Fostering Ethical Innovation in Engineering Education and Design

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Abstract

Undergraduate engineering programs often emphasize technological innovation, leadership, and professional ethics. It is less clear, though, how to cultivate the kind of ethical formation that enables students to integrate technical proficiency with ethical reasoning in the technological design process. To that end, the paper describes how ethical frameworks of sustainability, justice, and care were integrated into a first-year engineering course in Science, Technology, and Society. Course material and assignments, as well as select student written reflections, illustrate how the course challenged students to apply both technical and ethical training to generate innovative designs that facilitate socially responsible, just, and sustainable practices.

Keywords

Engineering ethics, sustainability, engineering education, technological design

Introduction

Undergraduate engineering programs often challenge students to become innovators in their respective fields. And engineering schools themselves take pride in their ability to graduate new generations of engineering leaders. For example, the mission statement of the University of Virginia's School of Engineering and Applied Sciences expresses a commitment "to make the world a better place. . . by preparing engineering leaders to solve global challenges"[1]. The institution goes on to elaborate a vision that includes becoming "a leader among engineering schools" by "educating engineering leaders"[1]. In keeping with this vision, the school promises to graduate students who "are fully prepared to be the leaders of the future"[1]. Undergirding the school's commitment to producing engineering leaders is a "determination to innovate, create knowledge and lead in teaching and research"[1].

When it comes to defining what engineering leadership and innovation entail, the school emphasizes the acquisition of practical vocational skills, pointing to the expert "technical and professional knowledge" students will gain from their academic training. Although the school's vision includes a commitment to "abid[e] by the highest standards of ethics"[1] and to graduate students who can apply their engineering expertise with "integrity and wisdom"[1], it does not explicitly incorporate ethical perspectives into the practice of technological design and innovation. How can engineering curricula prepare students not only to become technically proficient and virtuous professionals but also to practice ethical innovation by making design choices that prioritize and facilitate ethical practices?

To address these concerns, the following study describes how ethical frameworks such as John Rawls's theory of justice and care ethics were integrated into a first-year engineering course in Science, Technology, and Society (STS). These ethical frameworks were used in conjunction with the United Nations Sustainable Development Goals to offer a constructive, ethical vision of engineering practice oriented toward values of sustainability, justice, and care. The study draws on class materials, assignments, and select student written reflections to illustrate how the course challenged students to apply both technical and ethical training to generate innovative designs that prioritize and facilitate socially responsible, just, and sustainable practices.

Incorporating Ethics into Engineering Education and Design

The effort to integrate ethical frameworks into the course to guide the engineering design process builds on the work of several scholars engaged in engineering education and curriculum design. Some scholars have worked to incorporate broader ethical perspectives into engineering design projects and courses. For example, Devon, Lau, McReynolds, and Gordon (2001)[2], describe their efforts to develop a curriculum that engages and expands students' moral imagination in the engineering design process. Feister, Zoltowski, Buzzanell, and Torres (2016)[3] assess the extent to which ethical perspectives related to human-centered design frame students' discourse about their work on design projects. And Mehdiabadi, James, and Svihla (2019)[4] evaluate how students leveraged ethical reasoning in entrepreneurial and community-based chemical engineering design projects. The work of these scholars suggests that engineering design projects provide a constructive context in which to develop students' capacity for moral imagination and their ability to deploy ethical reasoning to approach engineering design problems.

Other scholars discuss the merits of employing particular ethical frameworks in engineering education and practice. Pantazidou and Nair (1999)[5], for instance, argue that an ethic of care is compatible with engineering work because both the practice of care and of engineering respond to need and are oriented toward problem-solving action in the context of relationships. Nair and Bulleit (2018)[6] offer a rationale and proposal for integrating pragmatism and care ethics into engineering education. They contend that these two ethical frameworks are especially well suited to engineering practice because of their flexibility and openness as well as their attention to specific contexts and interest in the practical consequences of actions. Fore, Hess, and Katz (2020)[7] chronicle a series of conversations among them in which they discuss the advantages of an ethic of care, as elaborated by Joan Tronto, and Dewey's approach to ethical inquiry in shaping a vision of "engineering in ethics," which "sees ethical life as primary and engineering as a response to the needs of a present, ethical situation." These studies share an interest in incorporating particular ethical frameworks more pointedly into engineering education.

Building on the work of these scholars, the introductory course in STS attempted to bridge the emphases in the two bodies of scholarship by giving students an opportunity to experiment with applying particular ethical frameworks to guide their work on course projects. The hope was that in affording students these opportunities they would come to appreciate both the need for and the value of ethical frameworks in shaping their approach to engineering design problems. The study begins by introducing the course and setting out three ethical frameworks students learned through a series of readings, lectures, and discussions. Next, it describes the major course assignments that provided the opportunity for students to apply the ethical frameworks to

engineering design challenges. Finally, the study reviews select student reflections that highlight ways students began to integrate ethical knowledge with their technical training to develop design ideas that foster values of sustainability, justice, and care.

Sustainability, Justice, and Care: Frameworks for Ethical Engineering Design

The first-year course in Science, Technology, and Society at the University of Virginia was co-taught by two instructors and a small team of graduate teaching associates. The course is required of every incoming class of engineering students and typically enrolls about 400 students each Fall and Spring semester. Given the scale of the course, the primary modes of instruction were a series of weekly course lectures, delivered by video asynchronously in Fall 2020, with accompanying assigned readings and discussions in smaller online classes of about 50 students each. Students also had the opportunity each week to reflect on their learning by posting short written responses to the course website that engaged the weekly course material as well as the ideas of their peers in the class. These reflections offer valuable insight into how students were responding to what they were learning and how they perceived its relevance to their work on course assignments and to their professional development as engineers. The section below summarizes the ethical frameworks that students learned in course lectures and readings. These frameworks were intended to provide an ethical foundation for their work on course projects that involved them in generating ideas for innovative technological designs oriented around values of sustainability, justice, and care.

Sustainability

The course began by providing students with a working definition of sustainable development and a framework for understanding sustainability in terms of its environmental, economic, and social dimensions. First, students encountered the definition of sustainable development set out in the 1987 Report of the World Commission on Environment and Development: Our Common Future, also known as the Brundtland Report: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[8]. With respect to use and allocation of resources, the definition underscores the practical and ethical commitment present generations have to future generations. In addition, the notion of "meeting needs" implies a goal of sufficiency rather than excess.

Next, students were introduced to the United Nations Sustainable Development Goals (SDGs), which elaborate the broad notion of sustainable development set out in the Brundtland Report by articulating 17 discrete Goals[9]. Taken together, the Goals express a notion of sustainability that involves three integrated thematic areas of focus for sustainable development: environmental, economic, and social. The following statement about the history of the SDGs from the United Nations Department of Economic and Social Affairs reflects these three areas of focus: "The Goals "recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests"[10].

These three themes are important to stress with students because, while conventional notions of sustainability frequently include environmental and perhaps economic aspects of sustainability,

they often neglect its social dimensions. For example, an article on Sustainability in the online version of Encyclopedia Britannica explains, "In general, sustainability is understood as a form of intergenerational ethics in which the environmental and economic actions taken by present persons do not diminish the opportunities of future persons to enjoy similar levels of wealth, utility, or welfare"[11]. Although the article goes on to mention social sustainability in conjunction with the term sustainable development, its initial definition and most of its discussion of sustainability foregrounds environmental and economic aspects. Emphasizing to students that the SDGs reflect all three areas of focus for sustainable development offers a more nuanced and holistic approach to sustainability that also helps them appreciate the contribution of their required STS courses to their engineering education.

From there, the course introduced students to two ethical frameworks whose principles undergird and inform the values of sustainability expressed in the SDGs. Because the Goals are forward looking in orientation, working to ensure the needs of both the present and future generations, they are, in effect, imagining a pathway to a more ideal just and sustainable world for all. This involves the Goals in addressing the ethical problem of distributive justice. The Goals, then, implicitly engage the question: How do we justly apportion benefits and burdens, rights and duties, resources and responsibilities in a society?

Justice

To guide students toward an ethical approach to resolving this question, course readings and lectures introduced them to John Rawls's theory of justice[12,13]. To begin, Rawls's theory was set in contrast to other attempts to address concerns of distributive justice such as appealing to tradition (i.e. a particular historical social arrangement) or prioritizing the happiness, interests, and welfare of a majority (i.e. classic Utilitarianism). Both of those approaches are limited because they risk neglecting marginalized or minority groups and privileging those who are already socially advantaged or who belong to a particular majority.

Next, students encountered key concepts in Rawls's theory such as the Original Position and Veil of Ignorance, as well as the Principle of Equal Liberty and the Difference Principle. Below is a summary of how these concepts were presented to students.

Original Position: As part of a thought experiment toward creating an ideal just and equitable society, Rawls begins by assuming that the people involved in designing such a society for themselves are both rational and motivated by self-interest or concern for personal welfare.

Veil of ignorance: From there, Rawls posits that there are certain things people designing the society would not know beforehand about themselves such as their gender, race, ethnicity, sexual orientation, social class, economic status, degree of physical ability, and where or when they will live. Although people designing the society are aware of the range of possibilities for these categories, they do not know any particulars about their identity and status with respect to them.

Given these parameters, Rawls argues that people would design a society that guarantees basic rights, freedoms and opportunities for everyone, and well as access to essential resources. That

is, people would end up creating a more just and equitable society. Rawls proceeds to characterize the ideal society that would emerge from his thought experiment by two principles.

Principle of Equal Liberty: Every person has an equal right to the most extensive list of basic civil liberties such as the right to vote, the right to hold public office, the right to acquire personal property, as well as basic freedoms like freedom of assembly, speech, and conscience, and the assurance of basic protections such as protection from arbitrary arrest and seizure.

Difference Principle: Social and economic differences may exist among people and groups in terms of outcomes. This means, for example, that people may have access to greater or lesser degrees of social privilege as well as the capacity to earn more or less money and secure differing degrees of personal wealth. But there are two important qualifications to the Difference Principle. First, though people may not experience the same outcomes, all people must have equal access to opportunities for personal and professional advancement such as education, public office, housing, and employment. Second, while people may profit from the use of their knowledge, time, and skills, those who have a greater proportion of social status and wealth have an obligation to benefit those who are most disadvantaged in society. So, people in certain professions (such as engineering) may earn more money as long as their work serves the interests of the least advantaged members of society.

It is important for students to bear in mind that Rawls's approach to an ethic of justice takes the form of a thought experiment. He is not necessarily suggesting that people should actually try to live under some sort of veil of ignorance about themselves and their place in the social order. Instead, his approach allows us to see the kind of ideal society that would result from adopting something like his veil of ignorance. From there, we can compare Rawls' society with our own social arrangements of power and privilege and see where they align with or run counter to the principles of justice and equity that emerge from his ideal society. As we are able, we can then take strides toward realizing the values and principles that undergird his society in our laws, policies, practices, and technological designs.

Understood as such, Rawls's theory of justice aligns with the notion of sustainability that undergirds the United Nations Sustainable Development Goals. Under the Veil of Ignorance, one of the things people do not know about their position in society is which generation they will be born into. This means that they do not know what share of resources will be available to their generation. So, under the conditions Rawls' sets up, people would want to design a society in which each generation has an adequate share of resources to meet its needs. The Brundtland Report's notion of sustainable development thus aligns with the ideas of justice and fairness elaborated in Rawls's theory.

From there, the course lectures explored how Rawls's theory of justice might pertain to engineering design. If, for example, certain technologies that all people need to use were designed to advantage only some, then that would be problematic according to Rawls's framework. Similarly, if certain technologies that some people had access to ended up exacerbating existing social or economic differences such that the least advantaged people were worse off, then that would also run counter to the terms of Rawls' ideal society. Rawls's theory of justice, then, can offer some moral guidelines for how engineers can make design choices that

express values of justice and equity and advance social as well as economic and environmental sustainability.

Care

Next, students learned of a second ethical framework that also resonates with the ideals of sustainability expressed in the SDGs: care ethics. Developed in the 1980s by feminist scholars Carol Gilligan and Nel Noddings[14,15], care ethics departs from normative ethical frameworks that appeal to moral norms and general or universal principles to govern moral action. Instead, care ethics prioritizes particular relationships, interconnectivity, social responsibility, the cultivation of empathy, and the practice of care. Below is a summary of some of the concepts within care ethics that students learned[16,17].

Care as Social Responsibility: People owe a duty of care to the other people in their lives. However, because the context of the relationship differs from person to person, the practice of care is not always the same. Although people have a basic duty to care for other people, the practice of care may differ when offered to a family member, friend, co-worker, client, customer, neighbor, or fellow citizen; and the idea of what constitutes good care may vary among cultures and communities. Care is also the province not only of individual people but also of groups, organizations, companies, and communities.

Care as Action: According to Berenice Fisher and Joan Tronto, care is "a species of activity that includes everything we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible. That world includes our bodies, our selves, and our environment, all of which we seek to interweave in a complex, life-sustaining web"*. Similar to virtue ethics, Tronto's definition of care emphasizes care as a form of moral praxis.

Care as Attitude: Care also involves the cultivation of mental and emotional dispositions of concern, compassion, empathy, attentiveness, and investment.

Care in Practice: Fisher and Tronto[18] elaborate the practice of care in terms of four iterative phases that include (1) "Caring about" or attentiveness: becoming aware of the need for caring, (2) "Caring for" or responsibility: assuming responsibility for showing care, (3) "Caregiving" or competence: adequately performing the appropriate tasks of providing care, and (4) "Care receiving" or responsiveness: responding well to an act of care.

Care and Power: Although care may be shown in relationships among equals, it is often practiced in unequal or asymmetrical relationships of power, which requires being attentive to power dynamics. Those in more powerful positions in relationships of care have a special obligation not to exploit a caring relationship, foster dependence, or otherwise harm the more vulnerable party.

After outlining some of the concepts associated with care ethics, the course lectures helped students forge connections between care and sustainability, care and justice, and care and technological design. For example, the notion of sustainability expressed in the Bruntdland Report is animated by concerns of care. The obligation to meet the needs not only of the present

but also of future generations involves compassionately attending to the needs of others, in this case other generations that have to rely on a finite set of resources. Further, according to Fisher and Tronto's understanding of care, the "world" that is the object of care includes the environment in addition to other people, an emphasis that aligns with the three areas of focus for sustainable development that characterize the SDGs.

Additionally, care ethics also resonates with aspects of Rawls's theory of justice. In effect, Rawls's Veil of Ignorance capitalizes on self-interest to encourage people to cultivate empathy for those in groups or communities different from their own. By prompting social architects to imagine what might happen were they to belong to a disadvantaged or minority group, Rawls's framework provides a catalyst for the kind of attentiveness and concern for the other that care ethics hopes to foster.

Finally, the practice of care ethics also pertains to technological design. Tronto, for example, underscores that care may be shown to a "thing, person, or group"[19]. This invites engineers to understand the object of care, the "world," in terms not only of the natural world but also of the technological world or human-built environment. The act of maintaining, continuing, and repairing that "world" thus includes taking responsibility for technical design choices and their potential impacts on the various groups that have a stake in a technology's development, maintenance, use, and non-use. Further, care ethics also draws attention to the importance of being mindful of the asymmetrical power dynamics between technological designers and certain stakeholder groups, not least users and non-users.

Course Assignments

While students were in the process of learning about the United Nations Sustainable Development Goals and the ethical concepts of justice and care that undergird them, they were also beginning work on a series of assignments that would challenge them to apply both technical and ethical knowledge.

Course Scenario: In the first class, students were presented with a scenario that would govern their work in the course and provide thematic coherence between the course lectures and assignments. According to the scenario, students were asked to imagine that the Jefferson Trust, a grant-awarding initiative of the University of Virginia Alumni Association, had issued a request for proposal (RFP) to solicit designs for new technologies that could help the university community make progress toward the United Nations Sustainable Development Goals. The design proposal would take the form of a provisional patent application that describes a technological innovation and argues for the design's advantages over related prior art. Introducing the patent application would be a cover letter that explains how the design fulfils the terms of the RFP, that is, how it relates to a specific SDG and how it could be implemented to serve the university community.

Design Notebook: Students then began work on a series of assignments that would prepare them to respond to the Jefferson Trust RFP. First, they recorded fifteen ideas for technological innovations in a design notebook. In addition to providing a brief illustrated technical description, each entry in the notebook had to explain how the design would address a particular

problem related to sustainability at the university; and each entry had to identify which UN Sustainable Development Goal the design was intended to advance.

Technical Description: While working on the notebook, students also gained experience in technical description writing. They were tasked to select a simple mechanical device they had at hand and describe its form and process of operation with accompanying figures. At the end of the description, students included a brief reflection that identified the device's target users, the particular design values it expresses, and the extent to which it includes or marginalizes certain groups of stakeholders.

Design Pitch: As students finished making their entries in the notebook around the middle of the semester, they selected one entry and developed a brief presentation in which they pitched their idea to a small group of their peers in the class. Then, after hearing the various presentations, each group selected one of the ideas they heard to make the centerpiece of its patent application project. An important parameter for the groups to consider when making their selection was how well the design proposals corresponded both with a particular UN SDG and with a problem pertaining to sustainability (environmental, economic, or social) at the university.

Provisional Patent Application: Having chosen a viable idea, each group then proceeded to describe its design in the patent application and argue that it adequately fulfilled the terms of the Jefferson Trust RFP in the accompanying cover letter. The semester concluded with each group presenting to the class the idea featured in its patent project. The presentations generated constructive class discussion about how the designs students proposed in the patent application could contribute to making the university a more just, inclusive, and sustainable environment. Accompanying these assignments were a series of online reflections students wrote on course materials as the semester progressed.

Student Reflections

The goal of the assignments was to challenge students to integrate their growing technical design skills with their knowledge of the ethical frameworks they were learning about in course readings and lectures. To foster this kind of integration of knowledge and practice, the course website provided students with a forum to reflect throughout the semester on how ethical values of sustainability, justice, and care could inform their work as engineers. These reflections indicate that many students were beginning to incorporate the kinds of ethical values and concerns reflected in the frameworks into their conception of engineering design and professional practice. Below is a small sample of student work that illustrates the kinds of connections they were making in their reflections.[1] In addition to interacting with course lectures and introductory readings on Rawls' theory of justice[13] and care ethics,[16] the following selections of student writings incorporate reflections on an article in *The Atlantic*[20] by Lolade Fadulu titled, "The Problem Sunscreen Poses for Dark Skin: Certain Ingredients are Pushing People of Color away from Good Skin Care."

      Reflection A

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[1] IRB approval was obtained for using anonymized data from select student reflections written for the course.

Each one of these articles helped me to realize some of the issues that come along with a career as an engineer. In Fadalu's "The Problem Sunscreen Poses for Dark Skin", the issues of sunscreen's color is the focus of the article. Sunscreen is helpful for a person's skin, as well as with preventing issues that can occur when exposed to the sun. However, it lacks a major feature that would create a better social impact for all those who want to use it: it does not account for the appearance it has on people with darker skin. This is a major problem with sunscreen, and while this issue was not blatantly skipped over by the creators of sunscreen, it does bring up an issue that we as a society have to face now. This has put people with darker skin at a disadvantage, as they can either go outside without wearing sunscreen, or look like they are wearing a white mask when they apply sunscreen.

As mentioned in the care ethics article, forming relationships with others while creating a product is crucial. Accepting a variety of different opinions from a diverse group of viewpoints can help a product designer to encounter issues with the product and solve them before it is released to the general public. The creators of sunscreen most likely skipped over this, as the problem has arisen in recent years. If the creators of sunscreen took an approach similar to Rawls' "Theory of Justice", they could have tried to put themselves in a situation similar to that of people with dark colored skin. While it is not as simple as that, they could have thought through the process of sunscreen for different people.

For my future career as an engineer, I now realize that looking at a problem from multiple different perspectives will help me to create a more thorough solution. Being able to use Rawls' method of Original Position and "the Veil of Ignorance" can help me to think of my product from many different angles and cultures. Using care ethics in designing and developing my product will also help to provide it to as many people as possible. If I am able to form relationships with various groups of people, I can more accurately design a product for them. If I do these things in my career as an engineer, I should be able to avoid problems like sunscreen's appearance on people with darker skin in the future.

Reflection B

The readings for this week highlighted the careful and necessary considerations that engineers must take into account regarding equity and relationships. In "John Rawls on Justice", the author discusses John Rawls' Theory of Justice, namely the importance of using the Veil of Ignorance in order to create a society that is just for everyone. This idea of ignorance in design allows engineers to think about what will benefit all people in many different situations. This unbiased approach to innovation would lead to technologies and products that are universally effective and that do not negatively affect certain groups. A failure to consider all types of people is described in Fadulu's article, "The Problem Sunscreen Poses for Dark Skin." In this article, Fadulu explains that sunscreen can have negative effects on the appearance of people with darker skin, leading these people to be less likely to put on sunscreen and thus more likely to get skin cancer. Sunscreen was not created from behind the Veil of Ignorance, and as a result, darker skinned people have been negatively affected. This issue has highlighted to me the importance of being unbiased as an engineer--when creating something, I must be completely conscious of its potential implications, thinking beyond just its functionality.

These articles relate to our exploration of science, technology, and society in that this course focuses on the ethics of science through the lens of building a sustainable world. The UN Sustainable Development Goals definitely follow Rawls' approach of improving society for everyone in various situations. I am excited to "create" something that will attempt to satisfy one of these goals and that will be consistent with the Rawls' Theory of Justice. Throughout my

engineering career, I hope to apply these principles of justice and to consider all people in society.

Importantly, each of these student reflections demonstrates an appreciation for how applying ethical frameworks to engineering design can result in designs that are more socially responsible and sustainable. In the exchange that follows, two students (D and E) respond to the concerns raised by a first student (C) whose remarks they find problematic. Both of the responders are able to use the ethical frameworks taught in the course to address conceptual and ethical limitations in the first student's remarks. Their responses demonstrate an ability to synthesize notions of sustainability, justice, and care with the kinds of technical design choices (and their attendant consequences) that engineers routinely confront.

Reflection C

After reading these articles I have some concerns.

1. The sunscreen article seems like a non-issue. I come form a multi-racial family including but not limited too; Asian Latino, and African American roots. We use spray sunscreen. I have never heard of this complaint.

2. Care ethics, if practiced, seems like it might create a nanny state. Where those in charge are tasked with more than is reasonable; taking care of fully functioning adults who should be able to fend for themselves, and their own families. If the higher ups do this, they risk creating dependents. People can be influenced to give up their freedoms in order to be cared for. If employers foot the bill for healthcare, the employees have less incentive to care for themselves. The employers have more, will they tell their employees to stop drinking alcohol, taking drugs, overeating? Shades of this are already happening as the federal government takes on more healthcare costs. NYC outlawed supersize drinks.

3. The Theory of Justice seems like a nice idea, however it can never happen. You can't put someone behind the "Veil of Ignorance."

Reflection D

I found your post interesting and thought I'd respond. In regard to your point on care ethics, it seems like you are deviating from van de Poel's definition of care as a virtue around which to construct an ethical framework for navigating relationships of power. Instead you juxtapose care ethics and individual liberties, two concepts I don't think should necessarily stand in opposition. Furthermore, regarding your point on the Theory of Justice, I agree it's true that one cannot literally be stripped of their identity and assume a veil of ignorance. The veil, however, essentially operationalizes empathy and fairness, and encourages us to strive for an ideal society, much like many other groundbreaking and guiding principles throughout history. In addition, if we observe the two principles of justice, equal liberty and the difference principle, Rawls emphasizes equality of opportunity and denounces equality of outcome. The vision of a perfectly meritocratic society naturally aligns with the libertarian ideals that arise from reading your earlier point on care ethics.

Reflection E

In response to your first point, I think the article about care ethics explains why, as an engineer, you maybe shouldn't have this mindset. Although you may not experience a problem, as engineers, our job is to come up with solutions to help others. We have an obligation per care ethics to help the users of our solutions because of the asymmetrical nature of our relationship to said users. Spray on sunscreen is a valid alternative to traditional sunscreen lotion, but I believe that a main point of the article was to highlight how a product that everyone should be using is designed in a way that excludes a large portion of the population. That design choice is unethical according to care ethics because it is inherently not empathetic to users and therefore should be redesigned. Not every solution can work for everyone, but the "not everyone" shouldn't be a whole race or complexion of people. One of the interesting things about Fadulu's article for me was how it relates to my life as a black woman. While reading the whole article, I was questioning why this problem hadn't already been solved. Seeing a response like yours, that probably explains why.

Conclusion

By having course materials and assignments oriented around ethical frameworks of sustainability, justice, and care, the course was able to challenge students to apply both technical and ethical training to generate innovative technological designs that could facilitate socially responsible, just, and sustainable practices. Going forward, it would be constructive to provide students the opportunity to reflect explicitly on how the ethical frameworks discussed in the course shaped the design choices they made as they developed their ideas for the patent project. The cover letter, in which students identify the specific SDG(s) they hope to promote through their designs, would seem an ideal place for such a reflection. Adding this component to the cover letter would further the goal of helping students appreciate the value of integrating ethical reasoning with engineering design by making them cognizant of how specific design choices they made were shaped by particular ethical concepts, principles, and values.

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