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Stubborn boundaries: the iron ring ritual as a case of mapping, resisting, and transforming Canadian engineering ethics

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This article explores the historical context and ongoing discussions of the iron ring ritual, a prominent tradition in Canadian engineering. We employ discourse analysis to describe and analyze components of the ritual itself, as well as more recent texts related to contemporary conversations about the ritual. We apply Alice Pawley's scholarship on boundary work in engineering as an analytical framework and find the ritual has served to reproduce and map boundaries around engineering ethics and responsibility in Canada, and numerous actors have resisted those boundaries based on opposition to the colonial, misogynistic, and Christian values embedded in the ritual, as well as the ritual's framing of engineering agency and responsibility. We reflect on the lessons this case can offer for members of the Canadian engineering and engineering education communities, as well as for those interested in the power and complexity of humanistic interventions in engineering.

KEYWORDS

iron ring, Rudyard Kipling, engineering ethics, colonialism, ritual and ceremony, discourse analysis, engineering education

1. Introduction

Since the mid-1920s, Canadian engineering students have marked the end of their studies by participating in *The Ritual of the Calling of an Engineer*, also known as the iron ring ceremony or iron ring ritual. The ritual is intended to incorporate newly graduated students into engineering culture and to remind them of their professional responsibilities. The "iron rings"—now more commonly made from stainless steel—that participants receive have long been a recognized and valued symbol of Canadian engineering identity. Engineers who have participated in the ritual typically wear the ring on the little finger of their working hand, serving as a daily reminder of their obligation to engage in ethical engineering practice.[1] In recent years, individuals and groups within the Canadian engineering community have

1 https://ironring.ca/home-en/. Accessed June 18, 2023.

called for the ritual to be renewed, rewritten, or discontinued, on the basis of the ritual's colonial values and alleged outdated framing of engineering (Hurley, 2023).

The ritual was written in 1923 by British poet Rudyard Kipling, at the request of University of Toronto engineering professor Herbert Edward Terrick Haultain (more on them and their influence later in the paper). Since the initial ceremony was held in Montreal in 1925, the ritual has spread throughout Canada. It is administered by the Corporation of the Seven Wardens, which oversees 28 "camps" throughout the country. Volunteer "wardens" at each of these camps organize and conduct the ceremonies for graduating engineering students and other candidates who meet the requirements for professional engineering licensure in Canada.

The ritual varies between camps to some extent: for example, some camps permit only engineers who have previously participated in the ritual to attend, while others allow participants' family and friends to observe. Camps can also create their own preamble and conclusion, and can invite guest speakers. However, during all ceremonies, the official text of the ritual remains unchanged from Kipling's writing, save for minor edits aimed at addressing the explicit masculine and Judeo-Christian language of the original. The full ritual text, which is not publicly available, includes a reading from the book of Esdras (one of several books of biblical apocrypha which are included in some Christian canons and teachings, but excluded from most modern bibles), an address to participants, and an "obligation" which participants recite. After reciting the obligation, participants receive their iron ring from a previously obligated engineer. The ritual employs various metal artifacts—rings, chains, and an anvil—as ceremonial objects.

The iron ring and the ritual are culturally important aspects of Canadian engineering, and studying their origins and ongoing presence in engineering discourses can help us to understand engineering attitudes and values in the Canadian context. In this paper, we argue that a critical examination of ritual texts and other related documents illuminates widely held and often implicit definitions of engineering responsibility, in particular the dominant narrative of (perceived) engineering objectivity. We apply Alice Pawley's analysis of the field-defining boundary work of engineers (Pawley, 2012a) to study the ways historical and contemporary actors map, maintain, police, and resist the boundaries around engineering responsibility. We find the ritual has solidified and maintained longstanding inequities and particular understandings of engineers' social responsibilities, and we describe how individuals and groups have attempted to critique both the tradition of the ritual and the implicit understandings of engineering embedded within it.

The iron ring ritual demonstrates the complexity and risks of integrating engineering and the humanities, as well as the special role education plays in such integration. Our critiques of the ritual are informed by humanistic thinking, including critical theory, post-colonial and decolonial thinking, and a valuing of equity, diversity, inclusion, indigeneity, and accessibility. We bring theories and practices typically found in the humanities to bear on engineering, and in the process reveal significant issues within engineering practice and culture. However, we do this warily, as the iron ring ritual itself serves as a cautionary tale. As a humanistic intervention aimed at creating and reinforcing notions of engineers' ethical and social responsibility, the ritual proves such interventions do not necessarily render engineering more inclusive or critical, and can instead serve to create and reify existing and problematic cultural norms.

Finally, while the ritual is aimed at engineering professionals, it is typically experienced by senior undergraduate students, thus serving as a symbolic bridge between student and professional experience. It is framed and introduced in the undergraduate years, and integrates with other symbolic experiences related to identity formation and cultural acceptance. We argue that the issues arising from the ritual extend well beyond the ceremony itself, and should be considered in the contexts of both engineering education and professional practice. In both contexts, but especially education, we argue for an increased emphasis on ethical agency and critical reflection. As Carl Mitcham puts it, "where might we begin to promote more critical reflection in our engineered lives? One natural site would be engineering education (Mitcham, 2014)." We could not agree more.

2. Theoretical and historical framing

Before delving into the iron ring ritual and surrounding discourse, it is necessary to provide some background and context on the history of engineering ethics, responsibility, and practice in Canada. In this section, we introduce objectivity narratives and social captivity, which we employ as theoretical framing, and demonstrate these concepts through a discussion of two significant events in early twentieth century Canadian engineering history.

2.1. Engineering responsibility and objectivity narratives

The ethical and social positioning of engineers has been a topic of contention since the beginning of the twentieth century (Mitcham, 2009). The early history of American engineering defined engineering responsibility through appeals to public welfare, starting in the 1900s (Layton, 1971) and continuing through the "long sixties" (Wisnioski, 2012). Today, engineering accreditation standards require that students learn about ethics, equity, and the social impact of technologies (Seabrook et al., 2020), while a growing field of scholarship advances social justice within engineering education (e.g., Riley, 2008; Baillie, 2020).

Still, engineering responsibility remains a slippery and contested concept, with social responsibilities being particularly contentious (Johnson, 1992). Technical codes define engineering responsibility through technical design criteria and safety standards, based on current standards of practice (Smith et al., 2014). Formal codes of ethics are widespread within professional associations and—especially in Canada—within the regulatory bodies that legally govern engineering work.[2] However, as Pesch (2015) argues, these require interpretation and active maintenance to be effective, skills engineers are not always trained to practice. Furthermore, formal processes of accountability for the social

2 Examples of Canadian codes of ethics. Accessed June 18, 2023: https://www.apegm.mb.ca/pdf/CodeOfEthics.pdf; https://www.ieee.org/about/corporate/governance/p7-8.html; https://www.peo.on.ca/licence-holders/code-ethics

responsibilities associated with technological design are mostly lacking. While practicing engineers are subject to legal standards that define some social responsibilities, the ability to act responsibly and ethically requires education, interpretation, and experience, which is neither guaranteed nor fully defined by regulations (Roncin, 2013; Randall and Strong, 2021).

In the absence of official standards, engineers' conceptions of social responsibilities often rest on dominant cultures, narratives, and beliefs, which provide boundaries around their responsibility. One boundary emerges through the narrative of engineering practice as scientifically objective and apolitical (Cech, 2014; Cech and Sherick, 2015). The "ideology of depoliticization" described by Cech separates engineers from their work's sociopolitical effects, allowing them to avoid collective responsibility for impacts viewed as non-technical. This allows engineers to evade responsibility perceived as subjective, including the decision-making processes determining if a design should exist at all. Scholars describe this as engineering's "social captivity" (Goldman, 1991; Johnston et al., 1996; Mitcham, 2009; Nolan, 2021), meaning engineers simply carry out directions from sources endowed with decision-making powers (such as nation states and corporations), effectively separating themselves from the decisions of those sources of power. Thus, engineers' framing of their work as "objective" excludes any responsibility to contribute to decision-making about what work is done, how their designs are used, or what lasting impacts occur.

These narratives are often supported by a useful vagueness around the concept of humility. In design, humility helps engineers acknowledge their partial perspectives, and to acknowledge perspectives from non-engineers. This is an essential aspect of community-based and social justice-oriented engineering. Cultural and epistemic humility is important in cases where engineers engage directly with users or community members as part of the design process (Riley and Lambrinidou, 2015; Mazzurco and Jesiek, 2017), or in teamwork (Nolan and Davis, 2022). However, humility can also reinforce the objectivity narrative. An engineer who frames the goals or consequences of a given project as "outside their expertise," may be practicing humility in a limiting way. The uses and ramifications of this approach to humility are seen in two examples of early 20th-century Canadian engineering: the Quebec Bridge collapse and the construction of the Greater Winnipeg Water District Aqueduct. The former is typically associated with the ritual, while the latter is not.

2.2. Engineering failures and the effects of the objectivity narrative

The Quebec Bridge collapse is frequently used as a cautionary ethical tale for Canadian engineers (Pearson and Delatte, 2006; Victor, 2022). The cantilever bridge over the St. Lawrence River collapsed in 1907 after the failure of the lower chords in the anchor arm near the main pier (Pearson and Delatte, 2006). Most workers present died in the collapse (75 of the 86), including 33 ironworkers from the Mohawk nation of Kahnawà:ke. The bridge collapse is technically attributed to improper latticing design on the compression chords, a result of miscalculation and inappropriate assumptions by the engineers responsible (Pearson and Delatte, 2006).

The story of the Quebec bridge is often discussed alongside the iron ring ceremony, in both historical and contemporary accounts (Roddis, 1993; Levert, 2020). There is a persistent—though apocryphal—belief that the original iron rings were created from materials salvaged from the collapsed bridge. The lessons typically drawn from this engineering failure include the importance of verifying calculations and designs, the risks of poor management, and the danger of valuing money over safety (Messier, 2022). While these lessons range from the technical to the values-oriented, they also conform to typical narratives of objective engineering responsibility. The Quebec bridge example aims to remind engineers—and participants in the iron ring ritual—to focus personal responsibility on safety, technical competence, and design approvals (Victor, 2022). These lessons support the objectivity narrative as they are securely framed within well-defined and verifiable bounds, but do not engage the engineer's subjective and agentive decision-making potential.

In contrast, the types of problems that emerged from the design and construction of the Greater Winnipeg Water District Aqueduct are not typically featured prominently in discussions of ethical engineering, such as those surrounding the iron ring ritual. The aqueduct extends approximately 154 kilometers from Shoal Lake, in Western Ontario, to the Deacon Reservoir on the outskirts of Winnipeg, Manitoba, supplying the city with drinking water (Ennis, 2011; Perry, 2016; Bernhardt, 2019). During aqueduct construction, beginning in 1914, the original Ojibwa village of Shoal Lake 40 First Nation was displaced and moved to a man-made island (Shoal Lake 40 First Nation, 2021). Both Shoal Lake 40 First Nation and the nearby Iskatewizaagegan #39 Independent First Nation suffered irreparable cultural, spiritual, and financial damage as a result of the project. For decades, the displaced residents of Shoal Lake 40 First Nation risked their lives crossing the water for everyday activities, resulting in multiple drownings (Bernhardt, 2019). In 1997, a cryptosporidiosis outbreak caused a boil water advisory on the lake (Puxley, 2015). The lack of a direct road to Shoal Lake 40 First Nation from the mainland made it difficult and expensive to move supplies to build a water treatment plant. Shoal Lake 40 First Nation has since advocated for and succeeded in building a road to the mainland, called Freedom Road and completed in 2019, nearly 100 years after the aqueduct's construction (Kabatay, 2022).

Throughout the early 20th century, politicians, newspapers, and engineers denied the existence of the Indigenous peoples living near Shoal Lake to gain support for the aqueduct project (Perry, 2016). During design and construction, engineers publicly encouraged the project in media and in technical reports (Ennis, 2011, 2013; Perry, 2016), stating in 1906 that the Shoal Lake area had "practically no habitation with the exception of a few Indians and an odd mining camp and no possibility of contamination from this source" (Manitoba Free Press, 1906). These reports and newspaper coverage encouraged strong support for the aqueduct project from Winnipeg residents.

The engineers who built and advocated for the aqueduct project were diligent in their assessment of the water quality, their structural design for the aqueduct itself, and even their consideration of the economic impact to Winnipeg residents. Thus, according to dominant engineering norms, the aqueduct project was a success: construction was largely completed within three years, without major incident, and the aqueduct continues to supply fresh drinking water to Winnipeg in 2023. The larger context

of the project illuminates the extent to which this perspective is limiting, by exposing the aqueduct's disastrous consequences for local Indigenous communities.

Although some recent coverage now critically frames the aqueduct construction as a tragedy, a violation of human rights, and an obstacle to reconciliation with Indigenous peoples (e.g., Lorraine, 2016), the project has not been widely recognized as an *engineering* failure. In the context of colonial Canada as a resource extraction society (Klein, 2016), beginning with the fur trade and continuing today with mining, oil, and natural gas projects situated within or near Indigenous communities, we recognize the aqueduct project and its consequences for the Shoal Lake 40 First Nation as one part of a much larger narrative. Canadian engineers played an outsized role in building their modern nation and in contributing to the colonialist project. However, the objectivity narrative and the framework of social captivity obscure certain community needs, contribute to the language of colonial erasure (Perry, 2016), and allow engineers to escape responsibility for consequences outside of these dominant narratives. As we will see below, this framing of ethical responsibility has recently been challenged through a resistance to the norms established in the iron ring ritual.

3. Methodology

In this research, we employ discourse analysis to describe and analyze the narratives and norms of engineering ethics, as communicated in the ritual and in contemporary discussions about the ritual in Canadian engineering culture. As Sara Mills describes, a discourse theory perspective allows us to view debates about language and texts as simultaneously "struggle[s] to change words" and "struggle[s] over legitimacy" (Mills, 2004). Thus, the ongoing discourse about the words, history and symbols associated with iron ring ritual is also a discussion of what engineering is and how the field and practice ought to be represented. By examining the texts included in this study, we locate different, and sometimes conflicting, understandings of engineering responsibility.

We draw from multiple texts as data sources, including poems, websites, public letters, a conference roundtable discussion, news articles, PowerPoint presentations, and the ritual's obligation text. We use Pawley's (2012a) analysis of boundary work in engineering as our analytical framework (see section 3.2 for details). Pawley herself applies Gee's (2005) theory of language and discourse analysis to structured interviews to reveal and analyze instances of boundary work. In our study, we apply Pawley's analytical categories to a wider range of texts, noting instances of boundary mapping and resistance related to engineering responsibility. The resulting analysis includes both descriptive and evaluative claims.

Through our analysis, we aim to understand both an established cultural tradition and ongoing events surrounding it. Conducting this work in the midst of the contemporary discussions allows us to capture details so they are not lost by time. As the iron ring ritual has remained largely unchanged for 100 years, the case represents a unique opportunity to examine attitudes and values concerning engineering social responsibility across a century. We, as authors, are also involved as actors in the case: we have (co-)written some of the contemporary texts, and we are discussed as subjects in others. As such, we have endeavored to be self-reflexive and self-critical in our description, analysis, and assessment.

3.1. Authors' positionality

In recent decades, there have been numerous calls to change, update or reimagine the iron ring ritual, with varying degrees of success. All the authors of this paper are currently involved in one such initiative—the Retool the Ring group—which began in summer 2022. Here, we present our own stories and personal perspectives on the iron ring and ritual, and how they inform this research. We do so because culture is the collective creation of subjective actors, and so by clearly identifying our subjectivity, we can make clear how our positioning impacts our approach to data collection, analysis, and discussion. As Riley and Lambrinidou (2015) and Stibbe (2015) argue, the normative nature and potential of culturally centered arguments should be openly embraced.

Robyn is a fourth-generation settler, with Ukrainian and British heritage. Coming from an academic family, she thrived in engineering education, doing her obligation and receiving her iron ring in 2011. As she started her master's in 2014, her engineering worldview began to change, which paralleled her journey into queerness and advocacy work. She now integrates social justice and feminism into her engineering research and teaching. About two weeks before meeting her colleagues and friends who would eventually become the Retool the Ring group, something drove her to take off her iron ring. It just didn't feel right anymore, and retrospectively it feels like fate. As a co-facilitator of the Retool the Ring group, over the last year, she is continuously humbled by the group of volunteers, the strength of their activism and the wealth of their experience and expertise.

Kari is a settler of mixed European descent, raised on the west coast of Canada. She participated in the ritual in 2008 and proudly wore her iron ring for years afterward, viewing it as a reminder of her ethical responsibility as an engineer and a symbol of her national and professional identity. It was not until she began a graduate program in Science and Technology Studies that she began to critically reflect on engineering culture, as well as on her own experiences of the iron ring ritual. She has since been motivated to advocate for changes to the ritual, and regularly discusses it with students in her engineering courses, analyzing the obligation's presentation of "good" engineering and engineering failures. Kari is an Assistant Professor in the University of Manitoba's Centre for Engineering Professional Practice and Engineering Education, and a co-facilitator of the Retool the Ring group.

Edmund (Ted) is a settler, of Irish descent and born in the United States. He is a poet, writer, applied linguist, and engineering educator who teaches in a first-year design and communication course. He has studied the intersections of poetic form and ideology, which informs his interpretation of the ritual, the oath, and Kipling's perspective on engineering. He studies the discourses at play in engineering design, communication, and education, and this informs his understanding of how the ritual interacts with student experience. He feels a moral and ethical responsibility to clearly communicate to students the true nature and histories of the many robust rituals, symbols, and traditions that populate Canadian engineering culture, believing students should actively engage in their culture not as a received context, but as unfinished, in process, and subject to their input.

Kyle is a graduate student in physics at the University of Manitoba. He has Indigenous and Ukrainian ancestry, and he is a part of the Métis Nation in Manitoba. While Kyle worked on his engineering degree, he was a student in the Engineering Access Program (ENGAP), for Indigenous students in engineering. Near his graduation date, he learned of the iron ring ritual and the association with Rudyard Kipling made him deeply uncomfortable. He did ultimately participate in the ritual and in some ways, he feels that he let himself down with this choice. In his role for the Retool the Ring group, he is most proud of the moments where he has shown other members support. In turn, he is grateful for the support he has received from the other members of this group.

Victoria is fourth generation settler of German, Swiss, Scottish, and British descent. While Victoria was in her undergraduate degree in mining engineering, she encountered her first teachings from Indigenous peoples and became curious about the relational dynamics of people and organizations with differing worldviews encompassing western resource development and Indigenous ways of knowing. When participating in the Ritual in 2018, she picked up the survey chain in one hand, collectively with other participants, and in that moment realized the engineering feats we are proud of have also caused great destruction to Indigenous people's livelihoods, lands, knowledge and cultures. She has not worn her iron ring since the ritual. Victoria is completing her Master's in engineering education research, studying the impact on engineering students' learning from participation in a transdisciplinary design-build course in partnership with Shoal Lake 40 First Nation.

3.2. Analytical framework: boundary work in engineering

Our discourse analysis focuses on demonstrations of boundary work related to engineering ethics and responsibility. Boundary work is the act of differentiating between things by placing a functional boundary between them, discursively or otherwise. It is a process all professionals engage in, consciously or not. Gieryn (1983) demonstrates that setting boundaries around scientific work and ways of thinking is not only a theoretical activity for philosophers and sociologists, but also a "practical problem" for scientists. Scientists cultivate or challenge public images of science by, for example, demarcating science from religion in terms of their respective "usefulness" to society. This boundary work establishes, maintains, or defends the credibility of science and other professional practices such as engineering (Beddoes, 2014).

Pawley demonstrates how engineers construct boundaries through the language and metaphors they use (Pawley, 2012a,b). Engineers may characterize their field by differentiating it from science or from the work of technologists and technicians, or note distinctions between engineering practice in their specific context and engineering elsewhere. Crucially for this study, another way engineers draw boundaries around and within their field is through discussions of ethics and responsibility. Through regulations, professional organizations, academic journals, and traditions (like the iron ring ritual), engineers define their field by differentiating between responsibilities that lie within the realm of engineering, and those that do not.

Pawley identifies four types of boundary work she describes as salient to academic engineering contexts (Pawley, 2012a). *Recognition* refers to awareness of a boundary through experiences or actions. Faculty members in Pawley's study recognized boundaries and acknowledged their impact on structuring their discipline and work. *Reproduction* denotes the policing or reinforcement of an existing boundary. *Mapping* refers to attempts to determine a boundary, either by claiming territory or redrawing boundaries to exclude certain spaces/ideas/people. *Resistance* describes "acts of counter-production": transgressions against an existing boundary in an attempt to change it.

As Pawley (2012a) notes, boundary work is more than simply differentiating between disciplines. Boundary work prompts us to consider who or what is being included and excluded, and draws attention to the (dis)continuity, mobility, and consequences of established boundaries. These socially constructed boundaries have power to influence and generate understandings of engineering, both inside and outside the field (Schön, 1979); to connect and unite engineers who are members of the "in group"; and to exclude others whose experiences, identities, or understandings do not fit within the boundaries. Pawley cites bell hooks' call to explore the margins to understand the center, and applies this to boundary work by asking us to consider who is excluded or punished by the creation and placement of boundaries, and who is included or benefits (hooks, 2000, cited in Pawley, 2012b).

We apply Pawley's (2012a) analytical categories (recognition, mapping, reproduction, resistance) to explore how different actors and texts involved in the iron ring ritual have attempted to construct boundaries around engineering ethics. In particular, we attend to the discourse of engineering responsibility within the ritual and the texts and narratives around it. The case presented allows us to examine this issue within a determined scope reflective of broader trends in engineering culture, discourse, and practice.

4. Analysis: the ritual, its context, and boundary work

This study is presented in four movements organized around Pawley's analytical categories of boundary work. These are presented linearly, as each text demonstrates one of Pawley's categories most prominently. However, some texts inhabit multiple categories of boundary work, and overlap in time with other texts. Many texts are ongoing, longstanding, and some are regular performances or occurrences (such as the century-old ritual). We acknowledge the limitations of the rearrangement: we are outputting a linear version of a more complex narrative. In doing so, we lend coherence to the narrative these texts constitute as well as the larger narratives they inhabit. This article considers essential texts involved in the boundary work done by and in relation to the iron ring and the ritual. Due to space constraints, there are limitations to the depth of our analysis and we cannot include every relevant text. In particular, we have not included the robust online conversations around the iron ring and the ritual—in forums, comment sections, and on social media—nor the ritual itself as a performance text, save for the obligation. However, we have endeavored to create as full a narrative as is possible.

4.1. Creating the ritual

The origins of the Ritual of the Calling of an Engineer *map* the boundaries of engineering responsibility according to Kipling's and Haultain's perspectives, and this mapping is reinforced with every subsequent performance of the ritual. As Mitcham and Muñoz write in *Humanitarian Engineering*, "The first persons explicitly denominated 'engineers' were members of a military corps, those who designed and operated fortifications and various 'engines of war' such as battering rams and catapults" (Mitcham and Muñoz, 2010). That concept crystallized between the seventeenth and nineteenth centuries in western military institutions from Peter the Great's Russia to West Point, which offered the first engineering program in North America in 1802. Eventually, the figure of the civil engineer evolved to become an entity separate from the military engineer (Mitcham and Muñoz, 2010; Mitcham, 2014).

Kipling's interest in engineering lay in the military and civil sub-disciplines, which often involved similar projects, like bridge building, and structural principles, and like those behind fortifications and buildings. Among his literary works is "The Bridge Builders" —the title alone speaks to his interests in engineering. In this section, we focus on Kipling's poem, "The Sons of Martha," as it is often recited as part of the ritual, and on the obligation from the ritual itself. While these texts seem obscure today, when decoded, they reveal a clear representation of Kipling's beliefs about engineers. The poetic language he devoted to engineering has played a prominent symbolic role in maintaining the perceived boundaries of engineering.

H.E.T. Haultain's motivation for creating the iron ring ritual similarly reflects both dominant attitudes in early twentieth century Canada, and Haultain's own positionality. Kipling's involvement in the ritual began when Haultain wrote to him for help in developing a ceremony for graduating engineers. At that time, women were excluded from professional engineering education and practice in Canada [the first woman to graduate with an engineering degree in Canada was Elsie MacGill in 1927, but we didn't achieve 1% women in engineering until the mid 1960s (StatCan, 2014; Corkle, 2020)]. Haultain felt women from outside the profession would be important to help the engineering profession find its "tribal soul" (Levert, 2020). Without a doubt, this shows the ritual was rooted in the underlying ideology that women were there to help men be engineers. Note also the culturally appropriative use of the term "tribal soul." These beliefs are indicative of Haultain's era and his positionality within it. They also exemplify the cultural shifts since his and Kipling's time.

4.1.1. The obligation

The text of the "Obligation of the Engineer" (included below) remains largely unchanged from Kipling's original. In providing instructions to obligated engineers, this text maps the discipline by implicitly defining engineering responsibility. The annual repetition of the ritual—and the wearing of the iron ring itself, as a symbol of the obligation—also reproduces the mapped boundaries.

> ***Obligation of the Engineer*** *(transcribed from the card received by author VT during her 2017 obligation ritual at camp 6):*
>
> *I [participant's name] in the presence of these my betters and my equals in my Calling, bind myself upon my Honour and Cold Iron, that, of the best of my knowledge and power, I will not henceforth suffer or pass, or be privy to the passing of, Bad Workmanship or Faulty Material in aught that concerns my works before mankind as an Engineer, or in my dealings with my own Soul before my Maker.*
>
> *MY TIME I will not refuse; my Thought I will not grudge, my Care I will not deny towards the honour, use, stability, and perfection of any works to which I may be called to set my hand.*
>
> *MY FAIR WAGES for that work I will openly take. My Reputation in my Calling I will honourably guard; but I will in no way go about to compass or wrest judgement or gratification from any one with whom I may deal. And further, I will early and warily strive my uttermost against professional jealousy and the belittling of my working-colleagues in any field of their labour.*
>
> *FOR MY ASSURED FAILURES and derelictions, I ask pardon beforehand of my betters and my equals in my Calling here assembled; praying that in the hour of my temptations, weakness and weariness, the memory of this my Obligation and of the company before whom it was entered into, may return to me to aid, comfort and restrain.*

The obligation, upon a first read, is vague and open to interpretation. It is short, and typically printed on a wallet-sized card, to be carried by the obligated engineer as a reminder of their oath. The standard version is in four short paragraphs, written in first person to explicitly indicate the engineer's personal responsibility.

Throughout the obligation, there is a hint towards an engineers' responsibility to avoid objective technical errors, such as those which occurred in the Quebec Bridge collapse. The first paragraph finds the engineer promising, "before my betters" to avoid "bad workmanship or faulty materials." The second paragraph equates work ethic to quality, with the engineer promising their full time and thought toward the "perfection of any works." The third paragraph indicates engineers should take what praise and wages they are owed but should not ask for more. "My fair wages for that work I will openly take" is straight-forward, as is the promise to protect the "reputation of my calling." But the statement "I will in no way go about to compass or wrest judgment or gratification from any one with whom I may deal" is less clear. Avoidance of judgment can be interpreted as an aim to avoid judging your peers. Though, it can also be a statement that engineers should attempt to remain objective, without judging the ethics or outcome of their work. This is reinforced in paragraph four, when the engineer promises to guard against jealousy and the temptation to "belittle" colleagues.

The obligation ends by invoking the inevitable "failures and derelictions," for which the engineer begs pre-emptive pardon. Again, invoking both "my betters" and prayer, the engineer pronounces their commitment to a type of humility steeped in Christian values, marked by "temptations, weakness and weariness" which is to be resolved into the memory of the obligation, which brings "aid, comfort and restrain." We note the odd use of "restrain" instead of the expected "restraint". Assuming "restraint" better captures the point, the obligation leaves the precise nature

of this restraint open to interpretation, along with the question of which "temptations" are to be avoided.

The lack of explication in the ritual itself, and the contextual instructions to "not discuss the [ritual] details," makes it likely the exact meaning of these phrases will remain open to interpretation (Camp One, n.d.). That opacity, itself, is worth noting, as it stands in stark contrast to the clarity and transparency usually demanded of engineering communication. But amid the general murkiness of the oath's language, certain patterns emerge. Along with the Christian overtones, also the constant defensiveness, wariness, and deference: "my betters;" "I will not refuse;" "I will in no way;" "warily strive against;" "I ask pardon." These phrases, and the oath itself, though obscured in exact meaning, clearly evoke a deferential positionality on the part of the "I" intended to speak and read it.

That the text is presented in a ritual—it arrives in the consciousness of participants packaged within a ceremonial performance—makes evocation an important element in how the oath creates meaning. Those performative elements, which impact how the oath is considered by participants long after it is done, ensure evocation will be impactful on the audience. That is, because the oath is meant to be introduced and remembered ("the memory of this my obligation") in an immersive and ultimately ephemeral ritual experience, providing meaning through obscure evocation rather than clarity and exactitude is a natural fit. But combining strong evocation with obscure and vague language leaves the meaning so open to interpretation—any two individuals would be unlikely to agree on the meaning. This is problematic when the meaning is intended to support ethics, because ethical standards depend on transparency, applicability, and shared meaning.

Still, evocation, as a communication strategy, is not necessarily a bad thing. But two questions emerge. The first is related to the above discussion: can evocation not be coupled with clarity of meaning? And: what is being evoked? This oath highly values humility and lacks any appreciation for the moral and ethical agency of the engineer. If anything, such agency is cautioned against, lest an engineer risk "professional jealousy" and "temptations." We note, again, while humility can be a positive force, the oath's overwhelming insistence on it threatens to overwhelm any principle that would encourage an engineer to speak up—especially to their "betters" —when ethical problems arise.

4.1.2. The sons of Martha

"The Sons of Martha," is a Kipling poem often read during the ritual.[3] The poem does not name engineers directly, but the historical association between the poem and the ritual clearly links engineers with the "wary and watchful" sons of Martha, who "must wait upon Mary's sons." Writing in the *Kipling Journal* in 1946, R.M. Harvey explains how the poem captures Kipling's concept of the engineer: "To him engineers typified the sons of Martha, the silent grimy Tubal Cains who made it possible for the light-hearted Jubals to live and give vent to their twitterings" (Harvey, 1946). The theme of predestined servitude is clear. The engineer's role is to provide "simple service simply given," while "to these from birth is belief forbidden." Forbidding belief strongly suggests "staying in line." This is a profound and concise evocation of social captivity.

In addition, "The Sons of Martha" has deep and disturbing colonial overtones. Kipling points out the newly cleared ground is "black already with blood some son of Martha spilled for that!" It is unclear if this blood is from a son of Martha, or if a son of Martha has spilled another's blood. But in either case, a bloody colonial struggle precedes this symbolic clearing of the land. Thus, engineers who hear these lines recited at their ceremony experience the mapping of their profession onto servitude to other more privileged classes, but also its alignment with the bloody project of colonial mastery. The fact this implication has gone unnoticed by many may speak to participants' lack of familiarity with Kipling and his poetry, but also itself exemplifies engineers' social captivity.

Both the obligation and "The Sons of Martha" indicate engineers should know their place and stay in it, clearly *mapping* the boundaries of engineering ethics and responsibility (Pawley, 2012a). Engineers should work, objectively, on projects, with a humble gratitude to their employers. Technical failures are to be avoided, along with critical thinking about the decisions of "betters." That "The Sons of Martha" has both deep and troubling colonial overtones as well as prescriptions against even criticizing decision-making power may not be a coincidence. It is, after all, typically easier to carry out certain orders if one does not consider their wider implications.

4.2. Contextualizing the ritual

Today, the definitions of engineering responsibility mapped by Haultain, Kipling, and the original wardens are reproduced, recognized, and occasionally resisted by modern engineers. This occurs through the ways the ritual is presented and contextualized to different audiences, including engineering students. Because the ritual occurs near graduation, it is symbolic of leaving student life and entering professional life. As such, it is held out to students throughout their education as a goal and milestone. How it is framed to students, then, is of the utmost importance.

In this section, we focus on a slide presentation prepared and delivered by Camp 1 wardens to graduating engineering students at the University of Toronto (Camp One, n.d.). Four of the five authors of this paper have attended a pre-ritual information session given by a local camp, when they themselves were graduating engineering students. The information presented in these sessions—which occurred in different years, at different camps in different provinces—was broadly similar to the publicly available slides analyzed here, which were created by Camp 1 and presented (to the best of our knowledge) in 2012 (Camp One, n.d.).

The slides consist of logistics for students planning to attend the iron ring ritual, as well as contextual information about the ring, the ritual, and the obligation. According to the presentation, the context is partly designed to "reinforce the rationale for an obligation." The slides present this rationale first through a discussion of Canadian engineering achievements—including the CP Rail High Level Bridge, the Sarnia Synthetic Rubber Plant, and the cardiac pacemaker—and subsequently through cautionary tales of engineering failures—including the sinking of Ocean Ranger oil rig, the Challenger disaster, and the 2006 collapse of the De

3 https://camp18ironring.ca/the-poetry-of-rudyard-kipling/. Accessed June 18, 2023.

La Concorde bridge overpass (author RP's contextual presentation also included discussion of the Quebec bridge collapse). The ritual itself is characterized as a reminder of an engineer's "professional responsibilities and personal ethics" and as a "voluntary privilege" (Camp One, n.d.).

The slides acknowledge the ritual is based in "Anglo-Christian morals" and includes "formal and old-fashioned language," but they nevertheless argue it includes "no religious or political agenda" (Camp One, n.d.). The argument for the ritual as apolitical and non-religious is echoed on the Corporation of the Seven Wardens' website, which provides the following response to a "frequently asked question" about whether the ritual is a religious ceremony: "Not true. The original Ritual written in the 1920s by Rudyard Kipling did contain some Judeo-Christian references but most of these have been removed in the current version of the Ritual. Those references remaining are made for their poetic and allegoric values".[4]

Kipling's colonialism is entirely absent from the presentation. The slides present Kipling as a "poet and author who respected and admired the work of engineers," and indicate he is a Nobel Laureate who was offered and declined both a knighthood and the post of Britain's Poet Laureate. The same slide contains a picture from the 1967 cartoon film "The Jungle Book," based on Kipling's book of the same name. This presentation of Kipling leaves out other equally accurate ways to contextualize Rudyard Kipling including: a public figure clearly associated with "outspoken jingoistic Imperialist tradition" (Varley, 1953); the author of the 1899 poem "The White Man's Burden," which characterizes Indigenous peoples as "half devil and half child" (Kipling, 1899); and an advocate for the American government to pursue colonization in the Philippines (Brantlinger, 2007).

Kipling is not without his defenders on these points. Critics point out his championing of those who, like engineers, were in the often uncelebrated middle rungs of British colonial society, and his treatment of colonized people often included respectful gestures at least complicating his work beyond the labels of "colonialist" and "racist" (Raine, 2002). Nevertheless, however complicated Kipling's intentions may be, his presentation in the pre-ceremony slide deck puts aside complexity in favor of a simple and purely laudatory characterization. In its exclusively positive framing, the presentation carefully reproduces and protects the boundaries of engineering responsibility as mapped by the original ritual texts and their author.

The Camp 1 presentation also directs participants to interpret the obligation in a non-critical manner. This suggestion is implicit in the obligation itself, given its insistence on humility, but it is strengthened in the way the obligation and ritual are presented. The presentation frames engineering responsibility through its five-part, and quite simplified, summary of the obligation. They break it down to, "eliminate faulty workmanship," "strive generously towards perfection," "be honourable and fair," "admit and deal with your mistakes," and "respect and support your colleagues." These are possible interpretations of the oath, but as we see above, not the only ones. This simplification suggests there is only one way to interpret. Yet, at the same time, the slides suggest the engineer consider the "obligation within your own code of ethics" before reminding them the "goal is integrity and ethics (*not* any specific religious or political agenda)" (emphasis in original). Again, we confront the oath's murkiness in these slides: an insistence on integrity and ethics while not defining those terms, and instead leaving it up to the individual. Another unresolved tension is found between the slide's claims of the ritual's non-religiosity and the acknowledgement of its Judeo-Christian origins and language. While aiming to inform, the slides leave much unresolved.

Similar contextualizations are aimed at wider audiences. Multiple sources present the ritual and the iron ring as safeguards against ethical failures that could lead to accident or disaster or as protection from the material consequences of engineering failure (e.g., TranBC, 2012; CBC News, 2015; Home-Douglas, 2019). Dan Levert's *On Cold Iron: A Story of Hubris and the 1907 Quebec Bridge Collapse*, (Levert, 2020) frames the ring around a "humility" he sees as vital to the ritual and to avoiding material failure, comparing that to the absence of humility apparent in what led to the Quebec bridge collapse. Despite his detailed discussion of the ritual's origins, Levert ignores or glosses over the more controversial aspects of its development. He presents the sexist and culturally appropriative contexts without any discussion or critique, including Haultain's 1922 speech pleading for the women attending to "help [engineers] find our tribal soul" (Haultain, 1922, as cited in Levert, 2020). Furthermore, Kipling is again celebrated as a poet and an admirer of engineers. On Kipling's literary work Levert writes, "All of Kipling's two hundred and fifty short stories carried a moral or lesson, as did his countless poems and several novels, including his timeless works The Jungle Book, Kim and the poem "If."" In Levert's book, in news coverage, and in presentations to students, the boundaries mapped and reproduced by and around the ritual are supported partially by providing a limited subset of information to the audience.

The exclusion of critical information about Kipling and the ritual misleads both the public and ritual participants. Avoiding this widely available, and obviously troubling, knowledge has two major impacts. First, it supports the boundary work of the ritual by allowing its problematic elements to evade discussion. Second, participants can be caught off guard by the ritual's content. The narratives collected by the Retool the Ring group suggest many participants are surprised, troubled and unprepared by what is revealed in the ritual.[5] This suggests there can be two stages of resisting established boundaries: overcoming reluctance to discuss the boundary, and conducting that discussion.

4.3. Disrupting the narrative

Acts of resistance constantly attempt to reconceptualize the world. Pawley describes a boundary as "an idea constructed by members of groups" helping to understand "people's experiences" (Pawley, 2012a, p. 147). Boundaries are social constructions, and are subject to social resistance. In this case, the formation of the Retool the Ring group was a catalyst of resistance, but it was preceded by work from the wider engineering culture in Canada. Many academic and professional engineers have tried to change the iron ring ritual over the last several decades (see text footnote

4 https://ironring.ca/faq-en/. Accessed June 18, 2023.

5 https://www.retoolthering.ca/others-stories. Accessed June 18, 2023.

5). In these acts, the "actors were clearly and intentionally making decisions counter to the more powerful hegemonic disciplinary engineering culture" (Pawley, 2012a, p. 162). This resistance was typically ignored, belittled, or forgotten without any change to the boundary definitions.

Here, we analyze four texts. First, we focus on three texts that led to disruption and resistance at the June 2022 conference of the Canadian Engineering Education Association–Association Canadienne de l'Éducation en Génie (CEEA-ACÉG). Then we turn to a statement emerging from that conference. That context is notable. Educators are inherently future looking, and given the centrality of engineering in the modern world, the guidance of engineering students' potential is incredibly important. It is apt, then, that this issue came to the fore in a setting focused on educating future engineers.

4.3.1. CEEA-ACÉG opening keynote talk

The CEEA-ACÉG conference began with a keynote presentation by Randy Herrmann, director of the University of Manitoba's Engineering Access Program (ENGAP), which aims to provide pathways and support for Indigenous students into engineering.[6] His talk, titled "Transforming learners to transform our world," argued for transformative change through decolonizing institutions by removing troublesome hierarchies (Herrmann, 2022).

Throughout the presentation, Herrmann leveraged work by others' (Feyerabend, 1996; Cull et al., 2018) to challenge the audience's beliefs around decolonization and the purpose of science. He provided clear comparisons between Western science and Indigenous science, showing how the boundaries of defining engineering were built to exclude Indigenous ways of knowing (**Figure 1**).

While the physical acts of colonial engineering (such as residential schools and the displacement of the Shoal Lake 40 First Nation) are most obviously prominent, Herrmann emphasizes the social acts of colonial engineering are equally damaging, especially in how they maintain exclusionary boundaries. He tells a story about the iron ring ritual to engage the audience in a thought activity:

> *"For a moment think about how your predominantly White male Anglo-Saxon Christian majority would feel if they had to undergo a ceremony that included a poem about the Daughters of Job with frequent references and readings from the Quran in order to gain their engineering ring. I can almost guarantee that there would be open revolt and perhaps even blood in the streets. And yet we presume to continue this ceremony because we have always done it with a subtle apology at the onset of the ceremony." (Herrmann, 2022)*

Herrmann argues the ritual exposes engineering culture as exclusionary (Pawley, 2012a), and powerful forces maintain this disciplinary boundary. He means to empower to the audience, to critically reflect and resist boundaries. The talk ends by asking the audience to ensure they do not "remain inflexible and unchanging" and quoting Dr. Margaret Mead (Keys, 1982): "Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has." Herrmann is attempting to support the audience to "transgress a dominant boundary" (Pawley, 2012a) by raising awareness of boundaries and evoking an emotional response regarding them. We note Herrmann is using a rhetorical tool—emotive evocation—that the ritual itself uses, but to a different end.

In one of his closing slides, he returns to clarity and directness, providing one way forward for the engineering educators in the audience:

> *"Don't continue misogynistic, patriarchal, white, Christian, ceremonies written by people that were (c)overtly racist just because tradition dictates that we should.*
> *Don't idolize people of the past that were overtly racist" (Herrmann, 2022).*

This reference to Kipling and the iron ring ritual emphasizes the continued reproduction of the boundary through tradition, and how harmful this has been to those excluded from, or at the margins of, engineering culture. It also implies engineers need to be more than objective actors following tradition, cultures, codes, and orders, but to engage in subjective thinking and actively critique how we approach our engineering work. Herrmann's keynote did more than suggest new ethical principles for engineers. It suggested a new, non-captive, and agentive way of determining those principles. Herrmann opens up discussion, resists boundaries and suggests a remapping.

4.3.2. Roundtable discussion

During the CEEA-ACÉG conference, Edmund Martin Nolan (co-author of this paper) facilitated a roundtable discussion titled, *We need to talk about Rudyard Kipling: On the origins of the Ritual Calling of the Engineer in an age of reconciliation* (Nolan, 2022). Attendees included undergraduate and graduate students, engineering faculty and educators, non-engineer change management experts, and two iron ring wardens. The wardens openly engaged in the discussion. They contextualized information for the participants and defended changes being made to the ritual already (for example changing "he" pronouns). They were also both sympathetic to the desire for change.

The title of the proposal is action-oriented— "We need to talk" typically implies a critical discussion—although the description states, "I do not intend to discuss solutions." The conversations followed the same pattern, starting with a radical sentiment ("We should boycott the iron ring!") and flowing into a more collaborative discussion on how to advocate for change within a deeply embedded tradition. These both expose hesitation and caution: a strong desire to resist is restrained by awareness of the entrenched powers maintaining the boundary.

Embedded traditions exemplify the continuity and functionality of the boundaries Pawley (2012a) describes. The iron ring ritual sets out a firm, functional boundary with real historical consequences for engineering culture. The roundtable description acknowledges this, emphasizing "engineering educators' responsibility to be critically aware of the history we inherit and embody" (Nolan, 2022). This suggests the attendees

6 https://umanitoba.ca/engineering/engineering-access-program. Accessed June 18, 2023.

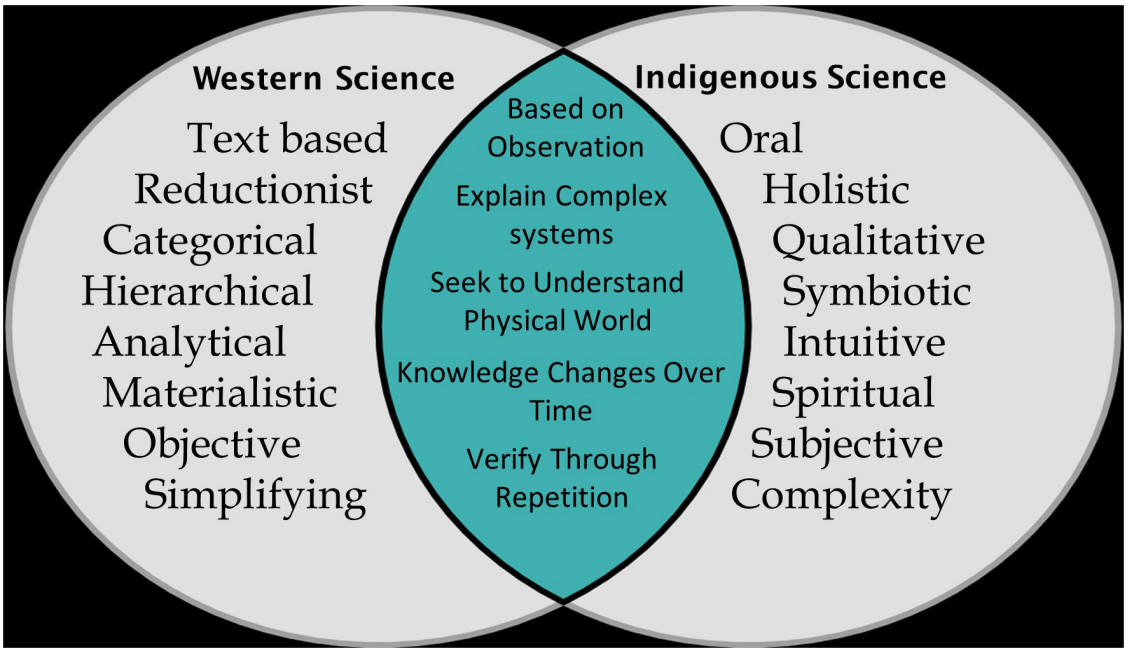

FIGURE 1
Slide from Randy Hermann's keynote speech (reproduced with permission) (Herrmann, 2022).

cease to reproduce the boundary as if unconscious of it and instead become aware of it and its impacts. Participants expressed frustration over the continued resistance to change and a desire to broadly call out the boundary and gather momentum to resist it. This calling out occurred during the conference's closing keynote session.

4.3.3. Closing keynote call to action

Participants from the roundtable requested and were granted a moment to speak during the closing keynote session [which was filmed and posted on YouTube (Paul, 2022)]. Five stories were told, ranging from the pride and responsibility within the symbolism of the ring, to the uncomfortable and "icky" feeling the ritual left. Two stories were told on behalf of someone who wanted to remain anonymous, and that exemplifies the fear and caution that comes with resisting an entrenched boundary. One anonymous story described students' difficulty in resisting this boundary: students typically only become aware of the details of the ritual in the final moments of their undergraduate education, thus they are limited in their ability and time to comprehend, let alone resist, what is presented to them, no matter how much it troubles them.

The speech ends with a speaker (author RP) claiming "We want to reclaim the essence and values of the iron ring [.] and we ask that if you want to engage in this dialogue with us that you please stand." As the video shows, an overwhelming number of the approximately 150 attendees proceed to stand-up in support of the call to action to begin a discussion about the iron ring ritual. Throughout the entire speech, the script was intentionally planned to cautiously move forward, with an underlying appreciation of the strong powerful influences maintaining the boundary established by the ritual. The speech describes "many have said these things before us," and yet change is elusive. The room's response shows a willingness to counter the "hegemonic disciplinary engineering culture" supporting established boundaries (Pawley, 2012a). Appropriately, this act is performative: participants signal ascent to common principles through the bodily act of standing.

These three texts demonstrate resistance growing into action. Herrmann outlines the problem: engineering is exclusive and harmful to many, in terms of both physical and social harms. Nolan bluntly calls out our responsibility to resist the boundary, claiming it is our "responsibility to be critically aware" of the history we are maintaining. The support during the closing keynote provides power in numbers to the resistance. All three texts raise awareness and coalesce a shared agreement around that awareness. With that accomplished, change becomes possible.

4.3.4. Retool the ring statement

In September 2022, the Retool the Ring group released a statement addressed to the Seven Wardens and wardens from across Canada, signed by 13 members (Campbell et al., 2022). The collaboratively written letter aims to "work together with the Corporation to retool the Iron Ring ceremony in ways that reflect contemporary engineering responsibility and values." We begin the statement by affirming the value of the iron ring within Canadian engineering culture. We then outline three problematic elements of the ritual: its presentation of engineering *Responsibility and Agency;* its lack of *Clarity and Transparency*; and its manifestation of the *Lingering Harms of Colonialism in Engineering.* In the final section, we provide a list of nine *Recommendations* for the Corporation of the Seven Wardens in three areas: (1) Re-envisioning the ritual for the 21st century, (2) Committing to accountability and transparency, (3) Addressing and reducing imminent harm during the re-envisioning process (Campbell et al., 2022).

We contextualize the situation within existing professional ethics boundaries, map out the boundary, question its relevance, and argue the ritual is ethically flawed. We discuss the importance of professional ethics, and that the "iron ring is a valued symbol of professional integrity" and "remains a treasured possession and powerful symbol of an engineer's responsibility." We then question this, claiming this apparent connection—between the ritual and engineering ethics—is false, as the ritual "fails to embody a comprehensive understanding of engineering ethics." We compare it to other ethical standards and curriculums in engineering, noting they "have all been renewed or developed to appropriately reflect modern engineering practice." We then analyze how the ritual reproduces a misleading boundary that "conveys a narrow definition of engineering and engineering failures," leaving out "numerous forms of modern-day engineering practice," and failing to address "engineers' roles in systemic environmental or social issues."

We argue in the letter that the ritual emphasizes the objectivity narrative and social captivity of engineering, claiming it "promotes humility to a fault, leaving open the interpretation that it is not the engineer's responsibility to consider anything beyond the details of their work, as assigned." We describe how participants are discouraged from both "taking on the work or responsibility of problem definition" and from calling out problems. We emphasize the ritual's reinforcement of the objectivism narrative, and how it restrains engineers' ethical agency.

We directly call out the ritual's "cultural power" in maintaining disciplinary boundaries, as well as its "elitism." Although the ring and ritual hold no legal authority, we recognize them as "powerful symbol[s] of engineering responsibility." We claim the ritual's poetic, antiquated language "reinforces a harmful elitism that is too common in engineering culture," that "(falsely) demonstrate[s] superiority." We argue when participants struggle to understand the ritual's language, this limits their agency to critique it, as they may fear ridicule, making it hard to question the ritual and the boundary it upholds. The lack of transparency surrounding the ritual and the Seven Wardens also creates barriers for change, as it is hard for something so opaque to be held accountable.

Finally, we emphasize the Retool the Ring group is based around building community and working together with the engineering community in Canada, and with the wardens. The overall goal is to synthesize and share our ideas and concerns with the community, and to solicit support for these ideas. The statement was closed for signatures in February 2023, and in the six months it was open, we solicited 515 signatures from a wide variety of community members. This is a demonstration of how community and collaboration can serve as a "counter to the more powerful hegemonic disciplinary engineering culture" and boundaries (Pawley, 2012a).

4.4. Responding to disruption

We find there have been two stages to resisting the boundaries that are mapped, reproduced and maintained by the iron ring and ritual. The first stage acknowledged issues and opened a discussion, where it took significant work to bring the problematic issues of this case to the fore. Despite broad unease, the issues remained largely latent within the culture. That latency, as we have shown, is partially by design (discussion of the matter is discouraged), and allowed and allows people and institutions within Canadian engineering culture to avoid taking a public stance on the matter. With that discouragement now significantly countered, the case enters the second stage of resistance, in which interested parties are more likely to take a public stance, given the cultural pressure applied.

With the boundary now open to negotiation and remapping, institutions like Engineers Canada and the Ontario Society of Professional Engineers joined the call for change, while the wardens have acknowledged the need for review. The topic also comes up on academic and industry-specific Reddit threads and other forums, and has appeared in popular media sources as well (Corbella, 2021; O'Gorman, 2022; Reddit, 2022; ENG-TIPS, 2023). We focus on public statements from the wardens and Engineers Canada, both of which suggest engineering culture in Canada is in a moment of transformation, typified by the iron ring and ritual. This tradition-valuing culture discusses revising a cherished tradition, and by extension a part of its collective identity.

The two responses reviewed below typify two potential reactions to this. We note that while these reactions represent different kinds of potential boundary re-mapping (one more cautious, one more proactive) that are informative and important in and of themselves, any interpretation of their public stances must consider their authors' positionalities and institutional responsibilities. Thus, when discussing this second stage of boundary resistance, we consider both what is said and the context from which it emanates.

4.4.1. Warden's letter

On November 21, 2022, The Corporation of the Seven Wardens (2022) released a statement announcing a review of the ritual. This was a profound moment: this steward of deep symbolic power, in a culture that values tradition and continuity, was questioning a tradition which had remained mostly unchanged for a century. Given this history and their heavy cultural burden, unsurprisingly the wardens were cautious in their approach to reviewing the ritual, which began months before the formation of the Retool the Ring group. In February 2022, the corporation formed an internal equity, diversity, and inclusion committee to review relevant issues with the ritual. This work was publicly announced in the November statement, and continues as of this writing.

We focus here on the November statement. It acknowledges major problematic aspects of the ritual, while defending its legacy and advocating for a cautious approach to remapping the boundary it establishes. After celebrating the history and tradition of the iron ring, which serves as "a constant reminder to [engineers] and others of their obligation," the wardens acknowledge the gap between the ritual and the "more diverse" country Canada has become. They cite recent revisions aimed at "gender neutrality" and removing overt religious language, and they acknowledge the oath's colonial language and the need for more inclusivity. Then they express their caution, relative to "some stakeholders" (such as ourselves), who "expressed urgency in replacing the ritual immediately." The wardens, instead, "wish to honour principles of the tradition and to respect all stakeholders' needs" through "thoughtful input and careful consideration."

Given the wardens' position, the caution they show is not surprising. When the statement invokes "gender neutrality," it

does not discuss the depth of engineering's historical antagonism toward women and the 2SLGTBQ + community. When it mentions religion, it does not name the religion (Christianity) the ritual is steeped in. They acknowledge the "overtones of colonialism," associated with the oath's "old English language," but like much of the text, this claim is vague, and open to the critical interpretation that the colonialism historically embedded in the ritual is just a matter of fixing some language, and nothing deeper. These problems with the ritual seem much more obvious and blatant than the wardens let on.

Institutionally and culturally motivated caution leads the wardens to reject the call for urgent change. This is in the name of carefulness, because "the Corporation wishes that the outcome of the Committee's work be relevant and enduring for the next 100 years." That long-term perspective is reiterated when they claim, "the current Ritual served its purpose for nearly 100 years." While that claim is dubious (served its purpose for whom?), it supports their larger argument for slow, careful incremental change, as that change is destined to have a lasting impact and should not be rushed.

Still, even cautious self-critique from the wardens is a notable development and their caution does not discount the clear call for a renegotiating of the boundaries established by the ritual. We reiterate that this is a big deal. However, we also note that a cautious approach to critiquing the ritual has historically contributed to its non-critical acceptance in the culture, and thus to the harm it has done and continues to do. In their approach, the wardens are attempting to have it both ways: to advocate for change while avoiding both acknowledgment of the true need for change and their culpability for addressing the issues so late.

4.4.2. Engineers Canada response

A statement released in December 2022 by Engineers Canada (EC) stands in contrast to the warden's letter (Engineers Canada, 2022). Before summarizing the actions of the Retool the Ring group in bringing this issue to the fore, the letter directly indicates the organization's support for change and acknowledgement of the issues. They continue this throughout the statement, responding to our open letter directly, point by point. On agency, they write that "the current ceremony [. . .] does not live up to expectations that engineers be critical thinkers and contribute to the high-level decisions that direct engineering work." On clarity and transparency, the language is "archaic and difficult to understand" and the process "is antithetical to ethical engineering practice that is transparent and meant to serve the public." They also call out "outdated and harmful worldviews," referring not to the 'famous' poet, but to the "noted imperialist Rudyard Kipling." Finally, they acknowledge the warden's letter and formation of a "Ritual Review Committee" as a reform process, as well as previous calls for change, including EC's own 2020 letter.

While they align themselves with the wardens at the end, the EC statement contains more urgency for change. It clearly acknowledges engineering's role in colonialism and suggests, "changing the Iron Ring Ceremony is one way in which engineers can respond to the Truth and Reconciliation Commission's Calls to Action." Where the wardens employ euphemism ("old-fashioned language"), Engineers Canada describes directly ("outdated and harmful"). We note the differences in writing style, because style contributes to meaning. The commonly stated principles of engineering communication—clarity, transparency, simplicity, directness, credibility, etc—are a good example of this style–content connection: the style is matched to the need (to not miscommunicate, or obfuscate, about impactful action). EC's statement comes much closer to attaining those principles than does the wardens'.

Of course, the EC statement is also mediated by their institutional and cultural positionality. While the wardens are charged to uphold a tradition, EC works with provincial regulators to promote a number of priorities (interestingly, while ethics are the purview of regulating bodies, neither the wardens nor EC are regulators). Those priorities include "sparking interest in the next generation of professionals" and "promoting diversity and inclusivity in the profession that reflects Canadian society," both of which would naturally motivate them to speak out on behalf of relatively bold changes to the ritual (Engineers Canada, n.d.). We might also point out that while their stance now is clear, EC is itself rather late to their critique of the century-old ritual.

Still, the contrast between these two texts is important, and likely predictive of future dialogues on this issue. Where the wardens hedge their argument cautiously, EC argues using direct, clear, and intentionally norm-building language that strongly suggests the directions they believe remapping efforts should move. That difference in approach will inevitably be replicated at multiple levels of Canadian engineering culture. As with the broader culture, there will be those advocating for deep and immediate changes to the *status quo*, and those urging caution. These letters may serve as a preview of how the dialogue surrounding the iron ring proceeds.

5. Discussion and conclusion

The case of *The Ritual of the Calling of an Engineer* shows how cultural boundaries within engineering can be resisted, and how they can stubbornly resist change. The texts demonstrate how a lack of transparency can reinforce boundaries by keeping boundary work implicit, shrouded, and difficult to identify. Solutions, by contrast, come about after matters are made explicit. At this point in the narrative, no solution is in place. However, the issues around the ritual and its boundary work have become subject to discussion and argumentation. The statement from Engineers Canada exemplifies this in its directness. Making implicit beliefs and boundaries explicit has opened those boundaries to renegotiation.

How urgent and thorough that renegotiation is, however, must be considered. Slow, incremental change can seem like progress, but it can also signal a boundary's stubbornness and durability. Changing, for instance, "my Maker" to "my profession," or removing all male pronouns *is* a *way* to change the obligation. Whether such changes address fundamental issues, or act as cosmetic adjustments obscuring the need for more fundamental change, may become the crux of the issue.

Our analysis also demonstrates the dangers of presenting the humanities, arts, and social sciences as sources of catch-all solutions for engineering and engineering education. We, the authors, are committed to inter- and transdisciplinary approaches. We believe the potential for humanistic training and interventions to enrich engineering education. Nevertheless, we must acknowledge the iron ring ritual was itself a humanistic intervention. Rudyard

Kipling's poetry and ritual reified dominant engineering attitudes and values. The power of his writing continues to obscure and uphold problematic boundaries established by the ritual.

The tensions between openness and opacity, and cosmetic and fundamental change, must be considered in their historical and cultural contexts. This work provides a(nother) counter to the dominant narrative that engineering is objective. The ritual and its surrounding systems map and reproduce engineering as an objective practice. The subjective beliefs of Haultain, Kipling, and others contributed to this supposedly objective stance, but we argue that engineering failures can be defined beyond the objectivity narrative. As Donna Riley points out, our "attempt to remain objective in engineering is harmful" (Riley, 2017) because, despite engineers' best attempts to remain neutral, the outcomes of their work are necessarily value laden.

We find that humility, in the extreme, lends itself to an objectivity narrative by supporting a belief that one is responsible only for objectively carrying out instructions. This is especially important now, as questions around the iron ring meet engineering culture, and human history, at a profound moment of change, crisis, and transformation. As global warming, geopolitical instability, and other forces challenge both Canada and the world, engineering is poised to play a very important role (Martin et al., 2022). It behooves the profession, then, to prepare for a world in which simply following orders is inadequate. We need, as many have argued before us, engineers that think critically and take agency over their work and its consequences.

Recent editorials in the *Journal of Engineering Education* demonstrate consistent push back to the objectivity narrative in regard to climate change: "Achieving just and equitable solutions will require engineers to avoid narrowly-defined 'optimal' solutions that can cause disproportionate harm to individual communities" (Martin et al., 2022); gun violence, "not discussing our feelings and reactions to gun violence events ignores the fact that engineers, engineering faculty, and engineering students are human beings and that human beings are subjective" (Buswell, 2022), and a number of other topics. Editorials highlighting the crisis of inclusivity in engineering are also prominent, calling to change "hostile environments" reinforced by the culture's "underlying norms, beliefs, and values" (Brown and Morton, 2023). We also see calls from engineering education scholars to acknowledge and discuss "how whiteness instituted the standards for admission, acceptance, and success that affirm the cultural norms of White people while demeaning others," in service of perpetuating dominant engineering paradigms (Holly and Masta, 2021). Our study builds on this work by demonstrating how a cultural phenomenon created by a white supremacist continues to reproduce boundaries that assume objectivity, and which perpetuate white and male dominant cultures, ideals, and norms within engineering.

The issues at the heart of the iron ring ritual reflect the broadest questions faced by the engineering profession when considering its role in the modern world. Engineering, we conclude, is at a dual crisis point. It is integral to a world in crisis, while it also wrestles with its own collective identity crisis. Engineers, we argue, should not be simply workers and followers of power, as Kipling's legacy suggests. Nor should they consider themselves world builders with sole license to determine the best course of action through "objective" decision making. Rather, engineers must acknowledge their own agency and responsibility—to communities, to the environment, and to the profession—and ask how they might move forward in light of this acknowledgement. The iron ring ritual plays a small but revealing role in addressing this question in the context of Canadian engineering. If the ritual can evolve to reflect a more inclusive and agentive view of engineering, we posit that Canadian engineering culture can hope to achieve the same.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

Ethical approval was not required for the study involving human participants in accordance with the local legislation and institutional requirements. Written informed consent was not required for participation or the publication of potentially identifiable information in accordance with the local legislation and institutional requirements.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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