AC 2010-1283: IN-SITU ETHICS: THE ETHICAL SENSIBILITY THAT ENGINEERS BRING TO THEIR WORK

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In-Situ Ethics: The Ethical Sensibility That Engineers Bring To Their Daily Work

Engineering educators often acknowledge that engineering ethics should be integral to undergraduate skills curriculums. In fact, the body of work regarding teaching engineering ethics to undergraduates is substantial and programs, courses, case studies, special assignments, partnerships with industry and other venues have been forged and implemented quite successfully in undergraduate education. A quick look in the IEEE archives, for example, shows over 75 recent papers and conference panels that address teaching undergraduate engineering ethics in the past three years alone.

However, the body of work about how professional engineers are trained about ethics on the job, how they enact ethical decision making, or how/if they think about ethics in daily work environments is not nearly as rich. And while various professional codes of ethics are easily found in the engineering, business, and technical fields, part of our study's purpose was to tease out the values and ethical positioning that engineers apply moment to moment during their work. Engineering, like all professional work, reflects an intricate interplay of social forces, economic forces, legal constraints, technological demands, and organizational cultures[1.] Any discussion about ethics on the job is complex, unwieldy, and may resist even the best attempts at categorization or standardization.

As part of our mixed-method, multi-year study of practicing engineers, we collected evidence regarding how ethics were enacted, enforced, or observed on the job. We asked engineers about the importance of engineering ethics, if ethical issues were encountered on the job, and where they learned about engineering ethics. This study was unique because it allowed researchers to observe engineers on-site, recording everyday work patterns, habits, and frameworks for decision making. Our team also works with the assumptions that the practicing engineers' voices need to be heard; thus, this article contains direct quotes gleaned from our participants in order to foreground their voices, not just our summaries of their input. Our observations in this particular paper are situated within the body of research and commentary regarding professional engineering ethics decision making [1, 2, 3, 4].

Herein, we first outline the goals and methodology of our study. Next, a discussion of *ethics* and a framework for exploring that concept is outlined. Finally, we will discuss two pieces of the more poignant findings, teasing out their possible implications. Those two themes will reveal the ways in which practicing engineers struggle with both personal and professional ethical quandaries, and they are as follows:

1. *Profit vs. Perfection*. Engineers struggle when reconciling the creation of a product in a safe and thorough manner while working under budget/profit demands within an organization.

2. *Ethics Unseen*. Practicing engineers too seldom recognize that daily decision making is an ethical act. Rather, they see their ethical choices as being simply part of job-specific decision making.

The final sections will begin with a look at how engineers are trained to think about ethics, both at the undergraduate and professional levels. Our study showed that there is some criticism from practicing engineers about ethical training on the job, and we will explore how ethics training methods may be missing the mark in some cases. Last, we will pick up their ideas, discussion how we, as engineering educators, might build better undergraduate ethics training pieces.

Study Description and Methods

Discussed herein are findings extracted from a larger study, sponsored by the National Science Foundation's Engineering Education and Centers group. The three-year study entitled "Aligning Educational Experiences with Ways of Knowing Engineering" examines the alignment of engineering practice and engineering preparation to determine how well engineering students are prepared for their careers. Our eventual aim is to suggest ways that engineering educators might better design curriculum and pathways to engage, retain, and eventually produce successful engineers.

Our analysis pulls from qualitative data collected over the past two+ years of a three year study, including surveys of engineers (n=162), interviews of engineers and their managers (n=100), and six workplace case studies (with over 53 hours of observation and more than 50 interviews). As of this writing, the final stage of data collection has begun, which will launch a second quantitative survey of practicing engineers.

Survey questions and interview protocols were crafted based on competencies identified in the National Academies reports *The Engineer of 2020*[5]*, Rising Above the Gathering Storm*[6]*,* and the American Society of Civil Engineers' Body of Knowledge [7]. Informing our stance on epistemology, we turned to Hatfield and Shaffer's (year) work while developing the survey and interview questions, as one of our many goals was to identify the ways that practicing engineers created their epistemic frame.

Our research team gathered qualitative pieces via three avenues. First, an electronic survey tool (N=264) was sent to alumni of the college of engineering of a large midwestern public university. In that survey, 37 questions (both Likert and open-ended answer styles) enabled us to gather feedback on topics such as personal background, salary range, educational status, ethics, values, work tasks, work habits, and other work-related issues. Respondents who identified themselves as now working in fields other than engineering were not used for this analysis, so the research herein is based only on the responses of engineers and engineering managers (n=162). We asked respondents to rank the importance of certain skills and attributes, with 1=essential and 7=not important. Regarding ethics specifically, our survey asked how important it was to "maintaining professional ethical standards." Using the same phrasing, we then followed up with a question that asked where specific skills/attributes were developed. Respondents could choose from these options:

- On the job
- On the job-professional development

- Grad school
- Co-op or internship
- Undergrad lecture
- Undergrad project/lab
- K-12
- Other
- N/A

Later in the survey, respondents were asked to describe a notable work event that gives a good description of what it means to be an engineer. As a follow-up to their narrative answer, they were asked to identify the skills/attributes most important to that notable work event.

Second, practicing engineers were interviewed by trained student research assistants who had been prepared with human-subjects training and instructed on good interviewing techniques. Transcripts were created from recorded interviews, and some email interviews were allowed to accommodate the practicing engineers. All interviews were then coded and put into the study's database. Participating engineering professionals ranged from practicing engineers, engineering managers, to individuals with engineering backgrounds but now in different callings. In all, 91 interviews were conducted using a protocol of 15 open-ended questions that asked participants about their background, their reasons for becoming an engineer, and their career goals. Regarding ethics, specifically, interviewers prompted participants to provide narrative data using the question: "Have you ever faced any ethical issues that you care to describe?"

Third, intensive case studies were conducted within six engineering organizations. Methods of data collection included interviews and observations with practicing engineers, their managers, and other personnel, representing a wide spectrum of engineering employers. The goal was to obtain a healthy cross-section of ethnographically-oriented data within the engineering fields. To that end, we identified engineering employers from government and private industry, from small to large-multinational conglomerates in size, and across a broad range of work sectors. For more information about these six organizations in the study, see Table 1.

> **Table 1: Study Sites Overview**. *In choosing sites, we focused on getting a range of employers representative of different workplace sizes, sectors, and business factors. The names of the firms are fictional in order to protect those participating.*

Name	Size	Sector	Description
Porter & Young Technologies	Large, multinational	Technology, public	Study took place at two different campuses.
Northwestern Construction Engineering	Mid-sized national	Construction, private consulting	Study took place at one campus.
Ayer Electronics	Small, national	Technology, private consulting & manufacturing	All aspects of the company were at one site, from the CEO to manufacturing.
Engpro International	Large, multinational	Construction technology, public	Study took place at one campus.
Geminid Environmental	Mid-sized, regional	Environmental, state government enforcement	Engineers in this organization worked individually on programs or in small teams with distinct, often unconnected goals.
Rowley Tech Innovations	Small, national	Aerospace technology, public	This organization is currently attempting to broaden its scope from government contracts to consumer product work

During observational visits with these organizations, a total of 53 semi-structured interviews were conducted; as well, participants were observed during individual and group work in the organizations for over 50 hours. Observations included "shadowing" a participant during a typical task, observing at group meetings, and recording some talk-aloud tasks during which the participant described what he or she was doing as a task was completed. Both during and following observation sessions, researchers took systematic field notes to capture descriptions of observations and verbatim or paraphrased statements. Researchers included faculty members and the study's lead researcher, all trained in a range of qualitative methods. Regarding ethics, the interview protocol for participating practicing engineers included this two-part question set: "Have you ever faced any ethical issues that you would care to describe? What did you learn from this situation?"

All study data collected has been managed and coded using the coding software package, NVivo. Forty different analytic categories have been developed and analysis of data within these categories is ongoing.

The Intersections of Codes of Ethics

When we use the term *ethics,* we need to define carefully. Necessarily, we must separate three different systems (or codes) of ethics being discussed here: *personal ethics*, *professional ethics*, and *organizational ethics*. *Personal ethics* are defined, for our purposes, as moral beliefs that guide individuals about what is right and wrong, stemming from personal spirituality, organized religious practice, political beliefs, family influence, culture, and so forth.

Professional codes of ethics ground individual professions as a whole. Professional engineering societies have published codes of ethics that are meant to shape and guide the behavior of individuals that subscribe to the professional society. Within the literature of ethics, perhaps Kultgen says it best: "Codes of ethics are official expressions of normative components in the self-images of the professions, as well as the ideas to which the professional is alleged to be committed" [8] These professional codes are prescriptive and even reactive; they reflect the state of the profession. They are vague by necessity, and they avoid addressing elements may not normally fall into personal codes of ethics, such the statue in the NSPE's entreaty to not "complete, sign, or seal plans and/or specifications that are not in conformity with applicable engineering standards" [9].

Drawn more closely, *organizational codes of ethics* are the behaviors set forth by individual organizations to serve those organizations both internally and externally. Like professional codes of ethics, organizational codes of ethics are social contracts that define the values, rights, responsibilities, and norms expected by both the organization and the larger society [10, 11, 12, 13]. Organizational codes of ethics can reflect the language and intent of the professional codes with added wording that reflects the need of the specific field or company. For example, organizational codes may articulate company policy covering non-compete clauses, secret profit clauses, insider trading clauses, conflicts of interest, confidentiality, machine hygiene, on-site safety practices, and so forth. Lockheed Martin (not part of our study), for example, provides a 23-page code of ethics, translated into 17 languages beyond English, that covers human trafficking, tobacco policies, antitrust issues, political contributions, protecting company and personal information, amongst other topics [14]. These are topics of specific concern to Lockheed Martin, and these issues are not outlined in such specificity in the NSPE or similar professional codes.

Thus, an astute reader of these professional and/or organizational codes of ethics begins to discern two separate categories of professional ethical expectations being outlined: general professional ethical behaviors and standards of professional practice [15]. General professional ethical behaviors include qualities such as honesty, impartiality, fair work, integrity, quality, faithfulness as agents of knowledge, competency, and so forth [11., 15.] As well, standards of professional practice define how professionals ensure the protection of the public's health/safety/welfare, work with each other, advance the profession, maintain credibility, conform to governing statutes and regulations, ensure competence, avoid financial dilemmas, protect the environment, and handle relationships with public entities and employer alike [15, 16].

Both undergraduates and practicing engineers are expected to navigate and enact all three modes of ethics: the personal, the professional, and the organizational. Professional and organizational codes of ethics do not necessarily have grounding in the same moral systems that form personal ethics systems[5].

As well, practitioners should be aware that professional and/or organizational codes of ethics are not legally binding in and of themselves; rather, they serve guides for conduct within a specific profession and/or organization[17]. Indeed, individual infractions may be punishable by law, but the code is not part of that legal application. And while most professionals would like to believe that an employer's code of ethics would align with their set of personal ethics, we cannot assume

that such a convenience exists universally [10, 12]. Taking a look at where and how practicing engineers enact ethical decisions was a part of this study, and the results brought forth some interesting results.

Situated Ethics for Practicing Engineers

Initial analysis of survey data and coded interview pieces revealed a wide range of attitudes and recollections about engineering ethics from our practicing engineers. Initial analysis of survey data and coded interview pieces revealed a wide range of attitudes and recollections about engineering ethics from our practicing engineers. In the initial phase of the study, our survey results indicated that when asked to rate how important certain skills/attributes were, the respondents (n=162) identified "maintaining professional ethical standards" as being "essential" 52% of the time. The only other skills that ranked a higher "essential" rating were communication (61%), utilizing resources to solve problems (55%), and working as part of the team was a close follower at (52%). In the same survey, practicing engineers were then asked to write up an example of a notable work experience that exemplified good engineering practice. Immediately following that action, participants were them prompted to indicate which of the same skills/attributes were most important in that story; participants chose "maintaining professional ethical standards" only 16% of the time in this scenario. We may be able to surmise that practicing engineers view maintaining professional ethical standards as important, but incidents of applied ethics on the job are considered to be few and far between.

The study has been able to collect and code over 140 interviews with practicing engineers. Within those interviews, remarkably, only one respondent spoke about a written code of ethics, saying "A good engineer is best defined by the engineer's creed. The engineer's creed requires an individual's dedication to one's professional knowledge and skill applied to the advancement and betterment of human welfare." Other participants would mention ethics training, but mentions of a code (or creed) of ethics did not otherwise surface in our inquiries. In fact, one electrical engineer, working on his second masters degree in engineering, when asked about his adherence to the NSPE Code of Ethics, said, without sarcasm, "What's that?"

Overwhelmingly, engineers responded to queries about ethics with a denial that they had ever been part of or witnessed anything that challenged personal or organizational ethics. This reveals an interesting contradiction; a majority of the study participants interviewed indicated they did not ever see anything "ethical" (bad or good) at work. This stands in direct contrast to the initial survey's results, wherein 52% or respondents marked that "maintaining professional ethical standards" was "essential." How do we account for the difference? Clearly, whether or not they label their behavior or decision-making practice as "ethical," practicing engineers have a powerful ethical compass that steers them in their daily pursuits. Perhaps these practicing engineers frame this more as "doing the job right," or maybe it falls more into the category of "integrity on the job." Perhaps thinking about their daily decision making as ethical decision making was not a familiar practice for them. Perhaps they used other words to describe their work, such as *integrity* or *quality*. They pride themselves on trying to do the best job within constraints that compromise their own professional high standards. This reveals a strong ethical code and a clear understanding of the requirement to balance competing ethical standards. As

well, even if they don't use the terminology of ethics, they understand the place and need for what researchers and educators would call *ethics training*.

An occasional respondent would provide specific instances where an ordinary day turned into a moment of profound ethical decision making. In the example below, a story unfolds, and the engineer, as he is telling the tale, comes to realize that, indeed, ethics were at the heart of his reaction to finding misbehavior inside his organization.

> "[At] the plant we found out that some of the upper management was embezzling money. I just kind of stumbled onto it. I always had to order a lot of stuff. A lot of parts, a lot of test equipment, so I ordered like $3 million worth of test equipment. The stuff would come in and it was damaged and screwed up. Well, I got on the phone, and I couldn't send it back because no one knew where it came from. I'm a guy that's going to get down to the bottom of it one way or the other. What I found out was it was all hot stuff that they were buying and they couldn't send it back because it was hot. I had the responsibility to report that, which I did. The FBI was in there two days later. That was a real ethical issue, thinking back. I thought they were going to fire me for it, and they probably would have liked to fire me for it. But the FBI came in and put them all in jail, so I got to keep my job."

While such dramatic examples were not the norm within our data sets, of particular interest in this nugget is the (understandable) element of self-interest at the end of the story; he got to keep his job. Until asked by the interviewer, he had not perceived his action as being one influenced by ethics. There was no reflection about the higher level ethics of the situation, no perceived anger, no sense of incredulity. It is only upon "thinking back" that he begins to categorize the series of events as a "ethics issue." It is clear by his wording that he simply was doing what was right; he was maintaining the integrity of the company, despite the illegal actions of the upper management. And while a code of ethics was at play here, it's unclear if it was a personal code, a professional code, or an organizational code.

At other times, the engineers recounted situations where the quandary between different codes of ethics left them at a loss. These practitioners experienced job-specific moments where the organizational code of ethics directly interfered with a personal code of ethics. During our interviews with practicing engineers, we had several who were willing to provide specific examples. Here, we see an engineer, functioning as an on-site inspector, who describes just such a ethical predicament:

> "There are times when I'm inspecting and the contractor is not properly shoring the trench. As the construction review technician, you can only advise them to shore up their trench. You can't tell them how to do it; you can't tell them techniques of doing it 'cause then you take that liability onto yourself. There is a fine line where your personal ethical factors come into it. If the trench is falling in or is shifting on somebody, you have to tell the person in the hole to get out of the hole, but technically you shouldn't say anything. So there is always that time where there are compromises, where you have to make a moral decision whether or not you professionally want to not say anything, but morally and personally you want to say something."

Quite literally in the trenches, this engineer describes the pull between personal ethics (tell the worker to get out of the hole) and organizational/professional ethics (avoid liability). An engineer in this situation does not have the luxury of an internal philosophical debate; a life may depend on his split-second decision. His ability to consciously decide whether or not to put out a helping hand to a worker in a trench relies on a keen awareness of where and when personal ethics trump organizational ethics.

Engineering Work and Ethical Conflicts

Described below are two explorations of the most commonly narrated places that engineers expressed or enacted a conflict of ethics. The first is a often-voiced concern of the engineers of working with constraints (most often budget vs. time/perfect product). The second exploration is gleaned from the observations of the researchers, and it demonstrates that ethical decision making happens constantly during an engineer's work, even when engineers do not recognize or categorize it as such.

The Constraints of Profit, Time, and Perfection

Engineers articulated repeatedly the constant pull between creating the best solution for a problem and the constraints of profit and time. Conceptualizing, designing, realizing, testing, and producing a product to specifications is a point of pride for most engineers; having that product or solution be safe was also an oft-stated goal. However, the demands placed on engineers to get the product out the door in a timely and cost-efficient manner can compromise these high standards. As an example, an engineering consultant with Geminid noted "In my dark hours of consulting, my phrase was 'there's never enough time to do what is right, but there's always enough time to do it over when it's not what your client wants.'" She added, "That's just pure factors of budget and profit."

Respondents from firms large and small, private and public, repeatedly shared their discomfort with pressures put upon them to ship out a product before it was ready or before it was tested properly. One reflected, "…it kinda comes down to the internal politics of the company…there are always some people out there that would be okay with cutting corners, but if you are able to get an ally or someone to agree with you, you can argue to do it the right way rather than just getting it done." Other times, the issue can be larger, with perhaps weightier consequences. "Management was incentivized to ship more product," one participant recalled. "There was a questionable test. Rather than pull the product, they rationalized why the tests were okay, especially the one in question, but did not file the FDA paperwork to raise the problem to authorities." The laudable element here is the desire from so many of our participants to have pride in product. The ever-present pressures of time and money, however, made them feel as if they had no choice but to release sub-standard or incomplete work.

Occasionally, a sense of ethics was intertwined with the obligation to produce profit directly. One of our respondents, when asked to describe what it means to be an engineer, noted that "On a day to day basis, engineering involves many problem solving skills and communication skills used over and over in an iterative fashion *to ethically make a profit for my employer*" (emphasis added). A particularly thoughtful participant said "Engineering is a service; you provide a

service to society to help people get certain things done. You protect the public safety...it's the responsibility of every member of society. What I do as an engineer is help people make their dreams come true. Most people's dreams are to make a little money; to have a nice place to take their kids to school or to get a new car. What we do is help them find the process in the system that is going to help make that product and make a little profit contributing to the economy. It's really a human effort." Engineers are systems thinkers, and in our work, as we can see from these examples, those engineers acknowledged that making a profit for the employer was part of the larger systems thinking. The engineering had become more than problem solving of technical issues; it had also become an ethical imperative to make money for the employer or client.

In each of these cases, participants express some sort of conflict between the company's expectations of behavior or output and personal expectations of themselves or sense of quality. It is not just a case of profit versus perfection, but a more subtle balance of competing factors that frequently left participants feeling less than proud of their work product.

The Unseen, Unarticulated Ethics

Recall our survey's results discussed earlier: respondents (n=162) identified "maintaining professional ethical standards" as being "essential" 52% of the time. In contrast, when practicing engineers were observed and/or interviewed on site, it was rare that activities that clearly fell into the realm of protecting the "health, safety, and welfare of the public" were categorized as ethical activities by the engineers themselves. Rather, work activities that were clearly under the umbrella of "ethical decision making" were regarded as simply regular decision-making tasks by the practicing engineers. Engineers clearly identified that moment-to-moment decisions had to be made every day; it was simply part of the job. The frameworks by which they made these decisions were varied, but professional integrity was at the core of their work. It could be debated whether that is an function of practicality, a sense of personal or moral obligation (I/we must do this correctly), fear of litigation or reprimand, or professionalism. In many instances, the activity could fall into all of those categories at the same time. However, when asked about decision-making, *ethics* or the *code of ethics* rarely surfaced.

The two examples below show specific observed moments of such ambiguity and complexity. At a large product review meeting at EngPro (see Table 1), the discussion came to the metal housing of the product's components. Since there was a chance of electrical shock if the housing was removed, it was part of this team's job to determine the best way to alert users of the hazard. This 20+ team debated the merits of various sticker warning placements for over 20 minutes inside a two-hour meeting. Would the sticker be seen? Would it be seen in time? Should there also be a warning in the documentation that was shipped with product? What color should the sticker be? None of these factors were framed as being the "right" answer, only the best one. Repeatedly, various engineers, from the metal worker to the project manager, echoed the sentiment of "We don't want anyone to get hurt." Afterwards, when the observer asked why so much time was spent on the sticker, the managing engineer said, "It's important. We don't want to get sued." In this situation, different motivations were at work: do the right thing, keep people safe, avoid litigation. It is in these moments when we can see how a personal ethical system (do the right thing, keep people safe) can work handily with organizational ethics (do the right thing, avoid litigation).

The second example was observed during a testing session for a supposed failed part at Ayer Electronics (see Table 1). This company was responsible for a sub-assembly only; the larger assembly was not working, and the client wanted an explanation and reimbursement for perceived faulty work. It was soon determined by the engineer that another piece of the assembly was shorting out; it was this third party piece that was faulty, not the Ayer product. While the determination of error was made quickly, the engineer continued to test and find the range of error, figuring out the exact problem in the third party's piece. He emailed an extensive memo to both the client and the third party. When asked why he went to such lengths, he simply said, "It's what we do. We have to make the whole industry stronger." Certainly, this engineer personally adhered to a set of professional guidelines that carried a greater obligation than most.

The interpretations of the survey results versus what we heard on-site could be explained in a myriad of ways. However, perhaps what is most compelling is that we witnessed engineering ethics, engineering integrity, and laudable engineering decision making. We found out that, while engineers may not often frame their activities by codes of ethics, articulations of their decision-making revealed otherwise. Our observations recorded that they acted ethically, but they did not drop those activities into an "ethics" bucket. For these practitioners, ethics have been completely subsumed by the idea that "this is what we do."

Ethics Training Mismatch

Further analysis of incoming data will enable us to develop a more robust understanding of these issues. Even at these early stages of analysis, however, we find compelling evidence to suggest that engineers frame their practice of decision-making in ethically sensible ways but do not connect their behaviors or attitudes with any formalized ethics training or codes. This holds several interesting implications for engineering educators. The question that drove our study asks: How can engineering educators, both undergraduate, graduate, and professional, better design curriculum and pathways to align engineering preparation with engineering practice?

Specific instances gathered in our interviews allow us to theorize a bit as to why our pool of engineers did not often identify ethics in specific moments of decision making. Of the six sites that were observed by our researchers, three of them had participants that openly criticized the ethics training provided by employers. Two of the larger participating interview/observation sites, EngPro and Porter and Young Technologies, provided the required yearly ethics training to their employees, thus complying with the Sarbanes-Oxley Act of 2002, wherein all publicly traded companies have to provide ethics training to employees. Amendments to the Federal Sentencing Guidelines require all organizations to periodically provide compliance and ethics training to all employees. The simple act of distributing an organization's code of ethics or code of conduct is no longer sufficient in the United States. Effective training is required, and proof of compliance and deployment of in-house ethics programs must be communicated to and used by employees. Both EngPro and Porter/Young required that all employees get yearly certification in their ethics training.

Several interviewees expressed, however, that these ethics training sessions were missing the mark. These engineers do not work with international laws, client contracts, contractors, stockholders, or in any circumstance that could be seen as an arena for possible corruption. One

noted, "[We] go through these trainings and they give you these little scenarios…what would you do in this case? No matter what you pick, there is usually a better answer. The way they word the questions is goofy. We always joke about it because it is kinda funny…". Certainly, this is not the result that Porter and Young was looking for in its ethics training efforts.

Likewise, at EngPro, a similar sentiment came across. "They have us do a lot of ethics things that don't deal with stuff we do," commented a design engineer. "It doesn't have anything to do with what we are actually doing. If you were high up in sales, maybe you could easily be in those situations in dealing with other countries and government and stuff. I guess they want you to know it trickles down all the way but the examples they give don't really mean too much to me personally, anyway." When asked further about the anti-trust training he had recently had, he said, "We had to read the thing and they gave you a quiz at the end. It does not really apply to engineers." This evaluation of the ethics training sessions was repeated, later in the day, with another engineer from another department.

Both informants clearly understand and appreciate the need for ethics training and certification. These engineers, however, clearly communicated that they wanted a targeted ethics curriculum that would address the kinds of issues that they face as engineers who work in-house with rare contact with clients, sales, international trust issues, and so forth.

After this initial analysis, we found it useful to pursue this question more specifically: How can ethics curriculum be designed such that engineering professionals transfer the concepts and skills of dealing with ethical conundrums from the isolated safety of the classroom to the complexity of the workplace?

A Potential Reconfiguration of Ethics Training and Pedagogy

Based on this qualitative analysis of practicing engineers, we draw the following conclusions about how ethics teaching can be enhanced in the undergraduate engineering curriculum to facilitate a higher degree of transferability. First, giving students the tools to pull apart any professional code of ethics and examine it for "ethical guidelines" (those elements that are fundamental such as honesty, integrity, fairness) versus the "organizational guidelines" (elements that parse conduct within a specific profession and/or organization) could be key to helping students develop a lifelong ethical code that could travel with them, no matter the career path they choose. A concerted and systemic approach to ethics would enhance the engineering professional's ability to understand and critically analyze the similarities and dissimilarities, contradictions, and points of connection between his/her own personal code of ethics and those that guide the profession or organization. Having the ability to pull apart morality from professional practice within a certain field, as asserted in its code of ethics, would be a valuable skill for any professional.

Another teaching technique to re-examine is the current trend to use isolated or uncommon case studies as a primary means of exemplifying ethical conundrums. Although large disasters or thrilling examples such as the embezzlement reported by a study participant provide multiple avenues for discussing practice and ethics, they provide examples that are too uncommon to give students information they can use in everyday practice.

If, as instructors for engineers we engage in open-ended, authentic discussion about what ethics *means* in a specific job setting, we gain the opportunity for reflection. As well, the issue of ethics becomes less about knowing what the Professor wants to hear and more about making difficult decisions in complicated situations—situations in which more than one code of ethics is operating and more than one answer is possible, depending on innumerable factors, not just one's own personal ethical perspective on what's right or wrong. Ethics are enacted in the smallest of moments, continually, all day long. The chance for students to see that engineering work is rife with ethical, moment-to-moment choices is a rich lesson indeed. It is the small daily ethical choices that an engineer makes that could determine profit, credibility, safety, reliability, and professional integrity. The moments where an engineer has to allow personal ethics (get him out of the hole) to trump organizational ethics (avoid liability) is the moment we want to explore in ethics training.

We learned from the engineers at EngPro and Porter/Young that ethics training needs to be scaled to the worker; the same advice can be taken for undergraduate education. What will they need to understand about engineering, codes of ethics, and personal decision making on their co-ops or internships? How will they handle non-disclosure agreements? What if they witness unethical behavior of a supervisor? We must impart the notion to the young professionals that the one thing that every engineer has to sell is credibility and integrity[18, 19]. An emphasis by instructors in this area, along with the core ethical guidelines, may result in more transferable ethical stances by students in their future career trajectories.

The explosion of ethics courses and pedagogies in engineering programs in the last 15 years is a positive step. Now, we need to align the realities of the engineering profession with the content we provide to our undergraduates. As well, professional life-long learning and training needs to be responsive to the working realities of engineers in the midst of their careers. Qualitative studies such as this one provide rich narrative data to help illuminate the complicated ways in which engineers perceive and apply codes of ethics in their daily work. Continued study of this area will help build our understanding of how our ethics education translates to everyday decision making in the professional workplace. This study has only begun to explore these topics. As educational practitioners, our own life-long learning is the ability to continually adjust our approaches to better prepare the undergraduate and to continually reinforce the abilities of the engineering practitioner.

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Bibliography

1. Moriarity, G. (Fall 2001). Three Kinds of Ethics for Three Kinds of Engineering. *IEEE Technology and Society Magazine*, vol 20, no 3.

2. Davis, M. (1991). Thinking Like an Engineer: The Place of a Code of Ethics in the Practice of the Profession. *Philosophy and Public Affairs*, vol 20.

3. Payne, D. (2003). Engineering Ethics and Business Ethics: Commonalities for a Comprehensive Code of Ethics. *IEEE Region 5, 2003 Annual Technical Conference*.

4. Rutland, P.J. (2002). Ethical Codes and Personal Values. *Cost Engineering*, vol 44, no. 12.

5. National Academy of Engineering (NAE). (2004) *The Engineer of 2020: Adapting Engineering Education to the New Century*. Washington, D.C.

6. National Academy of Sciences. (2006) *Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. National Academies Press, Washington, DC.

7. American Society of Civil Engineers. (2008). Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future (No: 978-0-7844-0965-7). Reston, Virginia, USA: ASCE Committee on Academic Prerequisites for Professional Practice.

8. Kultgen, J. (1982, Spring). The Ideological Use of Professional Codes. *Business and Professional Ethics Journal*, vol 1, no. 3.

9. National Society of Professional Engineers (NSPE). (2007). NSPE Code of Ethics for Engineers. Retrieved from http://www.nspe.org/Ethics/CodeofEthics/index.html .

10. Porter, J. C. (1993 January). Ethics in Practice. *Journal of Professional Issues in Engineering Education and Practice*, vol 199, no. 1.

11. Buccholz, W.J. (June 1989). Deciphering Professional Codes of Ethics. *IEEE Transactions on Professional Communication*, vol 32, no. 2.

12. Owen, E.L. (2009). A Personal View of Engineering Ethics. *Proceedings of the IEEE Conference on the History of Technical Societies*. Philadelphia, PA.

13. Fan, L.C.N and Fox, P.W. (April 2009). Exploring Factors for Ethical Decision Making: Views from Construction Professionals. *Journal of Professional Issues in Engineering Education and Practice*, vol 135, no. 2.

14. Lockheed Martin. (2008). Setting the Standard: Code of Ethics and Business Conduct. Bethesda, MD. Office of Ethics and Business Conduct, Lockheed Martin. Retrieved from http://www.lockheedmartin.com/data/assets/corporate/documents/ethics/setting-the-standard.pdf

15. Griggs, F. E. (Jan 2009). New Look at the Code of Ethics. *Journal of Professional Issues in Engineering Education and Practice*, vol 135, no. 1.

16. Iffland, J. (Jan 1994). Ethics and Quality in the constructed Project. *Journal of Professional Issues in Engineering Education and Practice*, vol 120, no. 1.

17. Schaub, J. H. and Pavlovik, K. (1983). *Engineering Professionalism and Ethics*. Wiley, New York. (page 420).

18. Poirot, J. W. (1992). Meeting Professional Development Needs in Large Consulting Firms. *Journal of Professional Issues in Engineering Education and Practice*, vol 119, no. 4.

19. Anderson, J. V. (1994 Oct). Is it Necessary to Compromise Engineering Ethics to Remain Competitive? *Journal of Professional Issues in Engineering Education and Practice*, vol 120, no. 4.