, and the duty to consult. The course can also examine how Indigenous communities operate (governance and financial models), and different models of decision making (majority, consensus, committee, etc.). For example, the development at Grand Rapids, Manitoba for hydroelectric power in the 1950s and later is an excellent local case study, where Indigenous knowledge-keepers are still available and willing to speak of their experiences to students. This will be facilitated through new content, discussions, and engaging in reflective-, critique-, and comparative-writing.

2.4. Capstone Courses

Design projects with the explicit concerns and perspectives of Indigenous communities will be sought. A natural congruence with the sustainable development initiatives exists with a focus on infrastructure development, energy independence, and food security. An initial target is that one-third of design projects available to students in a given course will have explicit Indigenous design emphasis which can be combined with sustainable development emphases outlined in the earlier section. The manifestation of sustainability of designs in Indigenous communities can be examined in detail, such as aligning lifecycle operation and maintenance needs of the design with the resources in the community.

Capstone projects are an opportunity to integrate Indigenous design principles. These principles include commitment to relationships, culturally relevant design, respecting Mother Earth, fostering a sense of community, and embracing a Seven Generation view [10]. Indigenous design principles have also been outlined as focusing on three elements: Timeline: 7 generations as opposed to a quarterly, three-year, or five-year approach; Integration: an interconnectedness and view on cumulative impact on air, land and water; and, a circular model: an approach to design and projects holistically and collaboratively, based on relationships and not hierarchy [1].

At the same time, Indigenous designers indicate that while Indigenous design comes out of the traditional, it must be contemporary, engaging with (not for) Indigenous communities who are also coming into their own manifestations of modernity, driven – as expected – by youth.

2.5. Indigenous Participation in Coop/IIP

Increasing the participation of Indigenous students in the Coop/Industrial Internship Program (IIP), and using the Coop/IIP to build authentic linkages to Manitoba Indigenous communities and environments to develop student work experience placements. A focus will be on the consulting engineering services sector, who are significantly invested in working with and for Indigenous communities in Manitoba. The focus will be on increasing the number of Indigenous engineering students in the Coop/IIP program, as well working to develop an increasing number of placements that exposure Coop/IIP students – Indigenous and non-Indigenous alike – to environments wherein they are working on projects and issues of concern to Indigenous communities.

2.6. Champions

Keeping in mind the axiom that that ‘nothing about us without us’, the approach relies on drawing on our Indigenous students and Indigenous engineers in the practice community. Currently, only one of the approximately 100 faculty members in the Faculty of Engineering self-identifies as an Indigenous Canadian, and he has agreed to serve as a champion for these initiatives. This role entails being a resource and sounding board to interested faculty members who bring ideas and need feedback to shape and implement them appropriately. Currently, the Faculty of Engineering is also seeking an Indigenous Scholar (jointly with the Faculty of Architecture) and an Indigenous Engineer-in-Residence whose roles, in part, will be to advance these curriculum directions.

3. OUTCOMES AND SIGNIFICANCE

3.1. Research and Evidence of Impact

Indigenous design principles and Indigenous knowledge will also serve as research areas for educational
research including the impact and efficacy of curriculum changes on student learning, expectations, and motivations. Faculty member support needs and efficacy in teaching sustainable design will also be explored through research. The activities to advance sustainable design education are a fertile research area for collaborative research in design innovation and sustainable development technologies with faculty members in allied areas. Research in Indigenous design principles is likewise an under-explored area that is expected to lead to novel insights in design and innovation.

The Faculty of Engineering has set targets by which to provide evidence of these initiatives and their impacts. The educational research will be designed to assess the evidence in these areas over five years (by 2023):

- 1/3 of capstone design courses will be identified by a sustainable development and/or Indigenous design element.
- A quantitative increase in the student outcomes in graduate attributes evaluated in target courses, using processes in place for continuous curriculum assessment and improvement.
- A qualitative increase in students’ readiness in and perceived value of sustainable design knowledge, Indigenous perspectives, design skills, and preparedness for practice, self-assessed in graduate exit interviews.
- A qualitative increase in industry partners’ perceptions of graduate readiness as a result of training in new design knowledge and design skills, assessed via the Faculty’s annual industry forums and other new, structured mechanisms.
- Operationalized design outcomes in partner organizations & sectors.

We are optimistic that these curriculum initiatives will lead to new design knowledge and innovative learning experiences in design topics related to sustainable development, where advancing and broadening design principles and practices through the framework of design for sustainable development addresses a relevant and emerging industry need in engineering capacity. Further to the inherent principles of accessibility and inclusion within sustainable development, all undergraduate students will learn Indigenous knowledge, perspectives, and design principles, fulfilling a TRCC recommendation and a University strategic priority and mandate. As such, undergraduate students will be better equipped to practice engineering in Canada.

4. CONCLUSION

4.1. A New Intellectual Space

To engage with Indigenous design principles requires opening up a different intellectual space. It requires engagement with and openness to the authority of an Indigenous epistemology of interconnected relationships, which contrasts a Western epistemology of linear thought (the latter of which is grounded in the elevation of certain forms of thought and inquiry that comply with Western principles of measurability and validity). Indigenous design principles are grounded in interconnectivity between humans and nature and rely foundationaly on the principle of “place”. The contrasts are evident in Indigenous vs. Western views of economics (concepts of private ownership of resources), relation to the environment (hierarchies, limits), and architecture (transience and forms) [3].

At the same time, it is important to recognize that there is no “Pan-Canadian” Indigenous person and there is no single profile of a reserve. There are differences within Indigenous traditions and between communities. This is overlaid with the natural evolution of communities to modernity and technology. The framework is a step toward re-imagining engineering with Indigenous peoples, rather than as something that one does to or for Indigenous people and communities. There is an exciting potential for collective nation-building through a re-envisioning of “a Canadian identity for Indigenous people, and an Indigenous identity for Canada” [2].

Acknowledgements

This work is supported by an NSERC Chair in Design Engineering to the first author and the University of Manitoba Faculty Development Initiatives (FDI) Fund.

References


