

Ethics in Engineering or Engineering in Ethics?

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Abstract

This paper explores how the relationship between ethics and engineering has been and could be framed. Specifically, two distinct framings will be conceptualized and explored: ethics in engineering and engineering in ethics. As with other disciplines, engineering typically subsumes ethics, appropriating it as its own unique subfield. As a framing, ethics in engineering produces specialized standards, codes, values, perspectives, and problems distinct to engineering thought and practice. These form an engineering education discourse with which engineers engage. It is epistemological in its focus, meaning that this framing constructs knowledge of proper disciplinary conduct. On the other hand, engineering in ethics as a framing device insists that engineering become a specialized articulation of ethical thought and action. Here, “engineer” and “engineering” are not nouns but verbs, referring to particular processes and technologies for transformation. One is not an “engineer;” rather, one “engineers.” One is first an ethical subject – an historical aggregate of continuous experiences/becomings – concerned with the pursuit of “the good” in the present; then, when contextually relevant, such a subject’s engineering knowledge and skills may be employed as powerful means for the becoming-good of shared worlds.

In this paper, engineering in ethics is further conceptualized through a playful intermingling of an ethic of care, via the scholarship of Joan Tronto, and a Deweyian approach to ethical inquiry. Tronto’s four elements of care – attentiveness, responsibility, competence, and responsiveness – are joined with what are arguably four key components of Dewey’s process of ethical inquiry: awareness, judgment, experimentation, and iteration. This paper argues that 1) being attentive is required to achieve awareness of a given need or problem, 2) taking responsibility is a necessary practice for making and acting on one’s judgements related to the need at hand, 3) competence in a relevant skill is needed to experiment with one’s judgements, and 4) careful consideration of how others respond to how one has addressed a need is essential for the purposes of iteration. While all four contribute to the notion of engineering in ethics, the relationship between competence and experimentation is where engineering is most evidently seized as an ethical expression. How one competently wields engineering knowledge and skillfully performs disciplinary techniques is, here, foremost about actively inquiring into how to provide care for a specific need and, in doing so, creating a world aligned with one’s vision of “the good.” This paper will close with a brief consideration of the educational implications of engineering in ethics.

Introduction

In October 2019, the authors of this paper began having conversations about the past, present, and future of engineering ethics and engineering ethics education. These conversations were

focused on exploring two concepts -- *ethics in engineering* and *engineering in ethics*-- both of which were synthesized from recent works in engineering ethics [1, 2]. Inspired by Thompson, Joslyn, and Chua's [3] work, here we aim to share the flow of these conversations through a dialogue, wherein the authors take turns posing and responding to questions. The structure of the manuscript is as follows: (1) operationalizing *ethics in engineering* and *engineering in ethics*, (2) considering how *the good* in engineering has been historically defined, and (3) moving to considerations for engineering ethics education. Throughout the dialogue, GF will be utilized to refer to the first author, JH to the second, and AK to the third.

Section 1. Ethics in Engineering versus Engineering in Ethics

GF: Ethics in engineering is intended to represent the current status quo of engineering ethics. Under this concept, **ethics flows from and in response to the exigencies of engineering theory and practice**. Engineering is a discipline and, as such, a legitimate and legitimating ethics – particularly one that is tailored to engineering – is needed. Alternatively, **engineering in ethics sees ethical life as primary and engineering as a response to the needs of a present, ethical situation**. In this case, engineers are entangled in an ongoing social enterprise to which their disciplinary knowledge and skills may or may not be relevant to the matter at hand. Each of these framings rely on different ethical perspectives, rationales, and conceptualizations of “the Good.”

JH: Following a few conversations with you two, I began reading a few books; the first, recommended by Andrew, was the “Revolt of the Engineers” [4] by Edwin Layton, Jr. This work outlines the early development of engineering as a profession in the US, largely with a focus on the role of professional engineering organizations such as the American Society of Civil Engineers (ASCE) and the American Society of Mechanical Engineers (ASME). Ethics was not a primary focus of Layton's work, and this is likely because ethical considerations were largely *a posteriori* rather than *a priori* in the historical unfolding of engineering as a profession. In other words, concerns pertaining to engineering ethics seemed to emerge alongside the evolution of engineering as a profession, rather than being laid down and agreed upon beforehand. The most vivid illustration of this was the rather slow emergence of ethical codes: while the American Institute of Electrical Engineers (AIEE) was founded in 1884, it was not until 1912 that they pioneered the first code of ethics for any engineering society. In contrast, while ASCE was founded in 1852, the organization's first code of ethics was adopted in 1914. I feel like the *a posteriori* and *a priori* conventions map closely to the *ethics in engineering* and *engineering in ethics* concepts, but would be interested in hearing your thoughts and perspectives.

GF: I appreciate your mapping of *a posteriori* and *a priori* to *ethics in engineering* and *engineering in ethics*, respectively. I do not think that *engineering in ethics* is necessarily fixated on or dependent on the kind of *a priori* knowledge present in Kant's categorical imperatives. I agree, however, that within the *engineering in ethics* framing, ethics comes first and engineering

second; in other words, the experience of relationality and ethical concern are ontologically prior to defining engineering's role in a given moment. Returning to one of our recent publications [1], I would argue that we first feel and experience what is going on before we can reflectively think about such experience. We feel and experience relationships with all that we encounter in a given event, and we are affected by those encounters. Responsibilities, obligations, and valuations arise therefrom. In being affected by the multiplicity within an encounter, there is significant potential for conflict and difficulties associated with assigning/identifying value(s). Once the experience occurs, we objectify it, mine it for information, and seek to address it according to the values (possibly *a priori*) we hold to be true within our own experience. We fashion a response and, in fashioning a response, we fashion ourselves, others, and the world. We first have moral/ethical situations or problems; we then address those problems (if appropriate and, if appropriate, not exclusively) with engineering knowledge and techniques. Of course, out of such practice professional codes of ethics are born *a posteriori* and then should be utilized as tools when relevant to a moral/ethical situation. Hence, as codes of ethics are derived from practice, codes of ethics are of great importance, but they are neither the beginning nor the end of ethics.

AK: Before going further, I think we need to elaborate a little more here on the significance of being a profession in terms of prestige and independence from reliance upon corporate decision-making. For example, Layton [5] describes the political struggles within the ranks of engineers to establish themselves as a profession. That distinction would theoretically earn them independence from reliance upon their employers. It could also earn them social prestige. However, in order to obtain that professional status bestowed upon other vocations (e.g., clergy, law, medicine), there were several conditions that needed to be met. Among those conditions was the adoption of a code of ethics to guide behavior of the professions' members. Consequently, one might argue that the adoption of codes of ethics emanated from a more instrumental motivation than anything else. Of course, the intervening 100 years have helped shape the importance and newer meanings of codes of ethics, but it is nevertheless important to remember some of the more material and less idealistic factors contributing to those original codes. On the other hand, to complicate matters, there clearly were more altruistic, service-oriented, and humanistic intentions expressed by some of the original champions of codes of ethics in engineering [6, 7]. Regardless, the entire conversation does raise (or possibly beg) the question of what work do codes of ethics actually do? Are they *a posteriori* generalized suggestions for proper conduct, aspirational notes toward which the profession's members can aspire, or are they something other than what Grant suggests?

JH: Andrew, I think you are suggesting that, on one hand, codes of ethics manifest post-hoc. We rationalize and codify those decisions and, ta-da! We feel ethically vindicated. These sentiments feel eerily similar to the moral foundations theory work of Jonathan Haidt, which I'm happy to expand on, but I think I might prefer to tackle a functional question that you each touch on: "What do codes of ethics do?" Michael Davis [8] argued that one of the important aspects of

codes is that they can allow one to reason with the weight of the profession behind them. Moreover, I postulate that there may be a direct correlation between the desire of engineers for an objective truth and the perception that codes provide just that. I base this postulation on my observations of resistance by faculty to counter-normative and subjective ways of teaching ethics [9].

However, as we know, there exist many codes, and codes of ethics may require change from time to time. But as I write this, I realize that we should likely partition between professional codes of ethics and organizational or industrial codes of ethics. As I think about the latter, for many engineers in a separate study [10], company codes were influential and provided comfortability with ethical decision-making processes, particularly for more junior practitioners. Yet, rarely did engineers in this study talk about *professional* codes beyond the organization. One notable exception was the influence of studying for or reflecting on the professional engineering exam, but many engineers do not seek professional status. I think it would be an interesting empirical study to explore engineers' perceptions of or application of ethical codes in practice, and potential variation based on factors such as professional status.

GA: I have a separate thought on Andrew's second question. He makes a great point that the drive for professional legitimacy and independence provided much of the rationale pushing the development of a code of ethics. I think it could be possible that codes of ethics could be both fashioned due to the profession's need for such codes and through a reflective process in which the empirical experiences of engineering reveal sets of generalizable rules that can be and are iterated upon. I think that the legitimating force of a professional code and that such a code or codes be comprised of objective rules born from technical experience fulfills a desire of engineers to have the weight of the profession behind them.

Section 2: Engineering and The Good

GF: But here, I think we should transition to a second set of questions that I hoped this work would cover. First, how can we understand the history of engineering ethics and its impact on contemporary practice through the framing of *ethics in engineering*? Second, how has "the Good" been defined in engineering?

AK: I'm happy to speak to some of this but I doubt I would be able to give it justice. There's a non-trivial amount of grandiose language that abounds in national reports about the role of engineers in societal advancement [11, 12] but it is unclear how well that percolates down to the education level. I also have a question and a comment for this one: Good defined by whom? I'm not entirely convinced there is a singular agreed upon conception of "The Good," or at least I'd have a hard time substantiating any claims about widely held beliefs on this.

GF: These are good points. I agree that conceptions of "the Good" are plural regardless of which framing we are considering. When I wrote about "the Good" here, I was thinking back to when, in earlier conversations, we discussed "the Good" being statically defined in terms of the market or competition. This seems to me to be a "Good" very much based in utility, which I think is a great deal different from the idea of ethical inquiry found in Dewey [13] and the idea of care from Tronto [14]. Also, if "the Good" is defined in terms of the market and competition, is "the good" then in danger of being technocratically constructed?

AK: This makes sense. In general, I still wonder if we think it would be better to be making the case for what the community should be doing or if it would be better for us to make the case of what actually is happening in contemporary engineering practice (or what has historically happened). I think we might have some issues with identifying data sources for the descriptive case, but either version seems like it would be useful and interesting.

GF: I wonder if we could do both...but do both cautiously and rather preliminarily. I find it important (though I could be swayed away from this) to determine whether the status quo is associated with ethics in engineering and, if so, how this does or does not impact conceptualizations of "the Good". Ultimately, I think that the crux of this paper is concerned with a normative argument and how a normative shift may spark educational considerations. I just think that before we propose a normative shift to engineering in ethics, we need to at least preliminarily establish whether *ethics in engineering* currently "rules the roost" or, in other words, whether there is actually something to shift from/to. Do you think that we can fairly suggest that *ethics in engineering* is the status quo with the data sources?

JH: I think these are gargantuan questions that this short piece can touch on but (obviously) not resolve. In my perspective, we are offering a different stance that involves a shift in normative thinking of engineering ethics. But we need a little more context to describe what that *norm* tends to be. I think a brief return to Layton [4] can be helpful here, as well as how that connects with contemporary codes, as well as how that connects with two more prominent moral theories utilized in engineering education (i.e., deontology and utilitarianism).

Layton documented myriad incongruities across engineering societies amidst their emergence and, often, within engineering societies. His work points out one important factor for us to consider in this work: historically, engineers have not agreed on foundational concerns or definitions of engineering. Hence, engineers do not have some form of constitution or bible that they can refer to provide any universal answers. To me, one of the best ways to consider current "norms," as well as the propensity towards *engineering in ethics* or *ethics in engineering*, would be to review how codes of ethics have evolved over time.

As one noteworthy example, ASCE recently added a Canon 8, “Treat All Persons Fairly.” Subpart C of Canon 8 focuses on diversity: “Engineers shall consider the diversity of the community, and shall endeavor in good faith to include diverse perspectives, in the planning and performance of their professional services.” This is one of the only explicit connections between diversity and ethics within an engineering organization, and it arose about 100 years after the original ASCE code of ethics. It presents a telling normative shift in how at least one engineering organization is thinking about ethics, but even ASCE is just one professional body among many. It will be interesting to see whether other engineering bodies follow suit.

But I also wonder to what extent norms are guided, knowingly or unknowingly, by aspects identified in broader moral theories. For example, Sandel [15] presents myriad stances on the notion of justice. One aspect which I found enlightening was discussions around “The Good” in Kantian and Rawlsian frameworks. Sandel’s point was that for Kant, followed by Rawls, ethical theories that emphasize maximizing goodness (i.e., utilitarianism, which we might argue abounds among engineering) are missing the point. Ethics is primary and the good is secondary; hence, in the Categorical Imperative, individual “good” flows naturally from the imperative rather than vice versa. With that said, I think the Categorical Imperative is presumed to be inherently good and universal. Any descriptions of maximizing “goodness” (i.e., via utilitarianism) are relative to individuals, their social contexts, and their prior experiences and hence, insufficient (or even irrelevant) to *ethics*. As Sandel writes:

For Kant and Rawls, the right is prior to the good. The principles of justice that define our duties and rights should be neutral with respect to competing conceptions of the good life. To arrive at the moral law, Kant argues, we must abstract from our contingent interests and ends. To deliberate about justice, Rawls maintains, we should set aside our particular aims, attachments, and conceptions of the good. That’s the point of thinking about justice behind a veil of ignorance.

AK: I've never been able to wholly understand this argument. To wit, regarding the veil of ignorance (or for Kant's categorical imperative), how does one identify what is "right"? Within a profession it seems plausible to have a quasi-democratic element to it wherein whatever the group determines to be right is considered right, but in general I think I struggle understanding how other definitions of “right” avoid question begging. Any thoughts to help clear up my confusion?

GF: I think Justin would be much better at answering these questions, but I'll give it a shot. I feel like the "right" is something that is achieved through pure reason; a proposition becomes right (i.e., universal) when it cannot be contradicted. Following the justice example, it seems like "one must act with justice toward humanity" is a categorical imperative. Personally, I am less interested in whether "justice" is a universal moral law than when, having accepted "justice" as

one of his/her moral truths, a person strives to shape themselves in the image of justice toward the addressing of present needs and problems. I personally don't understand why it matters if it is universally true. As the saying goes, the proof (the truth) is in the pudding. I suppose I share a lot of your confusion and remain skeptical.

JH: I do not claim to be a Kantian expert here, but my understanding is that our capacity for reason goes hand-in-hand with the imperative, or obligation, or duty we have to act in certain ways. Ethical or “right” actions are those which we might universalize, and those which respect others as autonomous beings. For Kant, considerations of the good are beside the point. For one, “goodness” considerations are so interwoven with the cultural context in which we are embedded, our life histories, and other myriad factors that universalizing a decision is impossible. Second, considerations of pleasure or happiness tend to vary from person to person. Think, for example, if we had a society full of sociopaths with a few empaths. The greatest happiness might be induced by rather morbid activities.

The murderer at the door is one traditional case utilized to show the alleged fallibility of Kant’s logic. According to Kant, lying is always wrong, so if a murderer at the door asks, “Is your roommate home? I would like to murder them,” it would seem that it is one’s duty to say, “Why yes, she is down the hall in the first room on the left.” However, I also feel a little troubled by the overall emphasis on respecting others’ autonomy, as it remains unclear to me what obligations we might have to the environment or earth, not to mention that it doesn’t feel right to treat sociopaths aspiring to murder my roommate the same way as any other individual.

While this elaboration on Kant might seem like a diversion from our initial goals, I wonder if this framework seems intuitively appealing to engineers who aspire for an objective morality. In other words, what many engineers seem to desire is some “objective goodness,” defined in terms of duty, such as that aligned with Kantian considerations. Given the purportedly “objective” nature of engineering, goodness that cannot be pinned down in such a way as Kant does is discomfiting. So, Grant, when you write that definitions of “the Good” are multiple, I’m not sure whether engineers, or Kant for that matter, would disagree. I just think that many may be dissatisfied for thinking about ethics in those terms.

AK: Are we sure that the desire for an “objective goodness” is specific to engineering rather than a manifestation of a more fundamental human yearning that engineers express in light of the fact that they are humans? I know this is an appeal to human nature, an inherently dubious task, but I'm struggling with the notion that this might be specific to engineers, which almost seems to be implied. Maybe it's pedantic, but I frequently struggle with disentangling the claims about engineers that seem to assume a uniqueness from other groups in contrast with those claims about engineers that are merely reflections of a broader human tendency, insofar as such a generalization is valid.

JH: I am not sure. Faith is one thing. Faith in objectivity yet another. Here I think we might distinguish between positivism, post-positivism, and various interpretive paradigms. I see this over and over again in our interviews with folks in the study mentioned earlier [10]. Engineers prize objectivity and many choose not to recognize the subjective nature of many aspects of ethical engineering practice. Of course, there are exceptions, and more comprehensive ways of experiencing ethical engineering practice is partially defined by an increased understanding of the sociotechnical complexity of engineering practice.

AK: That makes sense, but I still wonder how much of that just reflects views that the average person outside of engineering might also hold or whether there are pieces to this that are specific to engineering. In the example you gave, do you think there is something unique to the people in that industry or are they just exhibiting tendencies that plenty of other people in completely different industries and professions also exhibit?

JH: Thank you for this question, as it is worth emphasizing the study context and thus, the limitations. We conducted a phenomenography focused on a specific phenomenon (ethical engineering practice) in a specific context (the health products industry). While many participants refer to experiences outside of this industry, any inferences to other contexts would largely be conjecture. Nonetheless, I suspect the prizing of objectivity (or what Burge [16] calls “empirical objectivity”) is not unique to this one engineering context nor engineering as a profession, but rather is a Western ideal that we have inherited from many previous generations dating back to Aristotle.

GF: The way I am thinking about *engineering in ethics* – and ethics in general – is distinct from the establishment of universal moral law(s) and the pursuit of a predetermined end, such as maximal goodness (i.e., pleasure). It is perhaps more closely aligned with a practice-oriented virtue ethics, though I hesitate to reduce it to that. I can sympathize with the sense of dissatisfaction that one may associate with an ethical approach that may not be fixated on identifying and operating within a fundamental “objective goodness” or a universal moral law. Michel Foucault and John Dewey may provide a pathway through this dilemma. Thinking with and through Foucault [17], ethics is about the governing of self and others or, in other words, the fashioning of oneself and others. We use our capacity for reflective thought to shape ourselves as ethical subjects by objectifying our past thoughts and practices, critiquing them, and iterating upon them while conscious of how we desire to live and what we desire to become. As we relate to others within any given encounter, we must fashion responses to all that affect us. It is here that I think Dewey has a lot to contribute. Following Dewey’s [13] formulation of ethical inquiry, we must exceptionally draw on “moral excellencies” or virtues 1) to build awareness of the variables impacting the ethical situation, 2) to make judgements regarding what “the Good” is in the situation and what should be done, 3) to experiment with one’s informed

judgement(s), and 4) to iterate on one's judgement(s) if one's experiment fails. This is a distinct form of ethical life, in which the self, the other, and the whole are fashioned via a kind of virtuous pragmatism. I suppose this is how I understand *engineering in ethics*: engineering comprises a set of knowledge and skills that can be used in pursuit of the very human enterprise of fashioning a shared world, in which must dwell many players and at least as many problems.

To be clear, I do not think that such an approach necessarily denies a place for categorical imperatives or for the relevance of duty and obligation (at least as a commitment to “moral excellencies” or virtues); rather, ethical inquiry's focus on a lived, experiential ethics operates at a different scale than reasoning toward universal moral laws. Andrew, if I were to reframe one of the questions that opened this section on “the Good,” then you might feel better positioned to respond. “What are some of the popular ways that “the Good” is or has been defined in engineering? Where do these “Goods” come from?”

AK: Under some views, “the good” might be considered that which protects the health, safety, and welfare of the public. This is etched into many engineering codes of ethics. Under other views, this might be outsourced to market considerations and that which is good is that which is profitable. Obviously, this is problematic - market failures being the simplest, but certainly not, only cases for where this simplistic view fails. In general, I'm dubious about the extent to which there are meaningful definitions of “the good” in engineering beyond the general language about advancing civilization and protecting the public. These dictates themselves still smuggle in certain assumptions about which public counts and the scope of those societal advancements - i.e., advancements at what expense?

GF: Thanks for proposing a few ways that “the good” has been popularly conceived in engineering. I think that the process of ethical inquiry challenges our reliance on established ends or goods that pre-exist any experience of an ethical situation. Like with Kant and Rawls, moral excellencies exist prior to the pursuit of the good; however, Dewey – and I am in agreement here – is more interested in how these moral excellencies are enacted than in how reason may reveal their universality. I just do not have much confidence that such generalized conceptions of the good are sufficient for the particularistic problems identified and responded to through the engineering design process. I feel like many engineers would agree with such a statement, and if in fact they do, I think this necessitates a move away from universals, objective truths, and predetermined ends to better address the relativistic nature of many engineering problems. However, I cannot say that this means that a general “good” such as “protecting the public” is unimportant; rather, such a principle seems, to me, to be better thought of as a moral excellency or a “direction of change” [13] to grow toward than an objective state capable of being completely actualized. It is something to strive for; it is a tool with which one inquires. I wonder if seeing “goods” as tools is helpful, because sometimes tools just do not work as we hoped and swapping out tools may be necessary.

To sum up this Deweyian approach, every ethical situation has its own contextually specific end or good, which must be thoughtfully and virtuously discovered and addressed. Moral excellencies or “directions of change” will, of course, be utilized by the ethical inquirer. I think such an approach matches up nicely with the engineering design process, as does the very similar approach found in an ethic of care [1, 2]. I find that Tronto’s [14] four elements of care (*italicized* in the following sentence) actually add ethical obligations that enrich the process of ethical inquiry. When combining the two paradigms, awareness becomes a matter of *attentiveness*, judgement becomes an act of taking *responsibility*, experimentation becomes an act that must be completed *competently*, and iteration becomes an act of *responsiveness* to how one’s enacted judgement affected the care recipient. If one were to take this formulation seriously, the *technical* skills and knowledge of engineering come in most with competent experimentation. There are *a lot* of “professional skills” at play here, which makes sense if the experience of ethics is primary and engineering flows from that experience.

Engineering in Ethics and Reframing How we Think about and Teach Ethics

GF: I realize we have covered a lot of ground. I would like to transition to cover the third part that I hoped this work would cover. Specifically, in this final section, I was hoping we could briefly explore what a shift toward *engineering in ethics* may mean for engineering education. I know I would like to discuss experiential learning.

But first, I want to preliminarily identify what I see as three possible features of *engineering in ethics*:

1. Engineers must thoroughly interrogate present reality to account for all things contributing to needs or problems before making judgements or crafting responses. This is because needs and problems (i.e., moral/ethical situations) are complex and multi-faceted.
2. Engineering knowledge and skills are only needed when applicable *and* appropriate to the addressing of a present need or problem.
3. As tools for addressing present needs and problems, such engineering knowledge and skills must be performed competently.

I would also like to add that I recognize that these features are likely already performed by many engineers. It is possible for elements of *engineering in ethics* and *ethics in engineering* to co-exist. This is not a rigid binary opposition. Both are at play in our present. *Ethics in engineering* seems more ubiquitous at the moment.

JH: Let me problematize...

1. What does the phrase “thoroughly interrogate” mean? How does one “thoroughly” interrogate? How does one “interrogate” (here I am thinking about the engineering design method, or perhaps codes, or perhaps ethical theories, or an amalgamation of these)? How does interrogation differ among engineers and non-engineers? Assuming there is a difference, what are the methods or processes engineers need to “thoroughly” “interrogate”? And does “thoroughly interrogate” = “ethically interrogate”? I see a lot of room to include diversity and environmental considerations here, aspects that are seldom central to engineering decision-making or ethical decision-making processes (or ethical decision-making processes that are prominent in engineering).
2. What counts as engineering knowledge and skills? What does it mean to be an engineer? Is there a distinction between being an “engineer” and a “professional engineer”? If yes, what is the difference? Is it more than a diploma? Koen [18] argued that, “To be human is to be an engineer.” As we broaden our conceptualization of engineering, we open the door to various ways of doing engineering (i.e., ethno-engineering, see [19]). Second, where do the “needs” or “problems” that engineers must address come from? And how do we know which needs or problems are worthwhile?
3. As I read this, I get the sense that technical competence may be the penultimate aspect of ethical engineering practice. This is all over Layton’s book... and per the earlier discussion, Andrew touched on the importance of professionalization for engineers to (re?)capture their autonomy and become independent from corporations.

AK: Let me pile onto Justin’s problematization by questioning whether singular answers to these questions are what we want or whether it is sufficient to raise questions and leave them open for continuous grappling and iterations. After all, iteration does seem integral in the design process, and some conceptualization of ethical decision-making does resemble design. That may get back to Grant’s idea about *engineering in ethics* that seems to have motivated some of this paper originally. I would be remiss not to point out how Whitbeck [20] also made this point about ethical decision-making as design as well.

GF: First, thanks for bringing up the Whitbeck [20] article. I agree that there is overlap between *engineering in ethics* and “ethics as design,” inasmuch as both perspectives see ethical ends, judgments, and solutions as contingent upon the exigencies of a problem’s context, namely the constraints, allowances, and specifications that delineate possibilities. While Whitbeck appears to come to this conclusion through the experience of engineering design processes and practices, *engineering in ethics* was initially derived more from a Dewyan theory of experience and ethical inquiry, as well as an ethic of care.

Second, Justin raises important questions in his problematization of items 1 and 2. Those items are especially subject to the continuous grappling identified by Andrew. Essays, even books, could possibly be written from those questions. Given Andrew’s critique, one thing I would

likely change on item 1 is the first word “engineers.” I think it may be better to say “humans” or “human subjects.” Regarding item 3, I do not see competence as technical only, but rather socio-technical and involving care.

Competence in an ethic of care framework, at least the way I am thinking of it, may be distinct from competence as traditionally operationalized among engineers. The “competent” performance, in the sense that I am using it, of engineering knowledge/skills in pursuit of addressing a problem/need is a fundamentally ethical act. It is ethics first and engineering second. Ethics is not an afterthought, but neither is engineering. Ethics is found in the rich experiences of relating to ourselves and to others. In this framing, ethics is about living and, in living, responding with care and an inquiring mind to the exigencies born from relationality. Engineering is one mode of responding to life lived in a world of interaction. Through a lived ethics, we (re)fashion ourselves, others, and the world in which we dwell. Given that much of my professional focus is directed at education, this leads me to a difficult question: *if one desired to do so, how should this be taught to budding engineers, particularly at the post-secondary level?*

If Dewey [21] is correct in asserting that all experience becomes through continuity and interaction, then education must tend to these elements. How do educators choose strategically to build upon student experiences over time? How do educators assemble the right environment, comprising subjects and objects that, through interaction, lead to the greatest positive growth? Here, I am most interested in the second question. In agreement with Dewey, the significance of the experience is going to depend upon how well students are grounded in a shared “social enterprise.” This is not the kind of enterprise that one should associate with business or entrepreneurialism. It is, rather, enterprise as a complex project or problem, for which students must share responsibility for the actualization of a creative resolution. This speaks directly to project-based and problem-based learning. But it just as much speaks to the value of engagement beyond the walls of the university. Without some external engagement in the curriculum, projects and problems remain reason-based and/or hypothetical. For example, an imagined end-user does not speak back; however, someone with direct experience of an engineered technology may have something to say about where problems within a given device lie. Ethics education arguably has the same problem if the extent of ethical training remains in the student’s imagination and if ethics is not something consciously lived out within the context of the degree program.

JH: I appreciate all of these insights. I would like to touch on two points. First, I would like to reference two studies supporting the argument that experiential education is optimal for preparing students for ethical practice in their future careers. Second, I would like to add fodder to the iteration argument we have laid down regarding ethics.

First, in light of one of our recent work [22], it is apparent that folks tend to teach ethics in a manner that is less experiential than Dewey (and we) would think ideal. Specifically, engineering education seldom provides students with explicit opportunities to *act ethically* in real engineering environments (which I define very broadly), let alone critically reflect; but is simply learning about codes, theories, or other reasoning heuristics sufficient to ensure one is truly prepared for engineering practice? I think this is why the Wittig [23] study was so intriguing. The focus of Wittig's study was how students perceived their Engineers Without Borders project-based experiences had impacted their attainment of ABET-related outcomes relative to their regular curricular experiences. Ethics was not the focus of that article. Yet, the 14 students with EWB experiences by far felt that their EWB experiences were superior with helping students prepare for then-ABET-Outcome f ("possess an understanding of professional and ethical responsibility") when related to their traditional curriculum. This finding also aligns with another recent study [24] that shows industrial practitioners' ethical growth predominantly comes from workforce experiences; rarely was prior curricular experiences a "critical" dimension of growth.

Second, I cannot help but think of the Riley and Lambrinidou [25] article, "Cannons against Canons," that brings a social justice lens to the discussion around codes of ethics. In the work, the authors consider what a code of ethics operationalized from a social justice lens might look like. As I think about this, I see this approach closely resembling the *engineering in ethics* notion; the framework of and values associated with social justice come first (*a priori*), and the codes themselves would come second (*a posteriori*, perhaps based on practice). I will refer the reader to that article rather than summarize it in whole here, but what I find interesting is thinking about that work in light of our conversation around iteration. What exactly are we iterating on? If we are iterating on a system that has core features that are antithetical to considerations of care, social justice, sustainability, or related aspects, then is it truly iteration that we need, or is it perhaps time for a "scientific revolution" (to add another citation to Kuhn [26]) in the space of engineering ethics?

AK: Is this a gratuitous Kuhn reference or do you want to elaborate upon paradigm shifts and the notion of normal science (normal engineering ethics) needing adjustments? Are you implying a paradigm shift is in order and whether that suggested the normal science (engineering) paradigm is failing due to model drift and (maybe!?) crisis? If so, I would agree, and I think there's a clear case to make for climate change being a classic example of crisis that signals the need for a paradigm shift in how engineers think about their roles and responsibilities in the world, i.e., engineering ethics.

JH: While Kuhn is indeed often cited gratuitously, I do not think I am in error. Rather, I think you captured my intent perfectly.

GF: I didn't know we were going to be talking about revolution!?! Well, if that's the direction we are headed, it would be remiss to ignore Deleuze and Guattari's [27] conceptualizations of rhizomes, lines of articulation, and lines of flight. Assuming that a "revolution" is necessary, a rhizomatic mode of thought – non-hierarchical; processive becoming through continuous engagement with diversity/multiplicity – may be useful.

This requires a great deal of critical reflection to identify lines of articulation and lines of flight. Lines of articulation branch off in directions that (re)produce hierarchy, the status quo, and potentially hegemony. As subjects are produced through such lines, reality may appear consistent, static, and bounded. Lines of flight disrupt the production of such subjects and hierarchical systems and may detail trajectories away from rooted systems of power. I suppose that following lines of flight directed toward the processive becoming of novelty is a radical orientation to reality that, while acknowledging situatedness in hierarchical systems of power, it does not reify said systems; it, rather, sees them, and everything else, as always in the middle and not as something naturally complete.

In order to teach such a process-oriented approach, I think that instructors would need to be able to identify such notions in their own experience prior to accompanying students on their reflective, rhizomatic journeys. When are we following lines of articulation and when are we following lines of flight within the design process? How do we teach others to recognize these lines and how do we create dispositions to follow lines of flight? Drawing on our recent paper [1], I think that accomplishing this demands recognition that one's self and all that one co-creates perpetually becomes through a processive relationality, which is a relationality that leaves us indebted and obliged to foreclose on as little difference as possible, for it is this difference that constitutes us. This is a significant ontological shift that I believe is difficult to make. But, as a first step, I think that by reflectively mapping the relationships that contribute to engineering design, students and instructors can come to acknowledge multiplicity and tease apart where lines of articulation are ordering, and lines of flight are disrupting, the processes of becoming. There is much more that could and should be said on this topic, as such I think that this is a fascinating future direction for research.

AK: I appreciate the reference to the role of instructors in this conversation. Perhaps you could talk more about what this would look like as an example. Looking at the history of engineering ethics education in the past 50 years, I see stagnation punctured by systemic shocks in the form of changes to accreditation or large-scale public engineering disasters that incite action in a subset of engineering instructors [28-31]. Beyond that, I think it sometimes takes an exceptional person to engage in novel action in the classroom, particularly as it pertains to engineering ethics. Help shake me of this pessimism! Can a picture be painted in which this vision can come to fruition?

GF: That's a big question. I would like to return to your point about the crisis of anthropogenic climate change. What I find particularly important is finding ways to go deeper than simple appeals to master metaphors like sustainability, inclusivity, and even social justice. Underlying each of those terms is a network of relationships that reveal a fundamental interdependency and connectivity to a shared present. How do we draw out those relationships and make them explicit? What kind of scaffolding would students need to accomplish this? For me, this must include a deeper engagement with one's self and the value of all to which one relates through critical, reflective thought.

Let's consider sustainability. The movement toward sustainability is not just a shift in practices; a shift in disposition and perspective must accompany and perhaps precede these new practices. I think such a dispositional shift must embrace new ways of valuing. Think of someone that you consider close to you. This could be a friend, a spouse, a colleague, etc. Depending upon who you are thinking of, you likely know this person well, their history, their desires, and even how you are and have been affected by your interactions with them. It may be easy for you to recognize your indebtedness to them and that you are very much who you claim to be in this moment due, at least in part, to them. You may find it rather simple to fulfill your obligation to reciprocate within such relationships. However, we seldom, if ever, do the same for the food and resources we consume, for those species we deem less than human, for those geological materials we deem to be less than life, for the technologies and samples upon which we build academic careers, and for those human beings we may unjustly believe to lack status, to lack meaningful agency, or to possess inferior knowledge.

For me, sustainability begins with an attitude of humility and a recognition that everything has value, a value that is never fully captured by capital. We will never sustain something we do not respect, and we cannot respect something we do not justly value. This again brings me back to the question about how we teach this. Here is a far too brief example that is limited by virtue of its situatedness within the teaching and learning of engineering design.

Imagine a design course that requires students to work with mock end-users (hopefully one that can talk back) and other stakeholders to address a need over a series of design iterations. This imagined group of students is also expected to have a design concept relevant to the sustainability concerns (e.g., "green," "vitality," "connectivity") guiding their work. As the course progresses, so do the student designs, which are transformed as the desires and feedback of their mock end-users and other stakeholders are revealed, as the students learn more course content, and as the students deepen their understanding of and relationship to their design concept and the life cycle of the product they are designing. How do we turn those design iterations into maps that detail the relationships that contributed to the constitution of the lines that comprise the designs? How do we help students unpack these *storylines* [32] and recognize lines of articulation and lines of flight? I think this is where a rigorous, critical reflection strategy

is necessary. Prompts must be designed that guide students through a critical examination of what debts are etched upon their designs. These prompts can help students reflect on the forces that co-create them and their engineering designs. Then, these forces can be valued, respect can be built, and obligations reciprocated. If the reader is interested in how such prompts may connect to course assessments, to the overarching reflection strategy, and to learning goals and objectives, the DEAL (Describe, Examine, Articulate Learning) framework may be a practical aid [33].

For me, this example falls under the *engineering in ethics* framing simply because the engineering intervention is flowing from the experienced social need, which should be carefully and thoughtfully addressed. In other words, the engineering act in this example is occurring within and through the experience of an ethical situation or problem. The engineering act is not subject to ethics at a certain point in the design process; rather, it is always already ethical.

Conclusion

In this thought experiment, we grappled with considerations pertaining to two discrete but related ways of framing engineering ethics: *ethics in engineering* and *engineering in ethics*. We argued that these discrete framings bring discrete prioritizations. We called for a potential need for a paradigm shift that prioritizes a holistic engineering ethics education beyond codes and rules. Such an education would focus on the entire professional formation of the engineer, including myriad primarily affective considerations such as virtue and care. These specific considerations are often given short shrift in engineering due to their difficulty to assess; yet, these feel the most critical for helping promote a future engineering workforce committed to realizing a more sustainable future.

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