

Navigating Global Engineering Education Accreditation: Assessing Ethical Integration and Charting Pathways for Progress

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Abstract— Accreditation in engineering has been widely adopted, enabled by notable harmonization among accrediting bodies worldwide. This alignment, facilitated by accords among nations and regions, fosters a shared understanding of expectations critical for the globalized engineering profession. While ensuring graduates are equipped with essential skills for international collaboration, engineering education grapples with defining and instilling ethics, and the problematic nature of this endeavor is complicated by vague and ambiguous terminology within accreditation documents. Addressing this gap requires navigating power dynamics among education, accreditation, and licensure alongside creating localized, meaningful educational experiences. This paper overviews one section from the forthcoming Routledge International Handbook of Engineering Ethics Education, focusing on accreditation and its interconnectedness with ethics education. Starting with historical perspectives and contemporary practices, the paper describes efforts to balance standardized outcomes with cultural relevance, aiming to cultivate socially responsible engineers capable of navigating ethical complexities in a rapidly evolving world.

Keywords— Accreditation, ethics, engineering education, assessment, globalization.

I. INTRODUCTION

The global engineering community has widely adopted the practice of accrediting engineering education courses, and this has been enabled by a notable degree of harmonization among accrediting bodies worldwide [1]. Alignment across culturally and geographically diverse regions and nations has been facilitated by accords established at the global level, which foster a shared understanding of expectations. Cohesion is paramount, given the globalized nature of the engineering profession. In preparing today's engineering students, it is imperative to equip them with the skills necessary to contribute effectively to international teams and global projects. The outcomes of their work are likely to impact lives near and far and extend to the broader global context and environment.

Ethics is a pivotal component of engineering education, yet it lacks clear definition [2]. The terminology employed in current accreditation documents tends to be both vague and

ambiguous in addressing ethical considerations, and it varies between accreditation bodies [3]. Questions arise: *What specific competencies are anticipated from an engineering graduate in the realm of ethics? What is an engineering graduate expected to know and be able to do? How can accreditation formulations capture a global and culturally inclusive understanding of ethics? How can educators and education systems influence how engineering graduates behave and make decisions in complex situations where there is ambiguity about what is 'right' or 'wrong'?* There exists a notable gap in elucidating how educators and educational systems can equip engineering graduates to make decisions and behave ethically as they move into a dynamic and challenging career, in an increasingly interconnected global profession [4].

The research team authoring this conference paper is deeply immersed in extensive exploration and documentation on the subject at hand. We are six of the editors and authors of a comprehensive handbook tailored for educators, researchers, and academic managers' the handbook is in the final stages of publishing. The overall handbook is designed to provide readers with insight and guidance in navigating the intricate yet indispensable terrain of engineering ethics in education. This paper provides an overview of one section of the forthcoming *International Handbook of Engineering Ethics Education Handbook* [5] to be published in hardback and open-access digital formats by Routledge publishers in late 2024. The team authoring this paper comprises six of the sixteen authors and editors who created the handbook's section on engineering ethics accreditation (all chapters' lead authors were invited to provide input and those who did brought some authors on their teams on board). In our work, we endeavor to share key insights of the section, promote the handbook among prospective readers, grow our engineering education research community, and build knowledge and capacity around the topic of engineering accreditation. We have a strong calling to continually critique and refine the engineering education accreditation system, at local and global

levels. We are users of this professional accreditation system and voices in its ongoing development.

This paper focuses solely on engineering ethics accreditation, one of the six key themes in the forthcoming handbook [5]. The broader spectrum covered in the handbook encompasses (1) foundations of engineering ethics education, (2) interdisciplinary contributions to engineering ethics education, (3) ethical issues in various engineering disciplines, (4) teaching methods in engineering ethics education, and (5) assessment of diverse facets of engineering ethics education. Within the confines of this paper, our focus narrows down to the sixth and final theme: (6) accreditation and its interconnectedness with engineering ethics education.

II. CONTEXT

Embarking on our exploration, it's crucial to note that engineering education is regulated through a centralized, top-down approach. Accreditation is pivotal in determining the competencies graduates of engineering degree programs should possess for navigating engineering practice in our increasingly globalized world. The handbook chapters on accreditation elucidate the origins of accreditation processes, which initially took root in the United States and later extended to English-speaking countries. Over time, this influence has expanded globally, marked by the signing of international accords between countries and their professional engineering institutions.

In the contemporary landscape, graduates of accredited engineering programs, influenced by these international agreements, are expected to demonstrate a comprehensive range of abilities, skills, knowledge, and behaviors. This section of the Handbook systematically delves into key aspects of the global push for accrediting and aligning engineering programs – exploring the fundamental questions of who, what, when, where, why, and how ethics is regulated and assessed. The five chapters of the section consider accreditation in the context of engineering ethics education by exploring historical perspectives, the contemporary landscape, accreditation and professional licensure, and critical perspectives. These approaches are discussed in more detail in the preceding sections, with each sub-section dedicated to a single chapter of the handbook.

III. HISTORICAL PERSPECTIVES

The exploration of accreditation commences with a historical lens, tracing the roots of engineering education accreditation and its evolution to encompass ethical considerations. The opening chapter, titled "Foundational Perspectives on Ethics in Engineering Accreditation" [6], describes the formal inclusion of ethical outcomes within accreditation criteria for engineering graduates. The chapter provides a comprehensive overview of the historical trajectory of accreditation, focusing on pivotal developments in the

United States (US) spanning more than a century, before delving into aspects related specifically to ethics within accreditation. The authors identify the explicit inclusion of ethics in accreditation requirements as a more recent trend, beginning in the 1970s.

Acknowledging the evolution from input-based to output-based accreditation models (i.e., from what teachers deliver to what students know or can do), the chapter examines alternative quality assurance methods and the widespread global impact of the US-style accreditation approach in engineering ethics education. The chapter also examines global contexts where ethics and related outcomes are formally incorporated into accreditation requirements. Starting with the well-documented and influential case of the US, the chapter proceeds to examine Western/Anglo settings (the United Kingdom and Canada), international agreements (Washington Accord and EUR-ACE), and East Asian cases (Japan and China). In an overview of the case studies, the authors observe contemporary convergence toward a more consistent set of ideals and target outcomes related to ethics than was observable in the past. Most accreditation documents now specify general responsibilities and ethical implications across the design-source-produce-operate spectrum of engineering processes so that engineering graduates recognize the potential impacts their engineering work will have on society and, increasingly often, on the natural environment. They note that the two policies (Washington Accord and EUR-ACE) that most national and local standards draw from include these components.

This chapter's authors have synthesized prior scholarship and have conducted new analyses of some primary source materials. They created a very helpful table identifying passages of key accreditation documents worldwide that pertain to ethics. Their study allowed them to pinpoint areas and topics of convergence and divergence among more localized accreditation documents. Some current documents include equity and diversity, which might become a larger trend. Some countries' documents heavily emphasize codes of conduct, while the United Kingdom's do not. The authors also note points of unique emphases –Japan's documents emphasize collectivism, harmony, and local values and China's documents encourage engineers to align their ethical values with the government's. The authors encourage additional/future comparative research across national and cultural groups.

IV. CONTEMPORARY LANDSCAPE

Building upon this historical context and contributing the type of cross-national and cross-cultural comparative research encouraged in the opening chapter of the theme [6], the second chapter, titled "Contextual Mapping of Ethics Education and Accreditation Nationally and Internationally" [7], shifts the focus to the contemporary landscape. This chapter presents comprehensive analyses of currently enforced accreditation

documents spanning diverse regions worldwide. The primary objective is to discern and evaluate the nuances in how ethics is delineated and articulated within these documents. The authors, integral members of a broader team of researchers conducting a large project [e.g., see 2, 7, 8] (meaning, only a portion of that project is detailed in the Handbook chapter), are committed to identifying and monitoring how different cultural groups perceive, assess, and oversee ethics education within their own specific contexts.

The chapter poses critical questions about the global commonalities and local intricacies embedded in nationally sanctioned engineering accreditation documents. The collaborative team introduces a framework for cross-cultural comparative work, and the team applies it in their engineering ethics accreditation research to help ensure they consider a wide range of perspectives. They describe a slice of their larger comparative study, contrasting various approaches from around the globe. Like the authors of the previous chapter [6], this team aims to benchmark how ethics is portrayed in accreditation documents and draw from diverse regions of the world, including ones typically understudied in English-language publications. In contrast to the prior team, however, this team focuses exclusively on the current situation, to reach as widely as possible and represent as many different cultural and geographic positions as possible. To gauge how well they are doing that (i.e., how far they are reaching), they have adopted and presented a framework for international comparative research pioneered by Geert Hofstede and colleagues [9, 10]. They acknowledge critiques of the original model by Hofstede et al. but justify that early model as an ideal tool for their application based on its simplicity. The 'Hofstede model' [9, 10] considered six dimensions of culture (named the 'power distance' index, 'uncertainty avoidance' index, 'masculinity versus femininity,' 'individualism versus collectivism,' 'long-term versus short-term orientation,' and 'indulgence versus restraint') that were then used to identify clusters of cultures across the globe. In the resulting chapter [7], accreditation documents from four different major cultural groups are evaluated. The clusters ultimately represented via this chapter's case studies are Latin America, Latin Europe, Confucian Asia, and Anglo countries. The specific cases within each cluster were drawn from Colombia, France, Japan, and the United Kingdom (respectively), but the overview of current documents presented in other parts of the chapter (before the case studies) involves a much wider group of countries. The Hofstede framework has helped the team assess the degree of diversity they have achieved in their ongoing research projects.

Using the accreditation documents they have gathered from 12 countries to date, they have conducted comparative analyses involving seven cultural clusters: Africa, Anglo, Confucian Asia, East Europe, Latin America, Latin Europe, and Nordic Europe. First, they conducted word frequency counts of explicitly ethical terms ('ethics' and 'ethical') in these 12 countries' accreditation documents, as well as

implicitly ethical terms that they generated using the tables of content from five prominent textbooks on engineering. They also qualitatively analyzed the verbs used to describe desirable learning outcomes related to ethics. Linguistics has limited the scope of the study thus far; the work has included documents published in English or translated into English by members of their extended team. Seventy percent of the implicitly ethical terms in the 12 documents comprised the following terms: 'profession,' 'society,' 'charters and codes,' 'international context,' and 'responsibility.' Thus, the team's work sheds light on how engineering education systems conceptualize ethics, and articulates aspects that were previously invisible and/or tacit. The authors noted surprise that 'empathy' and 'justice' did not appear in any of the documents they studied.

Their chapter reports additional analyses, using statistical procedures of Principal Component Analysis to describe various characteristics, allowing the authors to report which groups have the most similarities and differences. For instance, they discovered that charters and codes were emphasized in documents from Latin America and East Europe but not mentioned in those from Confucian Asia and Nordic Europe. Related to verb use and analyzing content according to Bloom's Taxonomy [11], they found that 'application' is stressed most often, and 'evaluation' least often. They recommended moving engineering ethics education away from low-level 'application' toward increasingly high levels of engagement, requiring that students 'analyze,' 'evaluate,' and 'synthesize' or 'create' within the frame of ethics. Fortunately, from an education standpoint, the team was able to locate some occurrence of each of these levels in each cluster's documents despite there being a clear need to expand the integration of these higher-order skills.

Overall, the research in this second chapter aims to describe the current global landscape of ethics education and accreditation practices. Adopting a constructivist stance, the team endeavors to comprehensively understand and interpret the varied approaches employed in different cultural and national contexts. Their work to date has been limited by what they can access and read (which carries an Anglo/English bias). Still, their efforts to collect, understand, analyze, and evaluate various accreditation documents for ethical innuendos (implicit) and stated (explicit) components are ongoing. They encourage others to join their team and bring more insights from more countries into the mix. Readers of this conference paper are encouraged to join this team's efforts by contacting any authors of the forthcoming chapter or this paper.

V. ACCREDITATION AND PROFESSIONAL LICENSURE

To explore the multifaceted implications of engineering accreditation, particularly its components regarding ethics and educational program requirements, the chapter "Accreditation and Licensure: Processes and Implications" [12] examines interrelationships between accreditation and licensure across

various engineering sub-fields, focusing most on civil engineering. The focus on civil engineering is well-justified in the chapter because that field has traditionally taken the lead in defining standards used in North America and has thus influenced general practices and standards in engineering accreditation globally (including but not limited to ethics in accreditation).

While preceding chapters underscore standardized elements within educational systems' accreditation practices worldwide, this third chapter probes the legal intricacies surrounding the formal designation of individuals as 'engineers.' It describes the procedures for obtaining the requisite credentials to practice engineering, which vary significantly from one country to another and sometimes even across sub-areas within a country (i.e., states and provinces). Many different governmental and non-governmental groups interact within these processes. Frequently, licensure is grounded in accredited education that provides the necessary technical and professional skills for competent engineering work.

The rationale for licensure of professions is tied to public safety concerns, but licensure is also critiqued for issues related to power and upholding inequities. The initial licensing of an engineer and the maintenance of their license sometimes requires examination(s), documentation related to ethical behavior, and continuing education requirements that include ethical issues. Licensure requirements often pose barriers to individuals seeking to move between countries, and there are contemporary efforts to improve global mobility of credentials through cooperative agreements among countries.

After presenting global trends, the research team for this third chapter [12] narrows their focus to two illustrative cases. The first case study investigates the nexus between civil engineering education and licensure in the United States (US), offering insights into how ethics is integrated into this system. The authors present the US context, characterized by highly defined and carefully regulated relationships between education and professional practice in many fields of engineering, to illustrate the intricate dynamics involving diverse stakeholder perspectives that help garner widespread acceptance across the culturally diverse states of that nation.

In the US each engineering discipline adds unique program requirements to accreditation standards and has its own culture with respect to licensure. Of the sub-fields of engineering, civil engineering is tied most closely to licensure; a significant proportion of individuals in other disciplines work under industrial exemptions to licensure. A non-profit professional society, the American Society of Civil Engineers (ASCE), is deeply embedded within accreditation processes in the United States, lobbying for the importance of licensure. This group has been working diligently to increase the transparency of its processes. It has been at the forefront of promoting integrating ethical issues, including sustainability and inclusion, into its Code of Ethics and civil engineering accreditation requirements. Another non-profit organization,

the National Council for Engineering and Surveying, develops and administers two required levels of engineering licensure examinations. Ethical dilemmas are embedded within the processes of setting accreditation and licensure requirements and within the complex interplay of governmental and non-governmental groups.

In the second case study, the focus shifts to Ireland, a country with a smaller population yet one that has much in common with the US, culturally and linguistically. The national accreditation body called 'Engineers Ireland' is one of the original signatories of The Washington Accord. In Ireland, engineering accreditation serves as a catalyst for instigating change, with the accrediting body taking proactive measures to mandate progressive approaches to ethics in engineering. Notably, recent stipulations enacted by the accrediting body require engineering programs to explicitly integrate environmental and social sustainability, alongside diversity, equity, and inclusion considerations, into their curriculum and learning outcomes. Despite the efforts of Ireland's engineering accrediting body to drive transformative change, the research presented in this chapter [12] points to discrepancies between stated aims and evaluation practices during accreditation events. During these visits, assessors encounter challenges evaluating the programs' content purporting to ethics and often note that ethics is the learning outcome that is the least represented in the engineering curricula [13]. This trend is attributed, in part, to assessors' lack of familiarity with the term 'ethics' and what it might mean in engineering education and their uncertainty regarding how to effectively evaluate whether the curriculum adheres to ethical standards adopted by engineering professionals.

VI. CRITICAL PERSPECTIVES: EXAMINING THE POWERS AT PLAY

The fourth chapter, titled "A Feminist Critical Analysis of Engineering Ethics Education and the Powers at Play in Accreditation, Research, and Practice" [14], critically examines engineering ethics education in the context of accreditation and research. It questions whose voices are being amplified and whose are being marginalized in the global discourse surrounding accreditation in engineering, thus, exploring the ethics of engineering accreditation in and beyond ethics criteria. The chapter scrutinizes the structures that govern the inclusion and exclusion of content within engineering ethics. The authors delve into power dynamics, probing how hegemonic structures shape and perpetuate the landscape of ethics education in engineering as the idea originating from the 'Western' or 'Global North' perspective tends to overlook other viewpoints, and it often serves as a rhetorical defense, a performative expression, and an ineffective strategy for bringing about meaningful change.

Employing critical feminist analyses, the authors of this chapter challenge the complicity of individuals in upholding

existing exclusionary power dynamics through their endorsement of engineering accreditation. They argue:

1. Accreditation is Western / Global North-centered, and when non-Western countries (and/or countries in the Global South) join initiatives like the Washington Accord, they must adapt to the Western/Northern standards, and therefore local sensitivities vanish. This specific critique is the cornerstone of the subsequent chapter [15], which delves deeply into local issues.

2. Technical epistemology of engineering outbalances and marginalizes other disciplinary and epistemic perspectives.

3. Engineering education's emphasis on micro ethics and outcome-based assessment in ethics teaching decouples engineering ethics education from moral action and broader concepts of equity and social justice.

4. The engineering accreditation process produces "willful ignorance" [16, p. 10] of its own undesirable effects.

The authors [14] conclude that engineering educators are puppeteers of accreditation, limiting change and transformative engineering ethics education by dancing by the strings of accreditation instead of advocating for changes in the formulation of accreditation requirements. They underscore the imperative to embrace more critical perspectives within engineering ethics education, challenge or resist the power dynamics that maintain the exclusionary status quo, and transform engineering ethics education to support authentic, significant, and inclusive practices to do the profound work engineers have yet to do in reckoning with the trauma inflicted on our planet.

VII. CRITICAL PERSPECTIVES: LOCALIZING ENGINEERING ETHICS

Also adopting a critical approach, the concluding chapter of this section, titled "Accreditation Processes and Implications for Ethics Education at the Local Level" [15], investigates the disparity between (a) the implementation of ethics education at the grassroots level and its representation in (b) accreditation documents and (c) formal procedural requirements for accreditation. The authors observe that the bureaucratic procedures involved in operationalizing ethics education in engineering often result in abstract and decontextualized descriptions. In addition, the absence of higher-level verbs from Bloom's taxonomy [11] (e.g., compare, justify, evaluate) may lead to a lack of critical thinking around engineering ethics, and the exclusion of words such as 'global' or 'justice' can influence perceptions that these topics are not important to engineering ethics [8]. In this way, even though vague definitions may create space for multiple interpretations, these definitions also implicitly draw the line between what is considered important to engineering ethics, and what is not. This analysis reveals a disconnect between the abstract concepts in accreditation documents and the practices that can promote ethics in local contexts. This disconnect between abstract concepts and tangible actions, as

subsequently condensed into accreditation documents submitted by programs to justify their educational approaches to accrediting bodies, may lead educators to deliver content that lacks depth or, as perceived by the authors, lacks 'personality' or local relevance.

The authors [14] highlight the implications of this impersonal approach to ethics on the institutional and program levels, the course and instructor levels, and the student levels. At the institutional and program levels, the fact that engineering ethics topics are often relegated to one or two stand-alone courses means that students may need help to locate or understand ethics within their day-to-day technical work. In addition, institutions may have their own ethical commitments that involve a significant amount of labor (e.g., partnering with Indigenous communities) that may not be recognized or valued within the accreditation process. The authors [15] note that a vague definition of ethics may be useful because it allows for different interpretations by different engineering disciplines. For example, biomedical engineering students can learn about designing ethical testing protocols for medical devices, and software engineering students can learn about bias in algorithms. However, a lack of explicit guidance may lead to the use of "tried and true" engineering case studies such as the Challenger disaster or the Tacoma Narrows Bridge collapse, and the considerations and lessons learned from such cases may not be easily transferable to the ethical dilemmas that certain disciplines face.

For instructors, the absence of words such as 'justice' from accreditation documents [7, 8] may lead to a reliance on historical scenarios that do not address the ways in which systemic oppressions (such as racism and sexism) can be reproduced through engineering design work. Additionally, vague language may not adequately support instructors in trying new pedagogical approaches or connecting course content with their local communities. Lastly, at the student level, finding a stand-alone ethics course amongst many technical courses may lead students to conceive of ethics as something not at their program's core. They may fail to locate themselves within historical case studies and determine that they 'would never make that decision' without realizing that histories and cultures may influence those decisions, and that decisions are easily made in hindsight when variables are isolated and neatly presented via case studies. Heterogeneity of student identities and histories will influence what engineering ethics means to each individual student [17]. While broad definitions can create space for those multiple interpretations and 'personalizations,' they do not explicitly address the nuances and possible contradictions inherent in those personal interpretations.

The authors [15] propose strategies to address this structural challenge. Despite the standardized requirements imposed by accreditation documents and procedures, stakeholders directly involved in engineering courses – those situated within or closely connected to the educational environment – play a crucial role. Bridging the gap between

the definitions of engineering ethics from accreditation documents and the facets of engineering that are most important in the local contexts requires critical reflection from these stakeholders. They must collaborate to devise meaningful and captivating scenarios that facilitate students' development of essential knowledge, values, skills, and behaviors necessary for ethical living and working. Additionally, the scenarios they create should empower students to contribute to guiding society toward more ethical practices in behavior, construction, and innovation.

VIII. CONCLUSION

In conclusion, the section on engineering ethics accreditation of the forthcoming *International Handbook of Engineering Ethics Education Handbook* [5] illuminates the multifaceted nature of engineering ethics education and its accreditation process and practices, tracing the evolution from individual country-based systems to a network of accords aimed at fostering alignment among diverse national and regional frameworks worldwide. The chapters within this section highlight – and in some cases, challenge – a discernible shift towards a competency-based approach, emphasizing the imperative of equipping graduates with ethical reasoning skills, values, and attitudes essential for navigating the complexities of today's interconnected and highly mobile engineering profession, as suggested in our paper's title, 'Navigating Global Engineering Education Accreditation: Assessing Ethical Integration and Charting Pathways for Progress.'

The accreditation section of the Handbook delves into the integration of ethics into accreditation standards, recognizing the varying interpretations of ethical principles across cultures. It critically examines the power dynamics and interrelations among education, accreditation, and licensure, underscoring the challenges of implementing uniform ethical standards in diverse contexts. Authors in this section (and of this paper) amplify voices and raise awareness regarding the importance of providing localized, meaningful educational experiences that resonate with societal and environmental needs.

By scrutinizing the intricacies of accreditation processes, we, the researchers involved, advocate for an approach that infuses engineering ethics education and its accreditation processes with local cultural perspectives and personal engagement. We aim to cultivate engineers with technical proficiency, a heightened ethical consciousness, and a commitment to social responsibility.

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summary may have failed to highlight all key facets of their work, and we encourage readers to study all the chapters in the handbook once it is published. The digital version will be free to download and read worldwide.

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