

Encountering Engineering Ethics in the Workplace: Stories from the Trenches

Ms. Dayoung Kim, Purdue University, West Lafayette

Dayoung Kim is a Ph.D. Candidate in Engineering Education at Purdue University. Her current research interest centers on engineering ethics and social responsibility, and she is specifically interested in cultural influences on engineers' moral formation. She earned her B.S. in Chemical Engineering at Yonsei University (Seoul, South Korea) in 2017 and M.S. in Chemical Engineering at Purdue University (West Lafayette, USA) in 2021.

Ms. Shiloh James Howland, Brigham Young University

Shiloh James Howland is a doctoral candidate at Brigham Young University in Educational Inquiry, Measurement, and Evaluation. She received a master's degree in instructional psychology and technology as well as a bachelor's degree and master's degree in geology. Her current research interests are in educational assessment and measurement.

Prof. Brent K. Jesiek, Purdue University, West Lafayette

Dr. Brent K. Jesiek is an Associate Professor in the Schools of Engineering Education and Electrical and Computer Engineering at Purdue University. He also leads the Global Engineering Education Collaboratory (GEEC) research group, and is the recipient of an NSF CAREER award to study boundary-spanning roles and competencies among early career engineers. He holds a B.S. in Electrical Engineering from Michigan Tech and M.S. and Ph.D. degrees in Science and Technology Studies (STS) from Virginia Tech. Dr. Jesiek draws on expertise from engineering, computing, and the social sciences to advance understanding of geographic, disciplinary, and historical variations in engineering education and practice.

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While formal coursework remains one of the most common strategies for developing ethics knowledge and competence among engineering students [1], ethical situations also surface in many other settings. In our own research on engineering student perceptions of ethics and social responsibility, we found that many engineering interns and co-ops reported encountering ethical issues or dilemmas in the workplace [2]. This finding counters a common perception – often perpetuated by the prevalence of “big disaster” case studies in engineering ethics education – that ethical issues surface relatively rarely for most technical professionals. As Kline has argued, there is a continuing need to “move beyond this concern with what might be called ‘disaster ethics’ to study the ethical and social aspects of everyday engineering practice” [3, p. 14].

Aligned with Kline’s recommendation, the primary research objectives for this paper center on: 1) identifying and describing real-world ethical issues encountered by engineering students in workplace settings, and 2) investigating what students learned from these experiences. We address these objectives by reporting select results from an ongoing qualitative analysis of 33 interviews with undergraduate students in their fourth year of college [2], [4]. We more specifically present a series of illustrative cases drawn from four of the interviews, selected because the participants described specific work situations in considerable detail and the cases represent a wide variety of ethical concerns. In the first case, Benson explains how his time spent doing risk analysis and risk management work for a large multinational firm caused considerable discomfort when he observed other engineers pressured to adjust or revise risk evaluations. Next, Phineas describes tensions around decisions to “black box” information shared with a customer, including quality data that could impact how the customer understood the reliability of certain parts. A third example is from Beatrice, who in general characterizes her work environment as having high ethical standards and a lack of ethical dilemmas, yet she also describes design decisions that involve making judgment calls amidst considerable uncertainty. Fourth and finally, we explore Palano’s story of filing a sexual harassment complaint with his company’s human resources unit.

The overall purpose for sharing these cases is threefold. First, we note some specific lessons that our subjects learned (or failed to learn) through the selected cases. Second, we argue that the workplace is a particularly rich setting for learning about professional ethics. Third, we make a series of recommendations for better scaffolding and supporting student learning in workplace settings. We expect this paper will be of particular interest to engineering ethics scholars studying where and how students learn about ethics, instructors looking for ways to enhance and extend ethics learning, and students preparing for internship, co-op, and/or full-time job roles.

Literature Review

Internships and co-op experiences often provide students with a wealth of experiential learning opportunities. As Eyler points out, such opportunities provide students with “‘real world’ challenge” [5, p. 41], and through workplace experiences students often come to see “the relevance of the curriculum to life in a complex organization” [5, p. 50]. Eyler (1993) more specifically found that co-op students learned how to be “an expert on people and organizations” [5, p. 47], including how to be an effective member of their employing organization. It has also

been argued that internship or co-op programs are helpful for students' professional growth [6]. Based on their empirical study with business students, Bhattacharya and Neelam reported that students developed greater confidence, negotiation skills, social sensitivity, and cross-cultural understanding by interacting with various stakeholders during their internships [7].

While internships and co-op experiences provide students with opportunities for professional growth in general, including learning of various professional skills, these experiences have also been considered as supporting professional growth in the area of professional ethics. For example, in discussing various active learning strategies that can be implemented in an accounting ethics course, Loeb introduced the possibility of leveraging students' internship experience to facilitate their learning of ethics [8]. Given that students can encounter ethical issues during their internship, Loeb argued that an accounting ethics course could be coordinated with internship programs, with educators devoting some class time to discuss ethical issues that students encountered during their work experiences [8].

As in many other professions, internships and co-op experiences have been considered an important element of the college experience for engineering students [9]. Although there have not been many studies which investigated the influence internships and co-op experiences have on engineering students' learning of ethics specifically, a few studies have explored and reported on the potential impacts of such work experiences. For example, Burt et al. reported faculty members' frequent observation that such experiences have positive impacts on students' learning of ethics based on their study of how out-of-classroom experiences influence students' ethical development [10]. Although the evidence was anecdotal, Loui also observed students' self-reported learning about engineering values such as accuracy and precision [11]. Loui additionally reported a student's workplace observations of "many environmental problems of varying degrees of intensity" [11, p. 385].

However, other research has reported mixed results about how internships potentially impact student attitudes toward ethics and responsibility. Most notable, Rulifson and Bielefeldt reported evidence of some potential impacts of internship experiences on students' learning, finding 7 of 15 interviewed students explicitly linked their internship experiences to learning about socially responsible engineering practices. However, only four of these seven students reported that their internship experiences expanded their views of social responsibility [12].

Method

The results presented in this paper are from a larger mixed-methods, longitudinal research study. In Fall 2015, 757 undergraduate engineering students at four universities were recruited as part of our initial data collection efforts. The four universities included one private, religious university (Brigham Young University) and three public universities (Arizona State University, Colorado School of Mines, and Purdue University). Of those 757 students, 111 were selected for semi-structured interviews in Spring 2016. In our final phase of data collection in Spring 2019, we interviewed 33 of the 111 interviewees again using a similar semi-structured interview protocol approved by each university's IRB. These interviews were about one hour long and students who completed the interview received a \$20 gift card.

Analysis of those final 33 interviews is ongoing but recent analysis indicated the importance of experiential learning experiences such as internships and co-ops in shaping the students' ethical perspectives [2]. Of the experiences explored in that paper (family, academic, and work), internships and co-ops were discussed most often – 26 of the 33 interviewees specifically mentioned a work experience and evidence of possible lessons learned. Further building on that work, we drew on the experiences of four students: Beatrice and Benson from Brigham Young University (BYU) and Phineas and Palano from Purdue University. In their second interviews, each of these four students offered rich descriptions of specific encounters with ethical situations. Here we present these four students' internship experiences as case studies to highlight the ample opportunities ethics learning in the workplace, albeit with some notable variations in what students learn (or fail to learn) from direct or indirect encounters with ethical situations.

Findings

Beatrice: Antithetical engineering ethics

Beatrice is a fourth-year student at BYU, majoring in civil engineering and minoring in fine arts. She has also been working in an internship with a structural design company. She aspires to continue in a full-time role with the same firm after graduation, and wants to work toward her professional licensure. When asked to give examples of ethical situations she had previously faced in any setting, Beatrice noted: "I work at a company, where ... there aren't ethical dilemmas. Everyone's trying their best, they're all graduates of this college, they all signed the Honor Code. Not all of them, most of them, like 95% [are BYU graduates], and so we all have an expectation for each other, and so we tend to meet that. So, it's hard trying to think of [an ethical situation]." Nonetheless, Beatrice discusses a number of situations where she and other engineers in her firm are challenged to use professional judgment in situations involving considerable uncertainty.

As a more specific example, she described how – on the very same day of her interview with us – she was dealing with a situation involving an incorrectly sized beam that had been installed in a structure. This in turn raised the question of "how can we look at the calculations to see if this different size beam works?" As Beatrice went on to explain:

And if it doesn't pass, the moral dilemma of, what do you tell them to do? Because it's like, according to our conservative calculations, it fails. But those calculations are conservative, so can we say like, if it's failing by this much, if it's only failing by like 3%, it should be fine, but where do we draw that line ethically?

Beatrice added that she was ultimately able to establish that the structure "barely passed" after she confirmed the correct dimensions of the beam and reran the calculations. She went on to summarize that this particular situation "was a very interesting dilemma of me trying to, fudge the numbers is the wrong word, but the idea of, making sure the numbers were perfect, but also not too much all at the same time. It was very difficult." Elsewhere in the interview, Beatrice described other examples where her firm was able to approve major changes made to a structure by a client or contractor. Yet she also cited examples where the actual construction deviated so much from the original specifications that a given structural element (e.g., a building foundation)

had to be completely torn out and redone because there was no other way to fix the issue while meeting the original design specifications.

Beatrice additionally observed variations in professional judgment among the engineers she had worked with on various projects. As she explained in considerable detail:

So each one [professional engineer] is a different person, and they have their own personal preferences of, “This should be engineered this way, I would like you to do it this way.” It’s their license, so we do it their way. But if you were to talk to the other professional engineer, just in the other office, they might have a different opinion on it. So, it’s like, “Which one’s the right one?” Knowing what’s best is hard, especially in an area that can have so many variables. Because you can build a house so many different ways. So, knowing the right way to do it is often difficult because everyone has their own preference. Each client has their own preference. They all like it a different way, so it’s hard to know where we can allow the client’s preferences take over, or where we put our foot down and say, “No, this is the way it has to be done.” It’s really difficult knowing what to do sometimes.

As the preceding account suggests, Beatrice’s remarks reflect an interesting dichotomy. On the one hand, she speaks to her company’s high standards and notes a lack of ethical dilemmas. On the other hand, she gives multiple examples where difficult structural design decisions depend heavily on professional judgment, while also observing that specific design recommendations are often linked to the preferences of a given engineer.

Benson: “That’s not real. That’s an ideal.”

Benson was a fourth-year student at BYU majoring in chemical engineering. Through his internship in the risk management department of a large corporation he had dealt with risk evaluations for various project sites. As a chemical engineer working in the manufacturing field, Benson explained that tolerance for some amount of risk is needed when working with dangerous chemicals or big machinery: “you have to find a balance between cost, because the more safety measures you put into the place then the more expensive it is, and risk of the less safety measures the more bad things can happen.”

As part of his job role, he was more specifically tasked with going through about 15 years’ worth of data on risk evaluations carried out for different sites and units. For this task, he had to review considerable amounts of evidence, including by reading and listening to transcripts of relevant meetings and exploring considerable amounts of data. Reflecting on this task, he observed that for the “engineers doing these safety analyses [...] there’s a real conflict of interest,” especially because it is hard for engineers to recommend high-cost options to address safety issues when interacting with other company stakeholders in charge of those sites. As Benson explained:

So in the meetings between the risk engineers and the site engineers, I felt uncomfortable at times listening to how they would brush off risk in terms of cost... So I felt like there could have been a better use of a middleman to eliminate the conflict of interest.

Benson then went on to cite the example of the Challenger space shuttle disaster, explaining that for the risk assessment scenarios he had observed it was “not that extreme, but it was that same kind of thing where the manager says, ‘It’s too expensive. Change your numbers.’” When asked about how he responded to this situation, he added that “ethically, it was hard for me.” He also talked to his supervisor about how to balance risk and cost properly, but he was not fully satisfied with the supervisor’s answer, which he paraphrased as “Oh, yeah. It’s a hard thing to balance.” From this experience, Benson reported learning that “you’re not always going to see a perfect commitment to ethics in industry.” He also pointed out that even though there is a code of ethics for chemical engineers, “nobody sticks to that 100%. That’s not real. That’s an ideal.”

Phineas: “You need to tell them”

Phineas, a senior in materials engineering at Purdue, discussed her year-long co-op experience with an automotive supplier. She more specifically shared a number of insights about what colleagues in her co-op firm referred to as “black-boxing.” She explained that this involved deciding which information to share with a customer and which information to hold back:

So like the customer doesn’t need to know we’re having this problem. We know we’re having the problem, and we know we can fix it. But we would combine problems in order not to tell the customer that we were also having this issue. [...] We’re like, “Oh, we’re making the pedal stronger.” But we’re not telling them we’re making it stronger because it’s been failing.

As she explained this situation, Phineas noted that a project engineer was primarily involved in adopting this particular strategy and her manager had a different perspective and wanted to be more transparent with the customer about the issues they encountered. As she recounted:

So the project engineer’s, like, “I’m not going to tell them anything, because they don’t know. They don’t understand.” But my boss was like, “No, we need to tell them because it’s our responsibility to educate them.” But that was like saying, “They don’t understand, so I’m not responsible for them,” versus my manager was like, “No, we’re exactly responsible for them because they don’t understand.”

As Phineas went on to reflect, “If I was that customer [...] I would want to know that information.” She additionally added: “almost everybody on my team had been there for over ten years. I didn’t have the same loyalty to the company that they did, so I didn’t feel as responsible to keep stuff [from the customer].” Consequently, at that time she kept quiet about her concerns that her company was not sharing all available information with the customer.

However, by her third co-op session she had gained more respect from her co-workers and felt that she had “more experience, and I guess, more assimilation to the fact that the customer doesn’t need to know everything.” However, this “assimilation” did not change her feelings about keeping the customer informed. As she spoke up more during this last co-op session, she was aware that no one wanted to relay this kind of information to the customer even though “it needs to be done.” As she had no direct contact with the customer in her co-op role, she instead “remind[ed]” the project manager that “you need to tell them.” She felt that her standing in the company was not affected and stated just that “they [the project engineers] knew that it needed to

happen, so they weren't mad at me. Nobody was ever angry at me or angry at the person who needed to tell that information, because there was an understanding that the information needed to be spread. So nobody was mad, but nobody wanted to do it."

Phineas' observations of these interactions between herself, her manager, a project engineer, and the customer led to some interesting shifts in her thinking. Initially, she was a proponent of sharing all information with the customer (following the lead of her manager). Over time, she came to understand the reasons that the project engineer may want to limit the sharing of some information. By the conclusion, even though Phineas understood the reasons for withholding information, she still wanted to share as much as possible with the customer. She essentially ended at the same point she began regarding the need to share information, but her reasons for doing so were informed and bolstered by her increasing experience and confidence.

Palano: To report or not to report

Palano was a senior studying mechanical engineering at Purdue. In his interview, he described an experience involving sexual harassment during an internship he completed after his sophomore year. He explained that one of the intern coordinators was "handsy" with a female intern during an optional evening activity. Palano could tell the female intern was ill at ease: "it was very [pause] you could tell she was uncomfortable with it and a couple of my other intern friends and I sort of pulled her aside and we were like, 'Hey, is everything okay? Is it [pause] are you okay? Is it bothering you? We could figure out what to do from this.'" She said "No, don't [pause] it's fine, don't say anything." The intern coordinator eventually "cooled off" but another intern and Palano "explained the situation to the head of ethics there." Palano said that he felt "nervous because I feel like most people get nervous when you have to go talk to HR [Human Resources] [pause] ethics to report someone else that [pause] I mean, he seemed like he was a nice guy, very smart. He did a couple presentations throughout the semester but it was just unnerving that that happened." The female intern did not go with him to report, though she was aware that Palano and his friend were considering doing so. This incident occurred at the end of Palano's internship so he did not know what if any repercussions had resulted from the report he had made.

Palano's involvement in reporting the harassment of the female intern is interesting considering that he was a bystander. He and the other intern who reported the incident to HR had to consider several factors prior to making their report. One issue is that the female intern had tried to downplay the harassment. As a consequence, he could have simply disregarded the coordinator's behavior, but instead stated how "it sort of felt that we needed to [report the incident]." He might have also convinced himself that because the intern coordinator had stopped harassing the female intern, the issue had been resolved and did not require his involvement. Additionally, he could have decided that the matter was not worth addressing because his internship appointment ended that same week. Finally, he could have let his discomfort with talking to HR persuade him to not report the incident. Any one of those decisions could have led him away from reporting, but he made a series of decisions that ultimately led him to report the issue to HR.

Discussion and Conclusion

These four students' experiences illustrate the rich possibilities for internships to provide not only hands-on experience in engineering but also encounters with real-world ethical situations.

The examples outlined here also reflect a mix of outcomes and resolutions, some clearly more favorable than other. Beatrice and Palano serve as the most positive examples, with Beatrice explicitly noting that the engineers in her company are doing their best to uphold ethical conduct and Palano taking proactive steps to report a sexual harassment complaint. Phineas' case is more nuanced, as her experience gave her confidence to speak up about sharing information with customers, but she also came to better understand reasons to withhold such information. Finally, Benson observed engineers in his company adjust risk estimates in response to managerial pressures, realizing that he would not always see a perfect commitment to ethics in industry.

Aligned with some prior literature [9-11], participants also showed mixed reports of potential impacts from these situations. Both Benson and Phineas were able to speak to what they learned from their experience (e.g., for Benson, a non-perfect commitment to ethics in industry as a fact; for Phineas, a reaffirmation of her own opinion that sharing as much information with customers as possible is desirable based on a better understanding of reasons for withholding information). Yet the lessons learned by Beatrice and Palano were not as clear, perhaps because their observation and actions were largely consistent with their pre-existing values. While it is always difficult to predict other possible outcomes in a given situation, further reflection and feedback on these situations might have prompted deeper learning – such as to help Beatrice to better see the “everyday ethics” in her workplace.

Internships, along with other types of experiential learning including service learning, student-faculty research, study abroad, and capstone courses, have been identified as high-impact practices for enriching student learning [13]. For instance, AAC&U's College Learning for the New Global Century notes that such experiences offer “rich opportunities for connecting knowledge with choices and action” [14, p. 36]. However, as Beatrice's and Palano's experience demonstrates, students may have “had the experience but missed the meaning” [15, p. 151, quoting T. S. Eliot's *Four Quartets*]. Thus, there remains an open question about what could be done to help students learn even more, especially closer to the time when such situations arise.

The ethical situations that the students related to us were shared after at least six months had passed since the internship. In Palano's case, more than a year had passed. We hypothesize that these experiences could have been enhanced if students had, during their internships, been encouraged to actively reflect on the ethical decisions they faced. Reflection is a process by which students can discover the meaning within the experiences they have had. Indeed, “periodic, structured opportunities to reflect and integrate learning” are considered one of the key conditions for calling an activity a “high-impact practice” [13, p. 8]. The importance of reflection in learning, particularly in experiential learning activities such as internships, is well documented. Reflection has been defined as “the internal transformation of experiences” [16, p. 58] and “the element that transform simple experience into a learning experience” [17]. Since internships are often transitional experiences between the university and the workplace, helping students meaningfully reflect on the ethical situations they encounter in such roles could have implications for how they think and act in future ethical situations that encounter in their careers.

A similar insight comes from Rulifson and Bielefeldt's longitudinal study of students who participated in internships [12]. They found that eight of their fifteen interviewees did *not* “express a significant difference in their understanding of socially responsible engineering” following participating in an internship. They hypothesize that this may be due to the interviews

occurring about nine months after the internships were completed and “the impact of these experiences may have faded from their memory” [12, p. 5]. Rulifson and Bielefeldt also recommend encouraging students to reflect on their internship experiences to help them notice what they learned from those experiences (again, because the students themselves may just not be very aware of their own learning).

Yet despite the known benefits of reflection, students are unlikely to engage in extended reflection on their own. Rather than leaving students to “their own devices for any insights gained” [14, p. 36], faculty can help support them by providing opportunities throughout the internship to reflect on what they have experienced and what they have learned. As Bord and Clements argue, “reflective assignments provide students an avenue to support their learning by transforming tacit knowledge into explicit, codified knowledge to be shared with others and to inform future decisions” [18, p. 290]. Eyler additionally notes that students participating in experiential learning often encounter unexpected decisions, like those experienced by the four students profiled here, and that “reflection on these conflicts or surprises is the process by which individuals develop the capacity to understand and resolve complexity” [19, p. 522]. Continuous reflection, rather than reflection at the end of or after an experience, helps prevent “students from resisting the implications of the discrepancies between their assumptions and their current frames of reference” [19, p. 527]. As recommended in previous works focused on developing global and intercultural competencies, critical incident prompts based on a describe-analyze-evaluate (DAE) framework can help stimulate and deepen student reflection on specific situations [20, 21].

Each of the students highlighted in this paper encountered varying degrees of conflict between their preconceptions of professional practice versus the actual realities of the workplace. In each situation, students had to confront those inconsistencies and decide how to think and act. By encouraging students to more deeply reflect on such situations – e.g., through assignments, logs or journals, active mentoring, workshops, etc. – universities and companies alike can promote greater ethical awareness and more robust ethical commitments among current and future professionals.

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