2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #50522

Integrating Real-World Ethical Dilemmas into Engineering Education: Case Studies from Early-Career Engineers

Chika Winnifred Agha, Colorado State University

Chika Winnifred Agha is a Ph.D. candidate in the Department of Civil and Environmental Engineering at Colorado State University. She holds both bachelor's and master's degrees in Civil Engineering and brings a unique interdisciplinary perspective through her expertise in Engineering Education. Her research bridges technical engineering knowledge with critical educational frameworks, focusing on ethics, equity, diversity, and inclusion within the engineering profession. Her recent interests include the role of generative artificial intelligence (GenAI) in shaping engineering education.

Her work explores how early-career engineers navigate ethical challenges, equity issues and artificial intelligence (AI) as they transition from academia into professional practice. She employs both qualitative and quantitative research methods to investigate professional development, workforce preparation, and the broader goal of broadening participation in engineering.

Dr. Rebecca A Atadero P.E., Colorado State University

Rebecca Atadero is a professor in the Department of Civil and Environmental Engineering at Colorado State University, specializing in structural engineering. She conducts research on the inspection, management and renewal of existing structures, social equity in civil engineering work, and diversity, equity and inclusion in engineering education.

Dr. Amir Hedayati Mehdiabadi, University of New Mexico

Amir Hedayati Mehdiabadi is an Associate Professor at Organization, Information & Learning Sciences program at the University of New Mexico. His research seeks to answer how we can enhance ethical decision-making among professionals, including engineers and computer scientists, by understanding their ethical judgment processes.

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Abstract

This paper presents case studies designed based on empirical research among early-career engineers. As part of a larger mixed-methods study to explore how ethics and equity influence the early-career experiences of engineers, bridging the gap between engineering education and professional practice, this paper uses qualitative insights from 13 in-depth interviews with early-career engineers and data from the open-ended questions of 184 survey responses. Findings reveal that engineers frequently encounter complex situations where technical decisions intersect with issues of fairness, safety, accountability, and societal responsibility. These challenges highlight a disconnect between academic preparation and workplace realities, underscoring the need for structured interventions in engineering curricula. Each case study presented is grounded in professional codes of ethics from engineering societies, including the American Institute of Chemical Engineers (AIChE), American Society of Civil Engineers (ASCE), Institute of Electrical and Electronics Engineers (IEEE), Institute of Industrial and Systems Engineers (IISE), American Society of Mechanical Engineers (ASME) and National Society of Professional Engineers (NSPE), ensuring alignment with established standards. Beyond documenting lived experiences, the paper serves as a practical teaching resource, offering discussion guides, educator strategies, and activities to foster critical thinking and ethical decision-making among engineering students. By integrating real-world dilemmas into classroom conversations, this work equips future engineers to navigate ethical complexities and advocate for equity in professional practice. The study contributes to ongoing discourse on professional responsibility, emphasizing the importance of ethics education in shaping socially responsible engineers.

Keywords: engineering education; case study; engineering ethics; early-career engineers; mixed-methods research; ethical dilemmas

Introduction

The integration of ethics into undergraduate engineering curricula is crucial for preparing future professionals who can responsibly navigate complex socio-technical challenges [1], [2]. Across international contexts regarding engineering education, case studies stand out as the most popular and frequently employed pedagogical method for teaching engineering ethics, consistently identified in literature reviews of instructional strategies [3], [4], [5], [6], [7]. Case-based learning is valued for providing a context-driven approach that exposes students to authentic professional problems and dilemmas, thereby increasing their awareness of real-world situations and fostering critical thinking skills [6], [7], [8], [9], [10].

Despite this widespread consensus on utility, significant theoretical and practical tensions exist concerning the content, structure, and application of case studies. The dominant approach relies on cases focused narrowly on micro-ethical scenarios, often centered on individual professional dilemmas resolved through the application of codes of ethics or ethical theories [7], [9], [10], [11]. This micro-focus, while accessible to students with limited professional experience, has been criticized for failing to capture the complexity of organizational structures and power dynamics inherent in engineering practice [4], [7], [12]. It risks providing students with a false sense of individual decision-making autonomy and diminishing attention to broader macro-ethical issues, such as equity, public policy, and the societal mission of the profession [3], [10], [11]. Research indicates that ethics education is incomplete and sociologically deficient when decoupled from critical equity analysis [10].

A parallel tension exists between the scenario types most frequently used versus those preferred by educators and required by professional practice. Research shows that ethics instruction has often utilized highly visible, disaster-driven cases or hypothetical scenarios [6], [7], [13]. However, highly dramatic or historical cases can feel distant to students, potentially leading to emotional detachment or the simplistic conclusion that such catastrophic failures are irrelevant to routine engineering work [6]. Graduates entering the workforce report being unprepared for the complex ethical dilemmas such as public safety, environmental concerns, client expectations, and organizational power dynamics, because academic ethics training typically frames issues as clear right-or-wrong problems rather than ambiguous, ill-structured challenges[14], [15]. To maximize the impact of case studies, current literature underscores the need for methodological rigor. Effective pedagogical interventions should integrate role-playing activities to enhance empathy and perspective-taking, thereby helping students engage with conflicting viewpoints and the multiplicity of stakeholders [6], [16].

This paper is part of a large study [14], [17], [18], [19], [20], and addresses a critical gap in engineering education by exploring the lived experiences of early-career engineers as they navigate ethical and equity challenges in the workplace. This paper aims to examine the ethical and equity-related challenges faced by early-career engineers, translate these real-world dilemmas into classroom-ready case studies grounded in professional codes of ethics, and provide educators with practical tools to strengthen ethical reasoning and professional preparedness among engineering students. By employing a mixed-method approach combining semi-structured interviews and surveys, this paper provides real-life case study of the experiences of early-career engineers. The case study resource translates our findings into practical, discussion-oriented scenarios that educators can use to foster critical thinking and moral reasoning among engineering students. This research adds value by bridging the gap between abstract ethical principles and authentic workplace experiences, equipping future engineers with the skills to recognize, analyze, and address complex ethical dilemmas before they encounter them in practice. These case studies directly support ABET (2024) [21], student outcomes related to professional and ethical responsibility, preparing graduates to make informed decisions that uphold societal and professional standards.

Methodology

Research Design

This study is part of a larger mixed-methods study, combining qualitative and quantitative approaches to capture both the breadth and depth of early-career engineers' transition from academia to professional practice. The qualitative component consists of interviews with 13 early-career engineers, while the survey component consists of 184 responses comprising both closed- and open-ended questions. Integrating these methods provides a richer and more credible understanding of the transition phase. As Creswell and Plano Clark (2018) [22] note, mixed-methods research involves the integration of qualitative and quantitative data within a single study or across multiple studies, enabling researchers to analyze and synthesize diverse forms of evidence for a more comprehensive perspective on complex research problems. This study received Institutional Review Board (IRB) approval from Colorado State University (protocol #1736). Pseudonyms were used in this study.

For this project, **professional ethics** is defined as *"what professionals should or should not do to impact others, and society in general, in their professional practice"* [14]. To explore this concept, participants were asked the following questions:

- **Interview Question:** *Could you please share a dilemma you have had related to professional ethics since you started working as an engineer?*
- **Survey Open-ended Question:** *Please describe any other ethics or equity situation(s) that you have encountered at your engineering workplace.*

Qualitative Research Design

Thirteen early-career engineers participated in this study as volunteers with most participants within the 0-5 years range of professional experience. Recruitment was carried out through multiple channels, including direct messages on social media, LinkedIn posts, the researchers' professional networks, and emails sent to local engineering societies and chapters. Data collection involved online pre-interview surveys and semi-structured interviews, conducted via Zoom. Using Zoom ensured a convenient and accessible setting for participants to share their experiences comfortably. Each interview was recorded, transcribed verbatim, and organized prior to analysis. Interview durations ranged from 43 minutes 58 seconds to 1 hour 36 seconds. Only participants who provided informed consent were interviewed. Thematic analysis (TA) was employed for data analysis [23]. Coding and organization of themes were facilitated using ATLAS.ti after systematic coding of the transcribed data.

Interview Participant Demographics

The study involved thirteen early-career engineers who volunteered for semi-structured interviews. Of these, 62% were men (8 participants) and 38% were women (5 participants). The racial composition was predominantly White/European (69%), with smaller representations from Black/African American (7%), Black/African American & White/European (8%), Indian/Southeast Asian (8%), and Middle Eastern/North African (8%). Most participants had 0–5 years of professional experience, with the largest group (46%) in the 4–5 years range, followed by 15% each in 3–4 years and 5+ years, and smaller proportions in other categories. Employment fields varied, with Civil Engineering being the most common (46%), followed by Mechanical Engineering (23%), Computer & Electrical Engineering (15%), and single participants in Analytics Engineering and Mining Engineering (8% each).

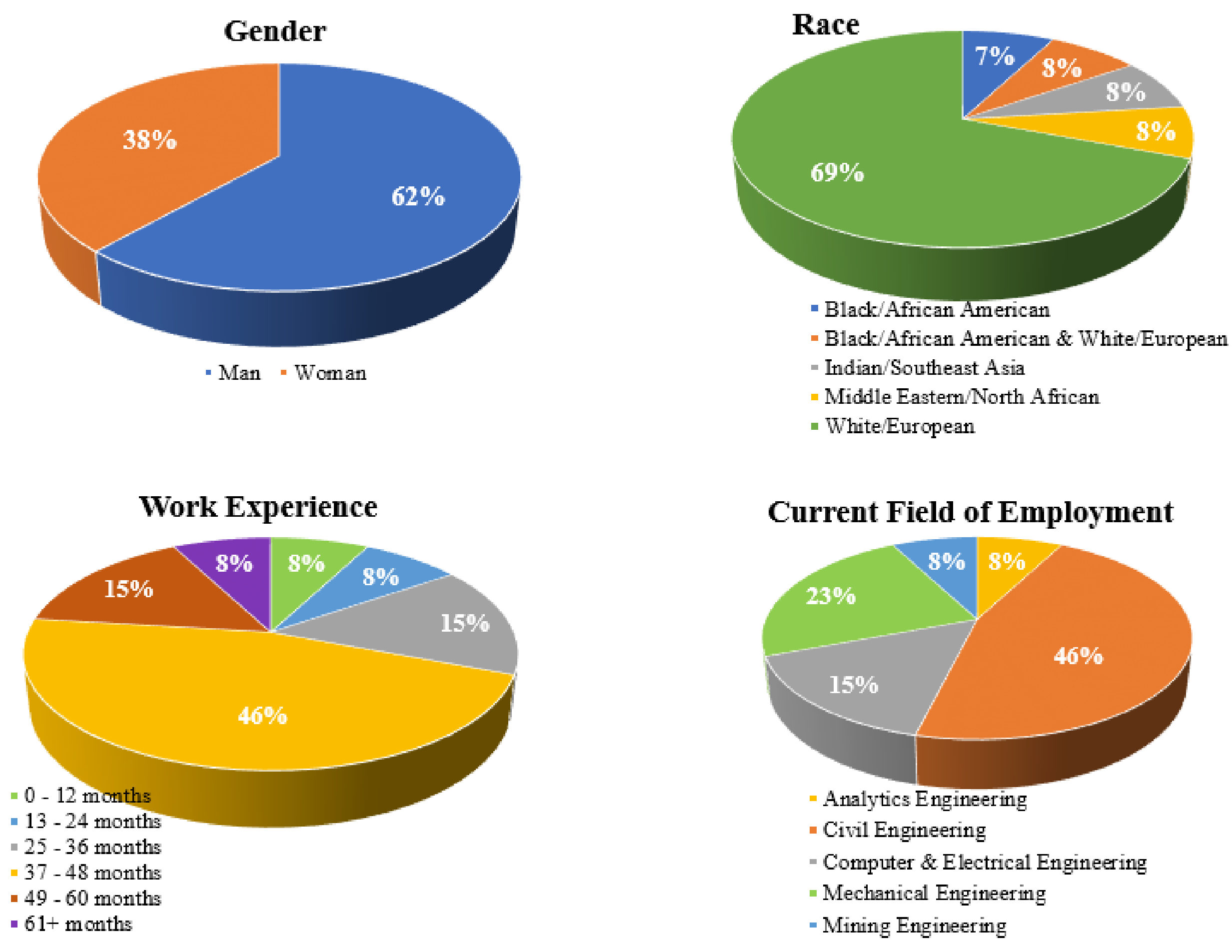

Figure1. *Interview Participant Demographics*

Survey

The survey instrument was designed as a multidimensional tool to capture early-career engineers' experiences, perceptions, and preparedness regarding ethics and equity in professional engineering practice. Development of the instrument was informed by preliminary qualitative research conducted during the initial phase of the broader study [14], [17]. The survey instrument comprised six sections: Demographic information; Workplace context; Relevance of ethics and equity to engineering practice; Preparation for professional engineering practice; Connections between ethics and equity; and Workplace experiences. The survey included 56 closed-ended questions and 8 open-ended questions, designed to capture both structured and open-ended perspectives. The instrument was administered via the Qualtrics platform and required approximately 15 minutes to complete. A total of 184 complete responses were collected.

Participants and Recruitment

Participants were early-career engineers with 3 months to 5 years of professional experience in the United States. Recruitment occurred through multiple channels. Initially the survey was distributed anonymously via professional engineering organizations and networks targeting early-career members. Participants were offered a $25 Amazon gift card as an incentive, but this resulted in low response. Due to low response rates and bot interference, the Institutional Review Board (IRB) protocol was amended to shift from anonymous to non-anonymous data collection. Updated recruitment procedures utilized Qualtrics' paid panel services to directly target eligible engineers. Only individuals who provided informed consent were permitted to complete the survey, ensuring compliance with ethical research standards.

Survey Participant Demographics

The study included 184 participants who completed the survey. Among them, 55% identified as men (n = 102), 44% as women (n = 81), and 1 participant reported another gender identity. In terms of race, the majority were White/European (71%, n = 131), followed by Black or African American (16%, n = 29), East Asian (5%, n = 9), Indian/Southeast Asian (1%, n = 2), and Other race (7%, n = 13), with no respondents identifying as American Indian/Alaska Native, Middle Eastern/North African, or Native Hawaiian/Pacific Islander. Work experience varied, with most participants having 37–48 months (35%) or 25–36 months (19%) of experience, while smaller proportions reported less than 12 months (5%) or more than 60 months (8%). Regarding employment fields, the largest groups worked in Computer Engineering & Computer Science (32%, n = 58) and Civil & Environmental Engineering (27%, n = 49), followed by smaller representation across Mechanical, Electrical, Industrial, Chemical, Biomedical, Biological, Aerospace, Architectural, and other engineering disciplines.

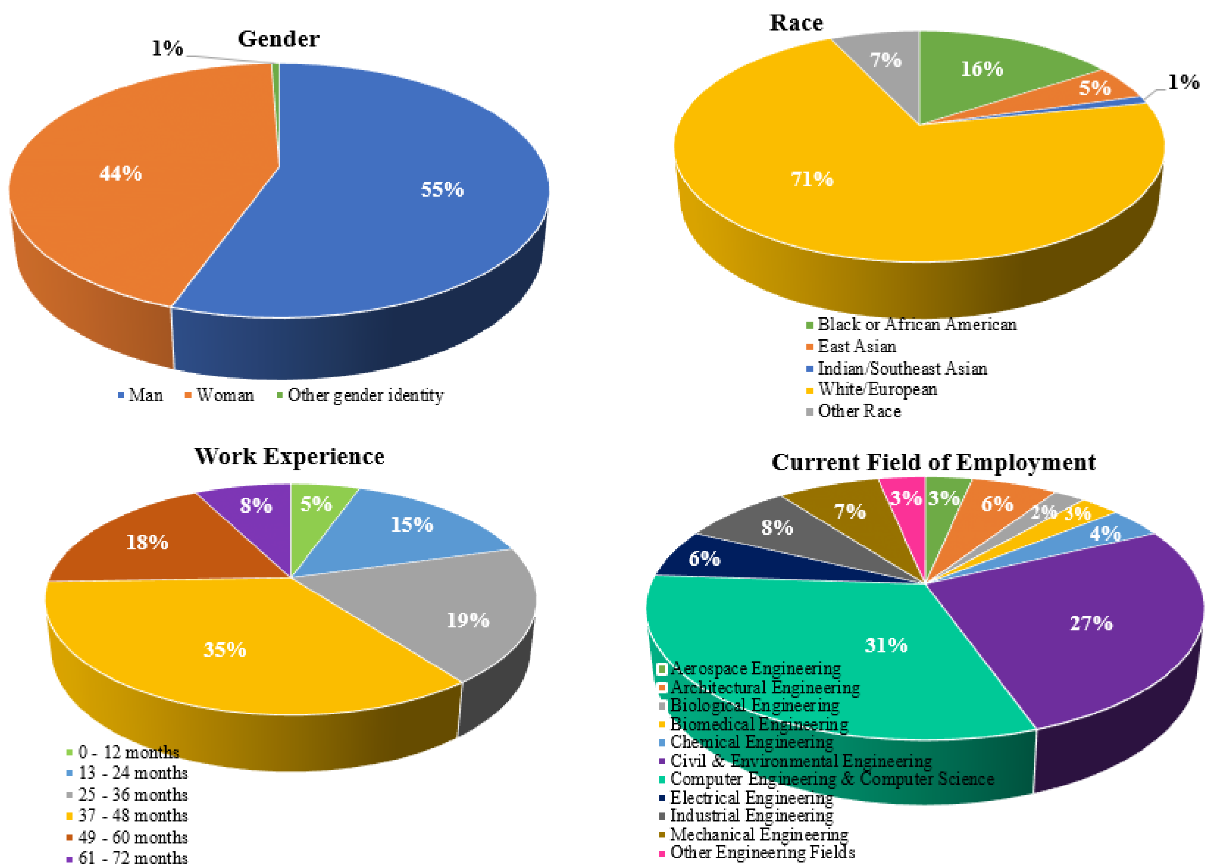

Figure 2. *Survey Participant Demographics*

Real Life Case Studies to Facilitate Class Discussion on Ethics

This paper presents case studies derived from interviews and open-ended surveys conducted with early-career engineers. The purpose of these case studies is to support engineering instructors and educators in facilitating classroom discussions about ethical issues in the workplace. By engaging with these discussions, students will develop a better understanding of ethical principles in engineering practice and learn to analyze conflicts between organizational directives and professional responsibilities. Students will also explore strategies for ethical decision-making under pressure, identify their ethical obligations, and advocate for ethical positions within organizational constraints. Furthermore, engineering students will recognize the relationship between technical requirements and broader social responsibilities, understand escalation pathways when initial ethical concerns are not addressed, and apply professional codes of ethics to real-world workplace dilemmas. Finally, these discussions aim to help students appreciate the competing pressures engineers face, such as employer loyalty, professional obligations, and public safety.

Suggested Teaching Approach for Educators

- Divide class into groups of 4-5 students
- Begin with a brief lecture on engineering ethics codes
- Use small group discussions to explore the dilemma and options
- Ask students for initial reactions: "What would you do if you are in this situation?"
- Role-play scenarios: where students act the cases provided
- Identify the key stakeholders and their interests
- Have groups identify: (a) ethical issues, (b) possible actions, (c) consequences of each action
- Conclude with a whole-class discussion to share insights and reflections.

We suggest using case studies multiple times throughout a course and using different teaching approaches each time to keep students engaged.

Overview of the Cases Presented in this Study

Table 1 presents the case number, the title of each case, the engineering discipline in which the early-career engineer is engaged, and the professional society code of ethics applied in the case study.

Table 1. *Overview of the Case Studies*

Case No	Case Title	Engineering Discipline	Code of Ethics
Case 1	Under Pressure: Timeline Compression	Chemical Engineering	American Institute of Chemical Engineers (AIChE)
Case 2	Favoritism and Unequal Opportunity in Project Assignment	Civil Engineering	American Society of Civil Engineers (ASCE)
Case 3	Approving Systems Under Pressure: Integrity vs. Job Security	Civil Engineering	American Society of Civil Engineers (ASCE)
Case 4	Prioritizing Safety in Civil Engineering Practice	Civil Engineering	American Society of Civil Engineers (ASCE)

			National Society of Professional Engineers (NSPE)
Case 5	Implicit Bias in Project Role Allocation: Equity in Engineering Team Leadership	Electrical Engineering	The Institute of Electrical and Electronics Engineers (IEEE)
Case 6	Gender-Based Pay Disparity in Engineering	Electrical Engineering	The Institute of Electrical and Electronics Engineers (IEEE)
Case 7	Unintended Bias in Engineering Design: Inclusive Design and Resource Allocation	Electrical Engineering	The Institute of Electrical and Electronics Engineers (IEEE)
Case 8	Beyond the Boundary: Ethical Challenges in Professional Competence	Industrial Engineering	National Society of Professional Engineers (NSPE) Institute of Industrial and Systems Engineers (IISE)
Case 9	Accuracy vs. Compliance: Misleading Data in Infrastructure Design	Mechanical Engineering	American Society of Mechanical Engineers (ASME) National Society of Professional Engineers (NSPE)
Case 10	Accessibility Overlooked: Designing for Inclusion in Mechanical Engineering	Mechanical Engineering	American Society of Mechanical Engineers (ASME)

Case 1. Under Pressure: Timeline Compression

Participants' Account

> "I was once pressured to complete a project in less than 2 weeks, a project that should naturally take 30 days to complete."

Background Context and Case Narrative

Ethan is a chemical engineer working in a private-sector chemical engineering firm. Under normal circumstances, the projects Ethan was working on require approximately 30 days to complete properly. However, Ethan's project manager has instructed him to complete the entire project in less than 2 weeks. This timeline compression would require compromising and potentially rushing through the project. Ethan recognizes that chemical process design errors can lead to catastrophic consequences including explosions, toxic releases, environmental contamination, and loss of life. He faces a difficult decision: comply with management's directive and risk compromising safety and professional standards, or resist the pressure and potentially face career consequences

American Institute of Chemical Engineers (AIChE) Code of Ethics

1: *Hold paramount the safety, health and welfare of the public and protect the environment in performance of their professional duties.*
7: *Perform professional services only in areas of their competence.*[24]

Discussion Questions for Students

1. What are the specific technical and safety risks associated with compressing a 30-day chemical engineering project into less than 2 weeks? Are there any circumstances under which the compressed timeline might be ethically acceptable?
2. What stakeholders are affected by Ethan's decision, and what are their competing interests? How should Ethan weigh the interests of his employer, clients, the public, regulatory bodies, and his own professional integrity?
3. If Ethan's employer continues to insist on the compressed timeline despite his objections, what are his ethical obligations according to the AIChE Code of Ethics? At what point, if any, should he consider external reporting or whistleblowing? Does Ethan have any responsibility to document this pressure or the potential risks?

Educator Guide

<u>Suggested Solutions</u>

- Create a detailed written record of the directive, including dates, who gave the instruction, and the normal timeline requirements. Maintain copies of all communications outside company systems

- Document the specific technical analyses that would be compromised. Prepare a technical memorandum outlining the specific process, safety analyses required and why each is critical.

- Quantify the risks by identifying potential failure modes, consequences, and probabilities that cannot be adequately addressed in the compressed timeline.

<u>Key Points to Emphasize</u>

- Safety is non-negotiable. Chemical engineering errors can result in catastrophic loss of life and environmental damage. The AIChE Code explicitly makes public safety the paramount concern.
- Early action is critical. Once Ethan becomes aware of the problematic directive, his ethical obligations begin immediately. Waiting or hoping the problem resolves itself increases risk.
- Professional responsibility transcends employment. Engineers have obligations to the profession and the public that supersede employer directives.

Case 2. Favoritism and Unequal Opportunity in Project Assignment

Participants' Account

> *"*Employees tend to be favored by the supervising staff if they happen to play golf. There is a clear distinction between those to play golf and those who do not. Younger staff who do get invited to play golf with the project managers and as a result get placed on more prestigious and interesting projects compared to those who don't golf."

Background Context and Case Narrative

Henry is a civil engineer working at a private-sector civil engineering firm where project assignments significantly impact career development, skill acquisition, and professional advancement. Over time, Henry has observed a pattern in how project managers distribute assignments. The firm's leadership includes several senior project managers who regularly play golf together. These managers have begun inviting select junior engineers to join their golf outings. Henry has noticed that engineers who participate in these golf sessions regardless of their technical qualifications or years of service consistently receive assignments to the firm's most prestigious projects. Meanwhile, equally or more qualified engineers who don't golf find themselves repeatedly assigned to less challenging work. This pattern has created a visible two-tier system within the engineering staff. The golf group and the non-golfing engineers.

American Society of Civil Engineers (ASCE) Code of Ethics

3. Profession

d: *reject practices of unfair competition*

4. Peers

d: *promote and exhibit inclusive, equitable, and ethical behavior in all engagements with colleagues*

g: *supervise equitably and respectfully* [25]

Discussion Questions for Students

1. What organizational conditions allowed this favoritism system to develop and persist? How might informal social activities transition from team building to discriminatory practices?
2. Is there a difference between social relationship-building (which naturally occurs in workplaces) and systematic favoritism? Where should organizations draw the line? How might this golf-based system disproportionately affect certain groups? Consider gender, physical ability, socioeconomic background, and cultural differences.
3. What are Henry's ethical obligations in this situation? What risks does he face in raising concerns? What strategies could he employ to address the issue effectively? What legitimate approaches could the organization use to build relationships between senior and junior engineers while ensuring equitable project assignment?
4. If you were one of the junior engineers receiving golf invitations and premium projects, what ethical obligations would you have? Would accepting these advantages make you complicit in the discriminatory system?

Educator Guide

Suggested Solutions

- Review the organization's employee handbook for formal grievance procedures, HR policies on workplace equity, or ethics hotlines. Submit a formal, documented complaint through appropriate channels.
- Formally ask management to establish and publish objective criteria for project assignments, including required qualifications, experience levels, and selection processes.
- Confidentially discuss observations with other affected engineers to determine if they've noticed similar patterns. Collective concern carries more weight than individual complaints.

Key Points to Emphasize

- Professionalism extends beyond technical work. Engineering ethics encompass how we treat colleagues, distribute opportunities, and build organizational cultures not just how we design structures.
- Intent vs. impact. Managers may genuinely enjoy golf and innocently invite engineers they connect with, but the systematic impact creates discriminatory outcomes regardless of intent.
- While individual action (like Henry reporting) is important, sustainable change requires organizational policy reform. Relying solely on individuals to resist unfair systems places undue burden on those with least power.

Case 3. Approving Systems Under Pressure: Integrity vs. Job Security

Participants' Account

> "I was sent out to be one of the install engineers... pretty intimidating at 22 years old... I had strict orders from the company: if there's any questioning about things that were right or matched or didn't match, to defer everything. But there were also a couple of parts on the systems that I had helped design. I had fairly intimate knowledge of them, and I did know that it didn't quite meet it... We passed all of the tests internally. We passed the first test on there, but in terms of how long would it end up lasting, it was a little more up in the air, and I was a little more forced, or at least felt forced into approving everything... they told me my signature is not going on it... which I was uncomfortable with, but also very early in career did not have much to go back on and it was a rather toxic company overall, so I did not want to run the risk of losing a job... It was more of approving giving a tacit approval to a system that I knew wasn't exactly what we were selling."

Background Context and Case Narrative

Amos, a 22-year-old civil engineer in his first job, was assigned as an installation engineer for multimillion-dollar industrial systems. Despite his youth and limited experience, he found himself in a leadership position overseeing the installation of $15 million equipment he had helped design.

American Society of Civil Engineers (ASCE) Code of Ethics

1. Society

a: *first and foremost, protect the health, safety, and welfare of the public*

2. Natural and built environment

b: *consider and balance societal, environmental, and economic impacts, along with opportunities for improvement, in their work* [25]

Discussion Questions for Students

1. Amos faced pressure from his employer to provide tacit approval while knowing the system had durability concerns. How should engineers balance loyalty to their employer with their professional duty to the public? What factors should weigh most heavily in this decision?
2. As a 22-year-old early-career engineer in a "toxic company," Amos felt he had limited options and feared job loss. How do power imbalances affect ethical decision-making? What protection should exist for early-career engineers in similar situations?
3. If the system fails prematurely, who bears responsibility, the company, the signing engineer, or Amos who provided tacit field approval? How might this incident affect Amos's career trajectory and professional reputation?

Educator Guide

<u>Suggested Solutions</u>

- Insist that a senior engineer or project manager come to the site to make the final approval decision. This removes Amos from sole decision-making responsibility while flagging concerns

- Email his supervisor outlining the durability concerns and requesting clarification on approval procedures. Create detailed field notes documenting specific concerns about the parts in question.
- Maintain personal copies of all correspondence and technical documentation. This creates a paper trail protecting him while alerting management formally.

<u>Key Points to Emphasize</u>

- New engineers face unique pressures such as financial insecurity, lack of professional networks, limited experience, fear of being labeled "difficult."
- Organizations may exploit this vulnerability by assigning risky decisions to junior staff.
- Engineers cannot hide behind employer directives when those directives violate ethics codes.

Case 4. Prioritizing Safety in Civil Engineering Practice

Participants' Account

"Pressure to complete work without the proper safety equipment or safety training."

Background Context and Case Narrative

Clara is a civil engineer employed in a private-sector civil engineering organization. She faces significant pressure from her employer to complete projects quickly. However, the organization does not provide adequate safety equipment or proper safety training. Clara is torn between meeting deadlines and ensuring safety standards, raising serious ethical concerns about professional responsibility, workplace safety, and organizational culture.

American Society of Civil Engineers (ASCE) Code of Ethics

1. Society

a: *first and foremost, protect the health, safety, and welfare of the public*

4. Clients and Employers

f: *perform services only in areas of their competence* [25]

National Society of Professional Engineers (NSPE) Code of Ethics

Engineers, in the fulfillment of their professional duties, shall:

Canon 2: *Perform services only in areas of their competence.* [26]

Discussion Questions for Students

1. Clara faces pressure from management to proceed despite safety concerns, yet her professional code demands she prioritize safety. How should engineers navigate situations where employer demands conflict with professional ethical obligations? What is the hierarchy of loyalties an engineer should maintain?
2. Clara fears negative consequences for her career if she refuses to proceed. How do power imbalances in employment relationships affect ethical decision-making? What protection exists for engineers who raise safety concerns, and are they adequate?
3. This appears to be an organizational culture issue rather than an isolated incident. What responsibility do individual engineers have to address systemic safety culture problems? How might Clara work to change her organization's approach to safety?

Educator Guide

<u>Suggested Solutions</u>

- Clara should formally document the lack of safety measures and report it internally to management or the safety officer.
- Specifically identify safety deficiencies and reference The Occupational Safety and Health Administration (OSHA) standards, company safety policies, and ASCE Code of Ethics Canon 1.

- Clearly state that she cannot proceed until deficiencies are addressed. Frame refusal in terms of professional obligations under licensure and ASCE code

Key Points to Emphasize

- Ethical codes provide a framework for decision-making under pressure. ASCE Canon 1's mandate to hold safety paramount is not optional or subject to employer override
- Professional integrity may require difficult choices, including reporting violations.
- Employers cannot legally require employees to work in unsafe conditions. Workers have protected right to refuse unsafe work without retaliation

Case 5. Implicit Bias in Project Role Allocation: Equity in Engineering Team Leadership

Participants' Account

> "At my engineering workplace, one ethics and equity situation I encountered involved the allocation of project responsibilities among team members. A junior engineer, who was highly capable, was consistently being overlooked for lead roles in favor of less experienced colleagues due to implicit bias. Recognizing this as both an ethical and equity issue, I raised the concern with the team lead, advocating for more transparent criteria in assigning responsibilities. As a result, the team began implementing a more structured and fair approach to project assignments, promoting inclusivity and recognizing merit more effectively."

Background Context and Case Narrative

Nathan, a computer engineer, observed an ethical and equity issue in his workplace. Project responsibilities were being allocated in a way that overlooked a highly capable junior engineer for lead roles. Instead, less experienced colleagues were consistently favored. Nathan identified this as an instance of implicit bias affecting fairness and inclusivity in the team. He decided to raise the concern with the team leader and advocated for transparent criteria in assigning responsibilities. This intervention led to the adoption of a more structured and equitable approach to project assignments.

The Institute of Electrical and Electronics Engineers (IEEE) Code of Ethics

> II: *To treat all persons fairly and with respect, to avoid harassment or discrimination, and to avoid injuring others.* [27]

Discussion Questions for Students

1. What specific indicators or patterns might Nathan have observed that led him to conclude implicit bias was occurring rather than legitimate differences in qualifications? How can engineers distinguish between valid professional judgments and bias-influenced decisions?
2. What professional and personal risks did Nathan take by raising this concern? What might have happened if he had remained silent? How should engineers balance career risks against ethical obligations?

3. Nathan chose to approach the team leader directly. What other intervention approaches could he have considered? What are the advantages and disadvantages of direct conversation versus formal complaint, involving HR, documenting patterns anonymously, or other approaches?

Educator Guide

Suggested Solutions

- Maintain objectivity by focusing on observable facts rather than assumptions about motivation.
- Before speaking up, take time for self-reflection and a bias check. Examine whether your perspective might be influenced by personal factors such as friendships, identification with certain individuals, or your own past experiences. This helps ensure that concerns are raised objectively and constructively.
- Engineers can ask management team for clear, documented guidelines for assigning roles based on skills, experience, and performance metrics.

Key Points to Emphasize

- Ethical responsibility includes fairness and transparency in professional roles. Implicit bias can undermine team effectiveness and violate ethical standards.
- The team leader may have been genuinely trying to make good decisions while being influenced by unconscious bias
- Silence in the face of inequity makes one complicit in perpetuating it. Professional codes of ethics explicitly require treating colleagues fairly. Engineers' ethical responsibilities extend beyond technical safety to workplace equity

Case 6. Gender-Based Pay Disparity in Engineering

Participants' Account

> "Because I am a woman in the department, I was making less than the other [men] engineers."

Background Context and Case Narrative

Amelia is a computer engineer working in a private-sector technology organization. Despite having similar qualifications and responsibilities as her male colleagues, Amelia discovered she was earning less than other engineers in her department. This situation raises ethical concerns about fairness, equality, and compliance with professional standards in engineering workplaces.

The Institute of Electrical and Electronics Engineers (IEEE) Code of Ethics

> II: *To treat all persons fairly and with respect, to avoid harassment or discrimination, and to avoid injuring others.*
>
>> 7: *To treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression.* [27]

Discussion Questions for Students

1. What are Amelia's ethical obligations upon discovering the pay disparity? Should she address this privately with management, document the discrepancy, consult with HR, or take other actions? What are the potential consequences of each approach?
2. What responsibility does the organization bear in this situation? How should compensation structures be designed and audited to prevent gender-based discrimination? What proactive measures should have been in place?
3. Beyond individual action, what systemic changes are needed? How can professional engineering organizations, industry standards, and legal frameworks better address wage discrimination? What role should transparency play in compensation practices?

Educator Guide

<u>Suggested Solutions</u>

- Amelia can raise the issue with HR or management, citing company policy and professional ethics.
- Ask for a formal explanation of how her salary was determined relative to market rates and internal equity.
- Advocate for transparent salary bands and regular pay audits within the organization.

<u>Key Points to Emphasize</u>

- Engineers have explicit ethical obligations under professional codes to oppose discrimination and promote fair treatment. Professional integrity requires action when ethical violations are identified, not just personal conduct compliance.
- Engineers must understand how discrimination undermines professional standards and organizational effectiveness.
- Systematic pay disparities often reflect organizational failures in compensation design, oversight, and accountability. Effective organizations implement regular equity audits, transparent salary bands, and objective promotion criteria.

Case 7. Unintended Bias in Engineering Design: Inclusive Design and Resource Allocation

Participants' Account

> "At my engineering workplace, I encountered a situation where project decisions unintentionally favored one community over another, prompting discussions on fair resource distribution and inclusive design."

Background Context and Case Narrative

Patrick, a computer engineer working in a private-sector technology organization, faced an ethical challenge during a project. The project involved designing a system intended to serve multiple communities. However, during decision-making, certain design choices unintentionally favored one community over another. This raised concerns about fairness, inclusivity, and equitable resource distribution. Patrick recognized the potential long-term impact of these decisions on the less favored community.

The Institute of Electrical and Electronics Engineers (IEEE) Code of Ethics

> I: *To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.* [27]

Discussion Questions for Students

1. Now that the disparity is evident, what are Patrick's ethical obligations? How should Patrick balance organizational goals with ethical responsibilities toward all communities?
2. How can engineers identify and mitigate unconscious bias in design and resource allocation? What strategies can organizations implement to ensure inclusivity in technical projects?
3. What systemic factors within the organization might have contributed to this oversight (e.g., lack of diversity in the engineering team, absence of inclusive design training, client requirements focused solely on efficiency)? What institutional changes could Patrick advocate for to prevent similar issues in future projects? How can engineers influence organizational priorities when ethics and profitability appear to conflict?

Educator Guide

<u>Suggested Solutions</u>

- Evaluate how design decisions affect different communities before implementation.
- Compile comprehensive data showing usage disparities across neighborhoods, correlating with demographic information.
- Discuss with management or leadership team and have the see the unfair impact of the project to one community.

<u>Key Points to Emphasize</u>

- Engineering ethics requires attention to outcomes, not just intentions. Engineers must proactively consider how design choices affect diverse populations.
- Inclusive design requires time, resources, and expertise. Ethical engineering means advocating for adequate resources to serve all stakeholders, particularly in public-serving applications. Engineers must make the business and ethical case for these investments.
- Professional codes of ethics serve as a guide for resolving dilemmas in real-world scenarios. The Association for Computing Machinery (ACM) and The Institute of Electrical and Electronics Engineers (IEEE) codes aren't abstract ideals, they provide concrete justification for pushing back on inequitable designs. Patrick can reference these standards when advocating for change, framing equity not as personal preference but as professional obligation.

Case 8. Beyond the Boundary: Ethical Challenges in Professional Competence

Participants' Account

> "At my place of work, I was being asked to work beyond my expertise."

Background Context and Case Narrative

Adrian is an industrial engineer employed in a public-sector industrial engineering organization. Adrian was assigned tasks that required expertise outside his professional training and experience. This situation raises ethical concerns about competence, responsibility, and public safety. The dilemma centers on whether Adrian should accept the assignment, seek additional support, or refuse the task to uphold professional standards.

National Society of Professional Engineers (NSPE) Code of Ethics

Engineers, in the fulfillment of their professional duties, shall:

2: *"Perform services only in areas of their competence."* [26]

Institute of Industrial and Systems Engineers (IISE) endorses the Canon of Ethics provided by the Accreditation Board for Engineering and Technology.

Canon 2: Engineers shall perform services only in the areas of their competence." [28]

Discussion Questions for Students

1. How should Adrian determine where his expertise legitimately ends? What factors should he consider when evaluating whether a task is slightly outside his comfort zone (presenting a growth opportunity) versus dangerously beyond his qualifications?
2. Who are all the stakeholders affected by Adrian's decision? Consider immediate supervisors, colleagues, taxpayers, end-users of his work, and his professional community. How should he weigh competing stakeholder interests?
3. What specific steps should Adrian take to document his concerns? How should he communicate his limitations to management in a way that is both professionally assertive and organizationally constructive?

Educator Guide

<u>Suggested Solutions</u>

- Adrian should clearly inform management about the limits of his expertise and the potential risks.
- Seek collaboration with qualified professionals or request training before proceeding. Propose a mentorship arrangement with a qualified professional who can supervise and validate his work.
- Create a detailed written analysis comparing the requested work requirements against his education, training, certifications, and experience.

<u>Key Points to Emphasize</u>

- Organizations share responsibility for assigning tasks within employees' expertise.
- Individual professionals remain accountable for their work regardless of management pressure. Professional engineers can face disciplinary action, license suspension, or legal liability.
- Career consequences of refusing inappropriate work are typically less severe than consequences of professional failure or ethical violations.

Case 9. Accuracy vs. Compliance: Misleading Data in Infrastructure Design

Participants' Account

> "I was on a project installing an older-style dam… one that's rarely produced anymore. We were the producer in America, and we were working with a site in Malaysia. The [Malaysian] engineers kept giving me incorrect information. I confirmed it was wrong each time, but I was told to make the product based on those drawings. Later, when things went wrong, I was still held responsible, even though I warned them from the start. It was an infrastructure project for a drainage ditch, but the ditch was in worse condition than we were told. Instead of actual photos, we got inaccurate engineering drawings. Much of the hardware was fatigued… bolts embedded in concrete were failing, and their actual position was different from what the drawings showed. So, we were misled about the quality and state of the environment, and how functional the dam would be in the long run."

Background Context and Case Narrative

Bob, a mechanical engineer employed by an engineering organization in the United States, was assigned to a project involving installing an older-style dam system for a drainage ditch in Malaysia. During the project, Bob encountered a significant ethical challenge. The Malaysian engineers supplying design information repeatedly provided incorrect data. Despite Bob's warnings that the drawings were inaccurate, he was instructed to proceed with manufacturing based on those drawings. Bob faced the dilemma of balancing professional responsibility with organizational directives, knowing the long-term functionality of the dam was compromised.

American Society of Mechanical Engineers (ASME) Code of Ethics

Canon 1: *Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties.* [29]

National Society of Professional Engineers (NSPE) Code of Ethics

Engineers, in the fulfillment of their professional duties, shall:

Canon 1: *Hold paramount the safety, health, and welfare of the public.* [26]

Discussion Questions for Students

1. How should Bob have responded when instructed to proceed despite his concerns? How should an engineer respond when instructed to follow incorrect specifications?
2. Should Bob refuse work if accurate data is unavailable? Why or why not? How can engineers advocate for accurate data without jeopardizing their position? What steps could have been taken to verify site conditions before manufacturing?
3. How do organizational pressures conflict with ethical obligations in engineering? What role does transparency play in preventing such dilemmas? What are the potential consequences of ignoring environmental realities in infrastructure projects?

Educator Guide

Suggested Solutions

- Submit formal written memos to supervisors documenting each discrepancy with specific technical details, dates, and potential safety implications.
- Request written authorization to proceed despite identified concerns, making decision-makers accountable.
- Insist on actual site photographs or video walkthroughs before finalizing manufacturing specifications.
- If the budget allowed request permission to conduct or commission an independent site assessment.

Key Points to Emphasize

- Documentation is protection. Written records are essential for both safety and professional protection. Verbal warnings alone are insufficient in high-stakes projects.
- Professional duty transcends employment. Engineers' obligations to public safety supersede employer directives. Canon 1 of ASME Code is paramount.
- International projects require extra diligence. Cross-cultural communication, varying standards, and distance create additional verification responsibilities.

Case 10. Accessibility Overlooked: Designing for Inclusion in Mechanical Engineering

Participants' Account

> "At my engineering workplace, I encountered a situation where a proposed product design did not fully account for accessibility needs, particularly for users with disabilities. While the design met technical requirements, it failed to consider equitable access. I raised the concern with my team, and we worked together to revise the design to include features like adjustable interfaces and screen reader compatibility."

Background Context and Case Narrative

Collins is a mechanical engineer working for a para-public sector engineering company. The organization was developing a new product intended for use in public. The design team focused primarily on technical specifications: durability, precision, cost-efficiency, and compliance with industry safety standards. However, during the design review phase, Collins recognized that the proposed interface did not adequately consider users with disabilities, potentially excluding individuals with visual impairments, limited mobility, or other accessibility needs.

Collins faced a dilemma: Should he raise concerns that might delay the project timeline and increase costs, or remain silent since the design technically met all specified requirements? After reflection, he decided to speak up to the team, explaining his concerns about equitable access and the organization's broader social responsibility. Colin's experience reinforced how ethical responsibility includes advocating for inclusive and fair solutions in engineering

American Society of Mechanical Engineers (ASME) Code of Ethics

> **Canon 1:** *"Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties."*
> **Canon 10*:*** *"Engineers shall, in all matters related to their profession, treat all persons equitably and encourage and support participation by all in accordance with Policy P-15.11 "Diversity, Equity and Inclusion""* [29]

Discussion Questions for Students

1. What was Collins's primary ethical obligation in this situation? Was it to the project timeline and budget, to his employer, to end users with disabilities, or to the broader public? How should engineers prioritize competing obligations?
2. Did Collins have a professional duty to raise accessibility concerns even though they weren't explicitly part of the project specifications? Where does an engineer's responsibility end regarding features not mandated by clients or regulations?
3. What if the team had rejected Collins's concerns? What additional steps could, or should Collins have taken? Should he have escalated the issue to management, accepted the team decision, or pursued other options?

Educator Guide

<u>Suggested Solutions</u>

- Raise concerns professionally during team meetings, providing specific examples and proposed solutions.
- Frame accessibility as ethical obligation aligned with professional codes and organizational values.
- If initial team resistance continues, formally document accessibility gaps in writing
- Reference ASME Code of Ethics and potential legal/reputational risks.

<u>Key Points to Emphasize</u>

- Professional responsibility extends beyond technical specifications. Engineers must consider broader impacts even when not explicitly required by project parameters.
- Speaking up requires courage and skill. Collins demonstrated both moral courage and professional communication by raising concerns constructively.
- Accessibility is not optional. For engineers committed to public welfare, designing for inclusion is an ethical imperative, not merely a legal compliance issue

Conclusion

This study demonstrates that ethical and equity challenges are integral to the early-career experiences of engineers, yet they remain insufficiently addressed in traditional engineering education and professional development in the workplace. Through mixed-methods research, we identified a persistent gap between academic preparation and professional practice, where technical decisions often carry profound social and ethical implications. By presenting real-world case studies grounded in professional codes of ethics, this paper offers educators actionable tools to prepare students for these realities. Structured discussions, role-play exercises, and critical analysis of dilemmas enable students to develop practical strategies for ethical decision-making under organizational constraints. Therefore, integrating ethics and equity into engineering curricula is not optional, it is essential for cultivating professionals who prioritize public safety, fairness, and accountability. These findings call for intentional, interdisciplinary approaches to ethics education, ensuring that future engineers are equipped to uphold their responsibilities to society.

Acknowledgment

This research was partially supported by the Organization, Information and Learning Sciences at the University of New Mexico and by the National Science Foundation under Grant Nos. 2135328 and 2135329. The opinions, findings, conclusions, and recommendations expressed in this material are solely those of the authors and do not necessarily reflect the views of the funding organizations.

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