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A New Vision for Mining Education—First Steps

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This paper narrates the experience of a Canadian university in reorienting its mining curriculum towards the goal of producing engineers who are sensitive to context. The authors acknowledge industry's historical association with environmental degradation and imperialism, but counter that mining is necessary to provide the materials of civil infrastructure, particularly that required to reduce green-house gas emissions. They also point to the potential for mining projects to rejuvenate communities, by providing the revenues that support self-determination, suggesting that more equitable distribution of impacts and benefits may be achieved through engineering design that is better informed and sensitive to community perspectives.

To promote such an approach to engineering design, the Robert M. Buchan Department of Mining at Queen's University has instituted a program of curriculum re-positioning that is informed by theories of situated and transformative learning. This paper traces the first steps in the development and execution of curriculum that supports the development of student awareness of context and culture and a new contextually-sensitive approach to professional practice.

KEYWORDS: Mining, engineering education, engineering ethics, environmental ethics, social responsibility, sustainability, curriculum

INTRODUCTION

Historically, the extractive sector has had a poor environmental record. In recent years, offshore incidents involving human-rights abuses at Canadian-owned mines (Leahy, 2006; Macdonald and Rowland, 2002; Mendleson, 2012; Payne, 2014; Popplewell, 2009; Sandborn, 2010) together with Aboriginal protests over development on traditional lands (Ball, 2011; Bigué and Hudon, 2008; Freeman, 2013; Halley, 2013) have brought into sharper focus the many social costs borne by affected communities. The potential for extractive projects to inflame social and cultural tensions is a major concern for advocacy organizations, policy makers and industry. As a result, the last thirty years have seen stricter legislation, increased scrutiny from civil society watchdogs, the proliferation of voluntary industry standards and the promotion of the Corporate Social Responsibility (CSR) function to corporate status, all of which have contributed to improved performance on many fronts, particularly environmental impact. However, competing cultural narratives of development, which are also highly contextual, continue to complicate the resolution of social tensions.

Notwithstanding the fact that mining projects can bring employment and economic opportunity to remote communities (Brereton & Forbes, 2004; Evans, 2013; Martin & Newell, 2008; World Bank and International Finance Corporation, 2002; Triscitti, 2012) even the best-planned have potential to cause environmental disruption and social destabilization. Environmental responsibility has

already been woven into the academic treatment of mining engineering—in every university mining department, researchers work to develop cleaner production processes and more reliable impoundment technologies in the quest to minimize environmental damage[1]. Additionally, as a requirement of program accreditation, students of mining engineering in Canada are now taught that their professional responsibility includes ensuring that design and operational decisions minimize environmental impacts. In Canada, and increasingly in other jurisdictions, ever more rigorous regulatory regimes underscore this responsibility. And, while researchers in fields such as sociology, public health, geography, politics and development studies have documented the harmful social effects of mining on communities, it is only relatively recently that *mining* schools have begun to contemplate how they might teach their own students about the profound social and cultural impacts of the very industry that will employ them. Equipping graduates with skills that will enable them to critically evaluate particular social contexts and identify opportunities to develop engineering approaches responsive to community concerns has not been part of the traditional undergraduate curriculum (Baillie, Pawley, and Riley, 2012).

An approach that is being explored by the authors is to conceptualize community concerns and aspirations as functions of culture, which might be addressed through engineering practice. We contend that while culture alone does not fully explain a community's view of itself or its response to proposed development, including extractive projects, the acquisition of a comprehensive understanding of the political-economic-historical context of a particular community is also inadequate as a foundation for effective dialogue with affected communities. So-called "cultural" or "cultural sensitivity" training, which typically includes an introduction to this history, as well as to the overt practices and communicative preferences of a particular group, has since mid-twentieth century been routinely offered to engineering professionals and executives to enhance their performance in multi-cultural teams and their ability to conduct business globally (Pusch, 2004). Such training has focused on presenting the history and etiquette associated with specific cultures. Typically, the focus of these programs has been neither on the skills and attitudes of the learner, nor the function of self-awareness and empathy in facilitating meaningful—rather than either expedient or superficial—dialogue. In contrast, *intercultural competence* (Deardorrf, 2006) approaches the facilitation of trust-building and authentic dialogue through development of a complement of skills and *learner attitudes.* The concept of intercultural competence has a loose and evolving definition, but nonetheless, has been shown to have practical value for predicting attitude change and adaptability to unfamiliar cultural contexts. Using the Bennett *Intercultural Development Inventory* (IDI) to track development of student attitudes and skill over time, we plan to evaluate the effectiveness of curriculum interventions in effecting a permanent change in the values of our own cultural community, the mining engineering department at Queen's University in Kingston, Ontario.

Currently, cultural differences in worldview enter the curriculum only through *cultural safety training* (National Aboriginal Health Organization, 2006), which is offered to final year students by staff from Four Directions, the university's Aboriginal cultural centre. The training introduces them

[1] Cleaner production fulfils many goals. From a business standpoint, more efficient technologies for processing contribute to lower production costs, increasing profits. At the same time, investment in improved energy efficiency has profound implications for the environment, particularly in isolated communities and in the North, where the only available energy source is diesel. Similarly, the quest for lowered water usage may be motivated by cost control, but nonetheless improves environmental performance. In jurisdictions where environmental regulations are more stringent, research into process and design innovation are similarly motivated by profit: minimizing costs of compliance with evolving standards illustrates the role of policy in creating conditions that balance support for business with driving innovation.

to Canada's colonial history and the pervasive intergenerational effects of trauma inflicted on Aboriginal peoples by systemic policies of assimilation. This background is certainly essential if students plan to work within Canada, but without directed intervention designed to promote the development of both *self-awareness* and a *sense of agency*, mining students are unlikely to embrace the task of re-conceptualizing the roles and responsibilities of either the mining industry or their profession. Our current research investigates how we might effectively integrate opportunities to develop self-awareness, the themes of social responsibility and agency into an already dense technical curriculum in order to equip students with the knowledge and skills needed to meaningfully bring social and cultural awareness into their practice.

We begin with the belief that mining engineers are well placed to become catalysts for the evolution of a more equitable relationship between communities and industry for two reasons. First, the professional responsibilities of mining engineers afford unique opportunities: over the progression of a project through the stages of the mine cycle their responsibility for the design of all aspects of the mine project provides opportunities to respond constructively to community concerns and aspirations *before* culturally damaging design decisions are taken. Second, during the construction, operation and decommissioning stages of the cycle, mining engineers are onsite, with unmatched opportunity to interact with and even become members of the community. To take advantage of these unique and substantial opportunities to build trust, engineers must be capable of recognizing them and appreciating the interplay of social trust and good engineering decision-making.

Our research thesis is that curriculum supporting the development of socio-cultural sensitivity and trust-building skills (orientations and skills in the affective domain) will prepare engineers to contribute to the creation of the respectful and resilient relationships needed to earn and maintain the *social license to operate,* a concept which is now widely accepted as an invaluable component of project success (Boutilier & Thomson, 2011). The social license conceptualizes the nature of a community/extractive company relationship in which the community is an informed and willing host with documented influence in decision-making and where benefits and risks of the project are managed collaboratively. From the perspective of business, the maintenance of the social license is an effective hedge against social risk because it can minimize the threat of community-level conflict that could result in revenue loss due to disruptions to operations or even project abandonment. Critics such as Kemp and Owen (2013) charge that the *social license to operate* reassures industry but fails to fulfill its promise to empower communities. Craig Ford, the former VP of Corporate Social Responsibility at Inmet Mining, concurs, arguing for replacement of the term *social license to operate* with *privilege to operate,* a term that implicitly challenges some of the assumptions inherent in a *license* (2014).

We contend that social risks are now so significant in mining that communication and cultural sensitivity should no longer be viewed as complementary skills for engineers in mining engineering, but rather, should be considered as core *engineering* skills within the discipline. In this paper we discuss initial steps taken by the mining department at Queen's to incorporate relationship-building skills into its curriculum, particularly at the undergraduate mining level.

WHY MINING EDUCATION NEEDS A NEW FOCUS

The 2013 Annual Review of the International Council of Mining and Metals (ICMM) was titled *Strengthening Relationships with Communities*, reflecting the refocusing of priorities by the 21 major member companies, on community relationships as a key measure of environmental and social performance. ICMM President Anthony Hodge has said that the landscape for industry has changed dramatically even in his six years as head of the organization. Indeed, Hodge has stated that today's

single most significant determinant of a project's success is neither ore grade nor financing, but *relationship with community* (March 6 2014, speaking to students at Queen's). The importance of forging strong relationships is echoed by Marketa Evans, Canada's former Councilor for the Extractive Sector, who has argued that trust-building is industry's *greatest challenge* (2013). Yet Kemp and Owen (2013) report that in spite of wide acceptance that community relations (CR) is core to business success, most mining companies still assume that CR is the sole responsibility of the community engagement staff and contracted consultancies.

As Ernst & Young Global confirm in their annual advice to the investment and corporate management communities (2013), social risk continues to threaten mining projects around the globe. Social risk may be defined as strategic risk that derives from stakeholder challenges to business practices, based on real or perceived impacts on human wellbeing (Befeki, Jenkins & Kytle, 2006). Interest in the management of social risk is due to its relation to profitability, yet the persistent failure of operators to engage effectively with the people who will be directly affected by mine projects illustrates industry's difficulty comprehending issues in the socially perceptive or culturally fluent manner that would lessen this risk. Although continuing conflict might appear to offer evidence of intransigence around community concerns, it is important to be fully cognizant of the gap between the reality of industry's present perspectives on its obligations to society (i.e., to create shareholder value and to a lesser extent contribute to the national economy) and the enlightened perspectives (i.e., to ensure that the communities that host resource extraction projects do not shoulder disproportional cost of impacts, and that they enjoy benefits *defined on their own terms*) that we aspire to for the future. We do not claim that the human and ethical dimensions of extractive projects influence the corporate agenda; however, the growing risk to profit posed by the status quo suggests that business cannot continue "as usual." Ironically perhaps, the threat to the bottom line becomes an advantageous starting position for re-conceptualizing the process and responsibilities of relationship (First Peoples Worldwide, 2013).

From this starting position, we are beginning to explore the potential that increased emphasis on socio-cultural skills within the mining curriculum might have for contributing to an incremental shift in the ways in which extractive operations are conceptualized by those in decision-making positions. While the enduring desire for precious metals and gemstones does suggest the need for serious soul-searching on a global scale, there is virtually no debate on the question of our need for industrial minerals. Even in the putative post-industrial West, where heavy industry has all but disappeared—having migrated to jurisdictions that offer cheap labour and loose environmental regulations—the products of the extractive sector are still required. Providing the major components of civil infrastructure (which many climate scientists and theorists argue must be enhanced and extended to more of the global population if global warming is to remain checked), mining remains an imperative. This is in spite of its record of negative environmental impacts and complicity in oppression, and the apparently intractable problem of inequitable distribution of impacts and benefits. Notwithstanding reservations we may have (which are shared by many within the industry) about some of the practices of resource extraction and asymmetric distribution of impacts and benefits, the pressing question is not whether mining development should/should not continue, but the immediate and far more complex question asked by Armstrong, Baillie and Cumming-Potvin: "How we can ensure that necessary minerals are obtained in a responsible way, i.e., observing the principles of environmental ethics and social justice?" (2014).

Some critics argue that corporate values are fundamentally incompatible with meaningful progress towards social justice and environmental stewardship. Whether or not this is true, we have chosen to set the argument aside in second and third year courses, in favour of a focus on impacts,

specifically, the implications of various engineering approaches on environmental and social impacts.

Becoming a more reflective engineer is a prerequisite for the adoption of a more informed, open and critical position on any charged topic, including on the role of corporations within an equitable and functioning society. In second and third years, we concentrate on supporting students' enculturation into their profession—learning to "think like engineers." Past research, particularly that which analyzed the culture of the engineering study/workplace for young women and minorities, indicated a tendency for successful students to defend practices and attitudes that they would otherwise be expected to view unfavourably while others struggle to reconcile self with a professional identity that privileges "masculine" qualities (Adam, 1997; Chu, 2007; McIlwee & Robinson, 1992; Saavedra, Araújo, Taveira, & Vieira, 2014). Authors of these studies have suggested that during university and early in their careers, students are motivated to identify as members of a community of practice, and that any criticisms or reservations they may have about the group's cultural values are subordinated to the desire to fit in. By the fourth year (when they take the sustainability course), we surmise that students are beginning to become comfortable in their identity as mining engineers—most have, by this time, participated in the profession as summer students at mine sites—and are better positioned to participate in a more critical analysis of the industry. One of the goals of our curriculum changes is to nurture the development in our students of a sense that reflection is a necessary component of the engineering mindset, and that as engineers they have both agency and a responsibility to effect change. Students learn that the corporation is a social construction, which behaves as it is constituted to behave. Building upon their understanding of this fact, we can introduce and support the acquisition of the knowledge and skills that will enable students to move beyond critique towards action—responding to corporate agendas from a position of agency in the context of their profession.

The tension between social/environmental risk and potential for cultural renewal and community well-being that characterizes the global mining industry compels us to help our students contextualize the work of the mining engineer within corporations. Modern mine design and mining methods require huge investment and thus, the corporate structure and culture of the industry have been accepted, for the most part without question, within mining schools. We might have approached our educational objectives via a critique of corporate capitalism, but because industrial scale mining has potential to play a contributing role in environmental stewardship and social justice, we take our immediate task to be the realization of that potential. Within our technical courses, we see a place for introducing students to the roots of community mistrust. We explore the experiences of communities, especially those emerging from a colonial history, and introduce the concept of culture as a fundamental determinant of worldviews. Assignments that invite reflection upon their own epistemic assumptions support the development of an expanded conception of what it means to be an engineer.

We ground our approach in the situated learning theory of Lave and Wenger (1991), placing learning activities within a social context that allows students and practicing professionals to experience culturally determined attitudes towards mining *together*. Professors model sensitivity to the values and experiences of affected communities, while industry support for our initiatives serves to reinforce cultural sensitivity in practice as a *professional norm*.

Over the course of their studies at Queen's, students are challenged to discard the assumptions about engineering that they brought with them. Combining the principles of both transformative learning (Mezirow, 1991) and situated learning, curriculum changes that have been implemented and those in the planning stage seek to ensure that the next generation of mining engineers

appreciates the human and environmental dimensions of their work and that they are equipped with the insight and tools needed to address the issues that arise as a consequence. We contend that a sustained effort in this aspect of their education will contribute to the intentional cultural shift that is known as *social innovation* (Westley, 2006)—the phenomenon whereby a series of small shifts in cultural values reaches a threshold or "tipping point," beyond which, cultural changes cascade to create new norms—here, norms respecting the epistemic values held by future generations of mining engineers and consequently, the approach taken to their practice. This, we believe, will contribute to building genuine—that is, *respectful, resilient, and lasting*—relationships with communities.

MINING ENGINEERING AT QUEEN'S UNIVERSITY

The Department is fortunate to have received a substantial endowment from alumnus Robert Buchan, the founder of Kinross, specifically to facilitate curriculum enrichment and ensure that the department will continue to have the resources to teach and provide experience with evolving best practice (in technical terms), but also that the curriculum will enable students to comprehend and address the social and environmental implications of their work.

In the sections that follow, we trace our first steps towards this curriculum. We present examples from MINE 422, *Mining and Sustainability*, MINE 201, the foundation course in mining, MINE 341, the introduction to surface mining, and the Graduate Certificate in Community Relations (GCCR), a new program designed to enhance the knowledge and skills of people working in community relations.

The First Step—A Course About Mining and Sustainability

In response to emerging industry standards and in anticipation of the coming Canadian Engineering Accreditation Board (CEAB) requirement that all Canadian engineering programs include training in sustainability, the mining department introduced a stand-alone sustainability course as an undergraduate elective in 2007. Since then, the department has embarked upon a gradual reorientation of the entire curriculum to ensure that a critical perspective on the environmentally and culturally complex context in which mining occurs is integrated throughout technical courses as a norm.

In its Minerals and Metals Policy, the Government of Canada offers guidance on conceptualizing the term "sustainable development" in the context of the extractive sector. Four principles are embodied within this conception:

- Finding, extracting, producing, adding value to, using, re-using, recycling, and when necessary, disposing of mineral and metal products in the most efficient, competitive, and environmentally responsible manner, using best practices;
- Respecting the needs and values of all resource users and considering those needs and values in government decision making;
- Maintaining or enhancing the quality of life and the environment for present and future generations; and
- Securing the involvement and participation of stakeholders, individuals, and communities in decision making. (Natural Resources Canada, Minerals and Metals Sector, 2000, p. 3)

In our re-orientation of the undergraduate mining curriculum, we have employed this distinct meaning of *sustainability,* in the context of resources that are inherently non-renewable, as our starting point.

Mining and Sustainability, was developed as a third year course by the aforementioned Anthony Hodge, a geological engineer whose extensive experience in the mining sector—including work with government, civil society organizations and industry—led him to the role of North American lead on the International Institute for Environment and Development's Mining, Mineral, and Sustainable Development (MMSD) project. The MMSD initiative sought to reconcile the practices of mineral extraction and processing with a broadening societal commitment to sustainable development (International Institute for Environment and Development, 2002). Hodge shared with students his perspective that mining has unique potential to bring benefit to society and that industry itself must take steps to ensure that environments are safeguarded and communities find themselves stronger and healthier as a consequence of mining. This vision was nascent in 2007, but Hodge's passion for the potential social contribution of mining was well received by third year students who enrolled in this course.

Hodge introduced students to such concepts as industrial ecology, full cost accounting, and the *Seven Questions on Sustainability* (Hodge, 2004)—presenting sustainability as an engineering problem where additional and competing constraints can only be balanced when all the stakeholders have meaningful input. Perhaps Hodge's personal story as much as his teaching ability contributed to the success of this course: in 2007, most mining students had not been meaningfully challenged to consider the harms caused by the industry or to imagine how things might be done differently, much less to consider their own responsibilities for effecting this change. Perhaps because Hodge so compellingly told stories that linked credible industry experience with his growing realization of the potential for doing better, perhaps because he challenged preconceptions with questions and good humour, or perhaps because students who chose this elective course were simply already open to a new perspective, the course was a great success, as indicated by formal evaluations and by numerous requests for a second course that would delve deeper into the issues and explore opportunities for contributing to improved outcomes for affected communities through mining. It must be noted that at this particular time, before environmental and social responsibility had secured their place in the corporate board room, many engineering students were deeply skeptical about sustainability, rejecting the messages of those who encouraged critical thinking about impacts (Johnson, 2009). A less accomplished person or more accusatory approach to critique might have been met with defensiveness by students eager to take on the identity of mining engineer. Hodge though, presented a visionary and empowering model of the responsible mining engineer who embraces a problem: a technically skilled professional who, acknowledging industry's historical association with hegemony and inherent risk, applies his knowledge of what is technically possible to the improvement of performance in the areas of environmental and social impacts. He portrayed the mining industry as a wonderful place to be because of its particular blend of human and technical challenges. Acknowledging past and indeed, some present irresponsible and unethical practices, Hodge impressed upon students the opportunities (as well as responsibilities) offered by their education—supporting the development of their ability to reflect—to constructively and critically analyze ways of practicing, impacts and possibilities for improvement—as well as a sense of agency to bring improvement into action.

By 2008, Hodge had taken up his position with the ICMM and was in the process of moving to London. The course timetable was compressed to accommodate his schedule. For two week-long blocks, students arrived at 8 AM daily for a 90 minute class—a very early start and very dense delivery format compared to what students are accustomed to in a standard twelve week term. The course was still an elective in 2008, but the class was consistently full of attentive students.

The instructors who have taught the course since have each brought a distinct focus to the integration of sustainability within the curriculum. From 2010 to 2012, the course was viewed

through the lens of systems ecology, when it was taught by post-doctoral fellow, Samir Doshi. After completing doctoral work at the University of Vermont, Doshi had gained experience working with the coal-mining communities of Appalachia. He was interested in reclaiming abandoned mine sites and re-empowering disenfranchised communities through facilitation of intergenerational sharing of stewardship knowledge. In Doshi's iteration of the course, students learned about natural systems, the concept of "tipping points," and resiliency. Adding a graduate version of the sustainability course (MINE 722), which included seminars enabling a deeper exploration of diverse areas of interest, Doshi brought an interconnected, ecosystem framework to the discussion of mining's impacts. He led students in an exploration of multi-disciplinary approaches that may be required to adequately comprehend and address them. The living environment and human's role within and relationship to it formed the dominant theme in both courses.

Vic Pakalnis followed, bringing a focus on occupational health and safety to the sustainability professorship, extending expertise gained through years of regulatory experience in Government of Ontario's Ministry of Labour[2] to broader applications in communities where mining development occurs. Pakalnis was most interested in the social and economic components of sustainability, and the themes of economic opportunity, building infrastructure to improve standards of living, and community empowerment characterized his iterations of MINE 322. Pakalnis shared with students an interest in improving participation in industry, in decision-making capacities, by those most affected by mining's presence. He was particularly interested in encouraging Aboriginal[3] Canadians to consider engineering careers. Working with colleagues in the School of Policy Studies, Pakalnis was instrumental in organizing several national symposia (2008, 2010, and 2011) that focused on issues of concern to Aboriginal Canadians—whose communities in the north are co-located with much of Canada's mineral wealth—and potential roles the energy and resource sectors might play in facilitating greater participation in project development as well as in incubating a diversified economy within affected communities. The most recent, in 2011, gathered community leaders, scholars and policy makers to identify the barriers to higher education facing Aboriginal youth. A seminar within this conference brought together representatives of mining companies, educators, and community leaders to work on strategies for building capacity within Aboriginal communities by recruiting and supporting Aboriginal students in fields associated with mining (particularly those in the sciences and engineering).

Jeffrey Davidson joined the Department in 2011. Davidson, an anthropologist who later studied mining engineering and mineral economics, brought years of in-the-field experience in community relations, having been influential in the early development of more progressive engagement policies implemented by companies such as Placer Dome and Rio Tinto. In addition to assuming the professorship of the sustainability course, Davidson created the graduate course MINE 860 *Mining and Human Rights*, a vehicle for sharing his unique expertise in the problems of artisanal mining and international conventions respecting human rights. A notable achievement of this course was the enrolment of non-engineering students. Students from the departments of politics, environmental studies, global development studies and geology contributed varied and critical perspectives to the course, which explored the many ways that mining projects have negatively impacted communities. The methods and perspectives of these different disciplines gave graduate students in mining direct experience working towards a shared analysis of highly complex social issues, as they completed group tasks that simulated negotiations, corporate planning, and policy development related to the linkage of trade, foreign aid, and domestic and international operations

[2] In Canada, both labour and mining are regulated at the provincial level

[3] In Canada, the term "Aboriginal" is legally defined and refers to persons who identify as belonging to one of the following ethnic groups: First Nations, Inuit, and Métis

by Canadian firms. Role play has been a dominant teaching method in the course, and students enthusiastically "get into character" bringing an authenticity and pathos to the concerns that often lie at the heart of conflict. In subsequent iterations of the course, students have been drawn from Policy Studies and philosophy. The centrepiece of Davidson's tenure however, is the mandate to develop a graduate program in community relations expressly for the extractive sector. The *Graduate Certificate in Community Relations* (the GCCR program), is described in a later section.

The *Mining and Sustainability* course has reflected the interests of each successive instructor, whose areas of expertise were very different. Now that the national accreditation body has mandated an undergraduate sustainability course, it is clear that a consistent set of learning objectives must be identified and variations in content and perspective subordinated to their achievement. As the work of integrating principles of sustainable practice into the core technical courses progresses, the content and focus of the undergraduate sustainability course must continue to evolve.

Re-Envisioning the Entire Curriculum - MINE 201 Introduction to Mining

Undergraduate programs in Engineering and Applied Science at Queen's have a common first year. Within this year of general science and professional skills, students encounter some specific disciplines (geology, computer, chemistry and materials, math and physics/mechanics/electrical), but they are not introduced to mining directly. Thus, for the majority of students, their first experience with the multi-faceted domain of mining only comes in second year, *after* they have selected their discipline. This fact provides the department with a unique opportunity for shaping student understanding of the professional culture and values of the discipline. In the theory of *situated learning*, Lave and Wenger introduced the concept of the *community of practice,* a social grouping that develops in the context of skills acquisition and performance—learning to perform a complex task set that combines specialized knowledge, motor skills and decision making procedures and heuristics (1991). They contend that the novice—here, the second-year student of mining engineering—has a profound desire to become an accepted member of his or her chosen community of practice—to identify and be recognized as *mining engineer*—and that this desire makes novices to a profession or trade particularly impressionable, eager not only to absorb the knowledge and acquire the skills of the group, but also to adopt its *affective and cognitive style*. The second year courses in mining and mineral processing provide an opportunity to revise and enrich the curriculum in order to ensure that the moment a student identifies as a "Queen's Mining Engineer," she or he will also identify as a contextually aware and professionally engaged social actor.

Research has shown that students resist direct challenges to their perception of so-called professional culture and values when the challenge is perceived to originate outside of the group. Even at early stages of their professional training, students displayed a narrow range of responses—from resistance to resentment—to invitations to engage in constructive criticism of current engineering practices. Baillie and Johnson (2008) found that first year engineering students rejected encouragement to reflect upon the implications of their practice, and instead, concluded that particular teachers were promoting attitudes inconsistent with professional norms. From this it is very important to seize the opportunity to articulate professional norms immediately upon a student's entry into professional training. As noted, most students who enter the mining program at Queen's do not have previous experience of the extractive sector, so the introductory courses of second year have a formative influence on student perception of what *mining engineering* is all about and a normative influence on what comprises its professional values. In addition, the CEAB has required that *sustainability concepts* be covered within all accredited curricula since 2008;

offering a stand-alone course in sustainability was a first effort, which fulfilled this minimum requirement. However, the stand-alone model suggests that sustainability is an add-on, subordinate to "real" mining, and coming in fourth year, misses the window for imprinting mining engineering's (re-envisioned) cultural values as students learn together. For these reasons, MINE 201, the introductory course in mining and mineral processing taught for the past three years by Dr. Josh Marshall, is the decisive course in terms of meeting learning objectives from the affective domain. If we want the next generation of mining engineers to value environmental stewardship and respect for communities, their education must equip them with the tools to operationalize these values, and their learning experience must encourage them to see critical reflection about human and cultural concerns as integral to engineering work.

From the first class each year, Marshall connects the human dimension of mine development into his discussion of the mining cycle. In recent years, the interplay of context and technical approaches to mine development have become inextricably linked through students' experience on field trips that form the basis of a series of learning activities. In 2011, the class travelled 26 km north of Kingston to a small mine, which was at the time, in the permitting phase. The Canadian Wollastonite Company's mine is situated within a farming community, 1 km south of Seeley's Bay, a village of approximately 550 households.

This field trip offered students an opportunity to experience first-hand the environmental and social problems that surround mineral development. By reading local newspapers, and speaking directly with people in the community and with the mine's owners and engineers, they learned about community concerns—noise, dust, increased heavy truck traffic—that can be mitigated through fairly straightforward means, as well as about concerns that are more difficult, or even impossible to fully resolve—anxiety and distrust. Students walked through the mine site (approximately 300 acres of privately owned land, upon which the owners live) and had the opportunity to learn about the process of environmental assessment and the types of impacts that even a small mine imposes on an ecosystem. The mine owner led the class through the site, describing how he had worked with the Queen's Biology Department to obtain baseline environmental studies (determining the variety and population of flora and fauna on the property), risk assessments (the risks posed by mine development and operation to wildlife habitat) and best-practice approaches to habitat protection that can be taken in the design phase. Student interest was visible as mine owner shared the excitement he had felt when biologists showed him how mine planning could contribute to conservation of the black rat snake, an endangered population, by creating sites suitable for hibernacula in areas clear of mine activity. The owner pointed out the mitigation techniques that had been and were being employed to address community reservations—seeing the dense border of pine and fir trees planted fifteen years earlier to provide a visual and sound buffer to mine operations, students gained a sense of the long timelines associated with responsible development, as well as of the large number of areas of specialized knowledge that must be brought together to ensure the mine has minimal negative impact.

Assignments that built upon the mine visit required students to explore divergent opinions around the mine development (protection of the rural heritage and pristine water supply vs. generation of revenue for three levels of government and opportunities for well-paid employment in an area that has fairly high unemployment) and to consider how these tensions might affect a small close-knit community. While they were not permitted to directly contact members of the community on their own, students were given a package of materials similar to what would be included in a social impact assessment. Their assignments required them to research, evaluate and determine costs of various methods of addressing stated concerns. During their first term in mining engineering, it was expected that the approach would be quite high-level, and this was the case. Some students

obviously spent additional research time, and offered quite detailed plans for mitigation along with thoughtful commentary on financial implications.

The course required students to learn about the permitting process and its complicated and multi-jurisdictional legal requirements. They learned that cautious planning and expert-designed mitigation of impacts may not satisfy all members of a community. They learned that community *perception* of risk and benefit plays a critical and inextricable role in the ability of a project to move forward. They learned firsthand that the pillars of sustainability are inextricably linked and that environmental concerns contribute to social issues and most importantly, that there are many problems in mining that cannot be solved by calculation.

MINE 201's 2012 field trip needed to accommodate a much larger incoming class (75 vs. 45 students plus teaching assistants), so the group travelled to Timmins, a northern Ontario town that owes its existence to the development of surrounding mines in the early twentieth century. For three days, different companies hosted this large incoming class. Unfortunately, logistics prevented the entire class from touring each host site, but roughly one third of the students were privileged to meet and talk with Anishnaabek elder Martin Millen at the Aboriginal Learning Centre at Goldcorp's Porcupine Gold Mine operations. Just as the trip to Canadian Wollastonite had opened students' eyes to the many non-technical considerations that are part of responsible mine-planning, the experience of learning about herbal sources of medicines, and the spiritual significance of water and animal life in the area of the mine to the local community made a strong impression upon students. Many had not considered the implications of site design for the nearby community and for most students this was their first encounter with Aboriginal teachings. The following summer, several students applied for summer positions at this mine specifically, because they wanted to learn more about the company's approach to working with the peoples from the nearby First Nations and how they might become better engineers by understanding culturally diverse perspectives on "responsible mining." During the summer of 2014, students from the same group sought and obtained summer internship positions in locations (Alberta, Peru) where there was an opportunity to observe and participate in projects that must obtain local consent. One student used the opportunity to talk to the local people and to collect their stories—these will inform his fourth year thesis.

Mine 341 – Introduction to Open Pit Mining

Ursula Thorley, who holds the Allied-Nevada Chair in Surface Mine Planning and Design, teaches MINE 341 (the open pit course), which introduces students in their second year of mining to the methods that create the most visible and arguably most lasting environmental impacts. Learning to manage the delicate balance of constraints and resources is the over-arching objective of the course. With several years of industry experience as a design engineer working in precious metal mines and in the bitumen mines in Alberta's Athabasca oil sands, Thorley has an informed appreciation of the many impacts and benefits of this massive industry. Before beginning doctoral work, Thorley was responsible for the design of waste impoundment facilities for Syncrude. Through this work, she developed a concern for the ability of the current regulatory framework to safeguard the environment over the long-term. An engineer, Thorley embraces the challenge of "solving a problem" but recognizing the limits of current technology. Her research explores the adequacy of sureties required for long-term impoundment of mine waste and whether policy makers need better models for incorporating costs of waste management and environmental monitoring into determination of mine profitability.

The particular social impacts associated with large scale mining are discussed in MINE 341 in the context of mine planning. Students learn the advantages and disadvantages of training and employing a local workforce, compared with operating with a fly-in/fly-out workforce. Using richly detailed case studies and data sets from existing projects, assignments and a major project ask students to experiment with different scenarios using simulation software.

In 2013, the MINE 341 class had the opportunity to participate in a four day field trip to Fort McMurray, the hub of the Canada's petroleum industry. A group of 20 students elected to join the trip which included tours to three production sites as well as to equipment maintenance facilities. The small size of the group was conducive to lively discussions about "life in Fort Mac" between students and the alumni who acted as guides. Many on this trip had travelled to the Timmins teaching teepee the previous year. These students were keenly interested in learning about the First Nations, the Athabasca Chippewyan First Nation and the Fort McKay First Nation, whose traditional territories are home to the oil sands. The students wanted to know whether the communities welcomed or were hostile to the projects, given the centrality of water to Aboriginal culture (in addition to the universal concern for conservation of ground water) and its intensive use in extraction. From direct experience living and working in the oil sands, Thorley was able to share with students the divergent views of the two communities. Fort McKay First Nation, closest to the city and upstream from most development has a favourable opinion of industry: community members have negotiated agreements that have enabled them to secure good jobs at the mine sites and to establish successful businesses to provide ancillary services. In contrast, the community of Fort Chippewyan is further north, *downstream* from development. Although they too have built some ancillary businesses, equivalent opportunities for employment have not benefitted the more distant community, and there are allegations that poor health outcomes are the result of toxins (McDermott, 2014). There is yet no proof to the claims, and attempts to secure participation of all of the nearby First Nations in a comprehensive public health investigation have encountered multiple hurdles (Weber, 2013).

Learning objectives related to sustainable engineering require that both cognitive and affective domains be applied to problems that have social, environmental and economic dimensions. Richly detailed and compellingly presented case studies could have been used in support of our learning objectives, but visiting the area allowed students to experience directly the scale of operations, the boreal forest environment, and the distances between the city, the production sites and the Aboriginal reserves. Whereas their technical courses rightly emphasize the acquisition of knowledge and skills related to safely mining and processing this resource, this trip provided a unique opportunity for students to sense the ethical dilemma of downstream effects. The contrasting experiences and attitudes of nearby communities underlined for students the difficulty of ensuring that the interests of so many diverse stakeholder groups are protected. Those who participated in this field trip have realized that exploitation of unconventional petroleum reserves requires that intersecting problems be addressed. An important lesson for young engineers who may practice within Canada is that the Aboriginal peoples of the country are culturally unique and their perspectives on mining's impacts and benefits are diverse and contextual.

Fort McMurray's situation has been likened by social historians to that of a gold-rush town, while residents will argue that modern approaches to planning have ensured that the city's growth is conducive to maintenance of a healthy young population. This debate notwithstanding, "Fort Mac" exemplifies the paradoxes that surround the extractive industry. These include the fact that the oil industry is a major employer of both highly skilled and marginally skilled workers, with an appetite for human resources that can scarcely be satisfied, even though the unemployment rate in the country is 6.7% (Statistics Canada, 2014). In addition to local residents, industry depends on a huge

transient workforce that flies in for three to six week blocks from as far away as Newfoundland. It generates much needed revenues for all levels of government from the Regional Municipality of Wood Buffalo, which is home to the city and its mines, to the federal government. In between, Alberta has developed a co-dependence on industry to fund increasing demands on provincial infrastructure (transportation, energy, education and health). The opportunity to earn money is almost without parallel in Canada (for example, truck operators with grade 11 educations easily earn over C$100,000) but the combination of fly-in camp lifestyle combines with high disposable income is correlated with drug and alcohol abuse, as well as creating labour shortages in other sectors. In Fort McMurray itself, housing demand outstrips supply while service jobs unrelated to the mines are overwhelmingly filled by "temporary foreign workers" (TFWs), mostly from the Philippines, who are indentured to a single employer for a period of up to four years (Bennett, 2014).

Next Steps—Continuing to Enrich the Undergraduate Curriculum

For a small department, its financial cushion notwithstanding, a critical decision is whether *Sustainability* will become a research as well as a teaching focus. It remains to be determined whether resources are available to support an interdisciplinary research program into aspects of sustainability, such as impacts on wildlife habitats and the effects of in-migration on incidence of sexually transmitted infections (STIs), gendered experiences of impacts, and other concerns that have not traditionally been a part of the mining curriculum. If the stand-alone sustainability course comes to be complemented by contextual discussion of issues within the technical curriculum, its evolution can take either of two paths: it can become the vehicle for a critical exploration of the philosophical underpinnings of sustainability: an economy predicated on growth, the environmental and social costs of unchecked consumption, inequitable distribution of impacts and benefits, the asymmetric political power of corporate and human interests and the ethical obligations of licensed engineers to participate in and inform public discourse about appropriate approaches to solve these problems; alternatively, the course can function as a practical knowledge (survey) course, enabling students to develop a more comprehensive understanding of the legal frameworks that bound their work. Given the number of jurisdictions and diversity of regulatory environments that students are likely to encounter during their careers, such an evolution would offer similar scope for critical reflection on mining practice, through an exploration of the interplay between expectation, aspirational commitment, and enforceable regulation.

The Graduate Certificate in Community Relations

A certificate program in Community Relations was launched at the University of Queensland (UQ) in 2006. With industry support in the form of both input into curriculum and financial resources to fund its development, the UQ program has enjoyed a healthy and steadily increasing enrollment from its inception, employment of graduates across the industry, expansion of opportunities for graduate studies, including development of diploma and master's level programs. To date, UQ has trained over two hundred field workers who liaise between local communities and mining companies.

Jeffrey Davidson was given the task of creating a similar program to support the adoption of more effective community relations practices by Canadian miners. The Queen's program, the GCCR, is modeled on UQ's successful template: a program of four courses delivered entirely by distance after an initial week-long intensive residential component. The courses introduce, respectively: Community Aspects of Mineral Resource Development, Community Development for the Mining Industry, Community Engagement and Mining and Mining Projects and Indigenous People; but there are some significant differences to the UQ program. Queen's is a *graduate* program, requiring

potential candidates to hold a minimum bachelor's degree, and it has also been tailored to address the contexts in which Canadian mining companies operate. Because Canada's federal government is committed to large scale mineral development in the country's Far North and in northern Ontario's "Ring of Fire," and because mainstream public education continues to leave most Canadians ignorant of the country's colonial past and the consequent challenges faced by today's Aboriginal Canadians, it was determined that the program's course on Indigenous peoples needed to include substantial content on the unique history, culture and concerns of Canada's Aboriginal peoples—particularly the First Nations and Inuit peoples who are at the nexus of development.

Launched late in 2012, the part-time graduate program attracted twelve candidates. Of these, two withdrew for reasons of increased professional workloads, four graduated after one year of study (taking two courses per term), and six completed the program in 2014. An additional six students enrolled in 2013, with two graduating thus far.

The mandate of the program is to familiarize students with the issues that matter to communities, the political and historical realities that underlie some mine-community conflicts and to prepare graduates with current best-practices from the fields of social and community work to assess and understand community needs and aspirations and to effectively develop and present plans for mining development that will assist communities in achieving their goals. The ability to build respectful and mutually beneficial relationships in the context of diverse (possibly incompatible) world views, often compounded by a profound power imbalance among the parties (as is evidenced in remote, often poor indigenous communities that lack political power, and multinational resource companies that wield influence) is the tall order for which this program aims to equip students.

The week-long residential component begins with an acknowledgment by the Dean of the Faculty of Engineering and Applied Science that Queen's University is situated on the traditional lands of the Algonquin and Mohawk nations and Prayer for Good Minds, led by an Anishnaabek elder. The department is fortunate that several Aboriginal scholars and elders have provided advice on the structure and content of the program and have been generous in sharing the experiences and worldviews that shape communities' perception of and attitudes towards mining. Given mining's historic role in the colonization and oppression of many communities and indeed, diversity of opinion among Aboriginal communities about the cultural and environmental appropriateness of industrial scale resource extraction, participation in the program is a sensitive matter for Aboriginal leaders, and we are grateful that participating leaders have honoured us with their trust in our commitment to partnership and respect.

Instructors of the four courses that comprise online portions of the program facilitate workshops during the residential week. In the first year, Aboriginal scholars and community members talked about their culture and spiritual connection to the natural world, as well as about their frustration with Canada's land claims process and the Indian Act.[4] This was done in *sharing* or *talking circles,* a traditional approach to the creation of safe space in which to air grievances and resolve conflicts. Some of the sharing circles were visibly uncomfortable for students, most of whom were confronting the historical facts and legacies of colonialism for the first time. In a facilitated discussion after the experience, several expressed indignation that they ". . . were being treated as if we were responsible . . ." They used words like "unfair," and "bullying." The obvious discomfort they

[4] The community members who spoke to the students are not named here because many are still distrustful of the mining industry and participation in any activity that does not condemn mining can be perceived as disloyal.

displayed can be interpreted as evidence of a disruption to previously unquestioned assumptions—expectations around identity, acceptance and accountability. However, by the end of the week, it appeared that students had begun to feel "safe" again, as indicated by the effusive praise given in their evaluations of the residential experience, to the dialogue exercises they engaged in with lead instructor Pam Bourke. These face-to-face events initiated a process of critical reflection that would be scaffolded in the online learning activities, in which Bourke explored how the companion problems of assumptions about others and of ourselves impede our ability to be authentic.

Specialists from private sector consultancies, with backgrounds in social work and conflict resolution offered advice and shared proven methods for coming to understand communities. Academics taught students about the interplay of soft and hard law, and the evolving international understanding of the Rights of Indigenous Peoples and implications of broader adoption of its principles of Free, Prior, and Informed Consent (FPIC). They shared experience negotiating Impact and Benefits Agreements (IBAs) and reflected on assumptions and omissions that can lead to community disappointment and loss of trust. Senior management from some of Canada's major mining companies and industry organizations explained how government regulations, corporate finance and frameworks for permitting constrain their decision-making. They offered guidance on how students can better understand these constraints in order to communicate the community relations plans to the boardroom and win board support.

Cranton (2006) contends that transformative learning, described by Mezirow, can be facilitated by the creation of situations that disrupt intellectual comfort and complacency. For these disruptions be effective, educators must provide supports that help students to arrive at new and expanded perspectives; but the journey's work is down to the student. The learning activities in the GCCR courses serve to support exploration of alternatives to outmoded worldviews, offering new perspectives that may reconcile old assumptions with new visions. End of term evaluations confirmed that students had found the learning process to be challenging and provocative, but that they also felt they were "beginning" to "see things differently."

We believe that the strength of this program as it evolves is its collaborative approach, bringing participants from stakeholder and advisory groups together outside the high-pressure context of a negotiation to permit a multi-layered and progressive dialogue. The second intake was smaller than anticipated, much smaller than could support the substantial costs of bringing specialists to Kingston for the week-long residential. The decision was made in 2013 to postpone the intensive component until the summer of 2014 when it is planned that the 2014 and 2013 intakes can be combined. This decision was not taken lightly since feedback from UQ (Bourke, in conversation, 2013) and from our own first cohort had confirmed both engagement with professors and fellow students and the provocative immersion in the issues as essential to the transformative value of the program (ahead of independent study).

This setback necessitated the revision of curriculum, adding introductory material to the front ends of all courses. Professors made greater use of multimedia to engage students in the discussion forums provided in the learning management system (LMS). Knowing that one of the reasons for the low 2013 enrollment was the industry downturn, which resulted in across-the-board cuts to professional development budgets, we sought to work more closely with industry to ensure that they would see the value in supporting the GCCR program. We convened an Advisory Meeting during the fall of 2013, inviting senior representatives from the CSR and CR divisions of Canadian major miners, government agencies and the Assembly of First Nations (AFN), a major Aboriginal policy and advocacy organization. We also invited faculty from departments whose expertise is

relevant to responsible mining and whose research includes work with communities affected by mining.

We were pleased with industry's willingness to advise us. Almost every company that we invited sent a senior manager or VP to the meeting, some travelling thousands of miles. The agenda for the day included three presentations on CR from the perspectives of a senior VP, a site CR manager and a field CR consultant. Bob Rae, a respected senior politician (former Premier of Ontario and former leader of the Liberal Party of Canada) who is currently the chief negotiator for the Matawa Tribal Council, an umbrella organization representing the interest of six First Nations whose traditional territories cover the mineral-rich Ring of Fire, delivered a keynote address that infused the day's work with purpose. Rae is a passionate voice for reconciliation of Canada's peoples after the violence of colonization. He also promotes the unique opportunity afforded by appropriate mining development to radically alter Canada's relationship with Aboriginal peoples. To do this, he argues, mining projects must look to a partnership model that sees decisions taken in collaboration with affected communities. A compelling speaker, with a vast knowledge of Canadian legal history and great respect for Aboriginal people, Rae's vision of mining's potential as the basis for healthy thriving communities underlined the importance of the GCCR program's objectives and added to the energy and enthusiasm among the participants.

After reviewing the program objectives and structure, participants were led in a gap analysis of the curriculum. This exercise took the form of facilitated small group discussion—where groups were constituted to include at least one member from each main stakeholder group: Aboriginal peoples, government, academia and industry, consultancy/NGO—around the following questions:

1. Does the program have the correct focus? That is, does it address needs?
2. Who should be targeted for participation?
3. How do you see the program leading to certification? (Canada does not have any industry standard for the certification of community relations personnel.) How should we plan to accommodate this in the intermediate and mid-term?
4. Are there additional or better ways to deliver the program's objectives? Feel free to consider all options.

The results of the exercise were made available in December 2013. There were five main recommendations:

1. Consider laddered credentialing (GCCR certificate as step towards a Master's).
2. Consider reducing the size and weight of the modules and increasing their number to allow students to select areas of specialty.
3. Improve marketing by developing a concise program purpose statement, articulating WHAT the program's aims are and WHO the program is designed for.
4. Balance the theoretical with the practical (Increase use of simulation and case study).
5. Increase the potential for capacity-building (sharing with colleagues).

The university has now granted permission for GCCR graduates to proceed to a master's degree (an M. Eng.) by taking four additional graduate courses. The development of additional distance offerings has begun and the first of these was offered September 2014.

The raw feedback data also emphatically showed a desire for short modules, particularly offered closer to head offices. As a result, the department is offering a two-day Seminar on Community Relations February 27-28, 2015.

The Seminar on Community Relations

The *Seminar on Community Relations* is conceived of as an annual event focusing on a single theme critical to supporting constructive community relations. The inaugural theme is Resettlement—a highly complex and contentious issue, particularly in the developing world where land tenure laws have not protected the rights of pastoralists and nomadic peoples. With participation of respected experts such as Luc Zandvliet and the staff of rePlan, the seminar promises to introduce participants to the competing agendas that collide when mineral projects are planned for areas where subsistence farming is practiced. The intensive week of the GCCR program has been reconfigured to benefit from synergy with this event. It will now begin with students joining industry practitioners at the seminar before spending three additional days immersed in dialogue training and becoming acquainted with their professors and the LMS. It is our hope that the seminar will address industry's request for short modules and serve to demonstrate the value of investing in the GCCR or M. Eng.

NEXT STEPS

Achieving social equity and environmental sustainability will depend in large measure on two factors: responsible agriculture and responsible mining. We have argued that access to metals is critical to increasing social and economic equity, but also for addressing environmental pressures resulting from past practices and a population of more than 8 billion. Access to the products of mining is highly correlated to standard of living—current levels of inequity would seem to imply that exploitation of the planet's mineral resources will be required for some time to come, even if the affluent countries of the global North can be persuaded to reduce their own consumption and increase percentage of materials recycled. The materials that comprise the bulk of water and waste systems, for example, are metals and plastics, both products of the extractive sector, with large volumes of aggregates used alongside. Thus, if we consider such a basic human right as clean water and the health that it protects, we *must* come to terms with our reliance on water-intensive activities such as mining. Add to this, the role of mined materials in the infrastructure of clean and renewable energy and transportation systems and telecommunications (which, as illustrated by events such as the Arab Spring, play a role in extending democracy and human rights throughout the world). It becomes evident that engaging constructively with mining's problems is our only ethical course of action.

What of the corporate nature of the extractive industry? Industrial scale mining is a multi-billion dollar sector operating globally. Critics are highly skeptical of the potential for the industry to bring lasting benefit to the less powerful citizens of the world, and some dismiss industry's progressive policies as mere *green-washing*. Such criticism serves a purpose, ensuring that attention remains focused on practices that do not serve society as well as they might, and that alternate conceptions of a healthy and just society are considered. The students who are currently studying mining engineering at Queen's are preparing for careers in which they are likely to work for and may eventually become directors of corporations engaged in industrial mining. Even at the pinnacle of their careers, they are unlikely to be able to alter the corporate imperative to "make money," but as engineers, there is broad scope for them to influence decisions about *how that money is made*. It is thus essential that we instill the values and impart the skills that will enable graduates of our programs to direct their corporations' economic and political influence towards support for environmental and social justice objectives.

The fruits of curriculum change are slow to ripen, but when today's graduates progress to the boardroom, we expect to see an acceleration of the pace of the adoption of enlightened corporate policy: that which embraces a broader conception of partnership—bringing the benefits of mining

to affected communities in forms that are culturally appropriate, continuing to make progress in lessening environmental risks, and effective rehabilitation of lands after closure.

In the words of Tye Burt, the former President and CEO of Kinross, "The mining industry needs more engineering graduates with the skills to meet the challenge of responsible mining. That includes the ability to understand the expectations and aspirations of communities where we work, and to find 'win-win' approaches that support business objectives while also making a positive net contribution to the long-term economic and social well-being of the community" (Kinross, 2007).

The process of curriculum revision and renewal, the weaving of contextual elements including historical, political, cultural and environmental concerns throughout the technical curriculum requires considerable collaborative effort and will take time to be fully realized, but faculty members are committed to preparing our graduates for a world that will depend upon more socially-engaged and competent engineers.

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