

Opinion: Reframing Engineering Education to Quench the Stench of Injustice

In 1985, Andy Kricun opened his car door in the parking lot of the Camden County wastewater treatment plant and was assaulted by a putrid odor. The plant operators were indifferent to the smell, having ignored the stench for years. Their housing in distant neighborhoods estranged them from the foul imposition which tormented nearby residents. The wastewater workers reasoned that the smell was beyond the scope of their duty, which was to maintain standards and regulations. Andy was astounded that these operators, who he knew to be good engineers, were apathetic towards the direct negative impact their work had on the community they sought to serve. These engineers illustrate, on a small scale, the larger picture: one does not have to do good to be a good engineer.

Just as the wastewater stench dissipated throughout the local neighborhood, inadvertent socioenvironmental harms are diffused throughout the engineering field's fetid history. For instance, the widespread construction of large-scale dams (intended to provide hydroelectric power and water storage) has damaged aquatic ecosystems, displaced hundreds of communities, and drowned culturally significant landmarks. The Dalles Dam exemplified all these detriments when its construction in Oregon disturbed salmon migration, displaced settlements, and completely flooded Celilo falls, a fishing site held sacred by the indigenous people who had lived along the Columbia River since time immemorial. Yet, these impacts are not regarded as primary concerns of engineering professionals.

Similarly, urban infrastructure projects (aimed at improving transportation, connectivity, and urban development) often destroy or pollute natural habitats. This perpetuates gentrification, forcing out disadvantaged peoples (disproportionately people of color) and exacerbates social inequities. Construction and transportation engineers directly shape the living environment of communities in which they work and, despite well-intentioned goals, often inflict unintended damage due to a lack of preparedness to consider socioenvironmental context.

Engineering, as a discipline and practice, is fundamentally flawed. From year one in engineering education, students are told they are destined to be problem solvers, above all. Driven by their technical expertise, engineers may consequently overlook the broader implications of their actions in the preemptive pursuit of solutions. Problem solving is key in engineering but overemphasis on solutions fails to acknowledge the importance of problem definition.

Real-world engineering problems are not one-dimensional as they are inside the classroom; they are complex and multifaceted, requiring a nuanced interpretation. Yet, engineers often gravitate to technical details because of their training. Engineers must recognize the interconnectedness of societal, economic, and environmental factors and give them equal consideration alongside technical aspects when defining a problem. By adopting a multidimensional approach, engineers can better address the complexities of the challenges at hand and create more comprehensive and sustainable solutions.

Instead of taking on this responsibility, engineers (like those in wastewater management) rely on regulatory agencies like the EPA, DEP, OSHA, and city councils to provide details about socioenvironmental process specifications. These regulations set bare minimum boundaries for

engineers to prevent the introduction of some direct harms but are in no way comprehensive. Government systems are hindered by bureaucracy and re-election interests by design to prevent power exploitation, but as a result are indisposed to address climate change and environmental injustices which require urgent actions. In the private sector, companies may take on social and environmental responsibility in their mission statements and corporate goals, passing on these expectations to their employed engineers. But very few companies are whole-heartedly invested. Greenwashing is the practice of branding companies or products as environmentally friendly to appeal to consumers, but the actions taken are performative and often overshadowed by the underlying monetary incentives ingrained in the extractive system of capitalism. Intricate and intersectional issues are not fully addressed by any one entity which holds power over the work of engineers, so relying only on a top-down approach to socioenvironmental guidelines will never be enough.

Amidst these flawed systems, the power of “we the people” provides a glimmer of hope. Passionate individuals who understand community needs can and will mobilize meaningful change. It is through this mobilization that I find hope, despite the inadequacies of existing systems.

Andy, for example, carried an unyielding determination that pierced through the foul fog of fecal fumes. He understood that he needed to go beyond regulatory compliance with unwavering resolve. After years of climbing the leadership ladder in the Camden County Municipal wastewater management facility, he was able to eliminate the smell and the community exhaled a collective sigh of relief.

Individual resistance inspires collective demand which propels society forward. As these people gain prominence, a movement which shifts engineers and other resource management professionals to pay attention to their socioenvironmental consequences is bound to happen.

However, relying on a few determined individuals to confront oppressive systems and disrupt the status quo is like recycling. While recycling provides a temporary solution by prolonging the lifecycle of materials, it fails to address the underlying issue: a linear use of resources. While recycling is good in the meantime, ultimately, we should strive for a circular economy which factors sustainability into a well-designed system that eliminates waste altogether. The stalwart individuals who illuminate injustices and innovations are heroes for whom we should be grateful. But, we should strive to lift the heavy, complacent fog which encompasses engineers altogether.

Tensions grow from deceptive actions, like greenwashing, which put band-aids over deep, infected wounds. I fear if we continue along, little-by-little relying on individuals to uncover systematic corruption, then the movement may arise as many have throughout history: from violence. Therefore, we need to be proactive and implement peacebuilding strategies within engineering projects through capacity building.

At Camden’s wastewater treatment plant, Andy did not stop when the direct harm was alleviated. He pursued retribution. After speaking with residents, he guided the plant to open publicly accessible greenspace, a commodity long sought-after by the community. He built

communication streams as a form of capacity building so that even without him in leadership, there could be dialogue between communities and the Camden's plant moving forward. Building capacity in engineering projects by establishing lines of communication with those they intend to serve or may inadvertently effect is a positive step practicing engineers can take to illuminating injustices and help build our society's capacity for peace as an ongoing process.

However, since it is not explicitly an engineer's job to maintain communication structures like Andy's, his successor may neglect to maintain the community relationship. The strength of systems lies in the individuals who operate and inherit them. For the sake of sustainability, the engineering community needs to build capacity from the bottom up. Meaning, every engineer (not just strong leaders) should carry with them the tools necessary to interpret and adapt to complex problems. That capacity is built through education.

The first and foremost fundamental canon in the engineering code of ethics is to "hold paramount the safety, health, and welfare of the public," so the educational system should be shaped accordingly. The Cold War, industrialism, and capitalism sunk their claws deep into the engineering profession and as a result isolated the curriculum from social context. To confront the climate crisis and social injustices, engineers need to be freed from these influences. By promoting social awareness within courses, colleges, and professional societies, we empower engineers to address socioenvironmental challenges peacefully and sustainably.

To reframe engineering education, we must rework the core curriculum and the specifications set by universities. While math and science courses are foundational elements in an engineer's tool-belt, requiring all students to take derivation-based engineering classes like fluid mechanics and heat mass transfer is superfluous. Modifying the curriculum of these courses to shift focus away from derivations would allow engineering professors to explore the context and factors at play when each technical set of tools may be used. That is not to say the important tools and equations would not be taught, but instead of focusing on deriving those equations we focus on the situations they are most often used. This also opens space to teach problem identification and outlining. Engineering projects have a pivotal role within societal development, so being intentional with defining and outlining complex socioenvironmental problems is highly relevant to engineers. Classes need to teach skills like resource mapping, gathering community and stakeholder interests, and identifying ways the assumptions or compromises we make when developing engineering solutions might perpetuate social injustices and disadvantage marginalized people. Details about software syntax and manipulating expanded equations (which students often memorize and immediately forget after exams) are typically retaught in the workplace when relevant, but understanding one's place in society is not.

Apart from the engineering fundamental courses, most universities only require engineering students to fulfill core humanities requirements which are disconnected from the context of engineering and are weighted less in GPA calculations. This supports the perception amongst engineering students that their humanities studies are frivolous "blow-off" classes. By instead requiring core classes which are interdisciplinary history and sociology classes centered around the impacts of engineering projects, students could contextualize engineering work within the communities they operate. Many universities, like Drexel, offer socially informed engineering

courses, but are optional electives rather than requirements. Further, by hosting these courses within engineering colleges (weighting these course grades equally in their GPA calculations), students would recognize that they must hold themselves to the same standard of learning for socioenvironmental contextualization.

There will likely be resistance from traditional engineering faculty and administrators (like the resistance Andy encountered with the plant operators) who perceive the inclusion of social context as detracting from core engineering principles. But the climate is changing, and generational values are shifting, regardless of educators' decision to adapt and improve. To stay relevant and competitive, maintain student retention, and attract a diverse student body, engineering colleges must keep up with the demands of this younger generation who are experiencing climate change impacts firsthand and demanding more from the unsustainable systems which perpetuated this global crisis. Workshops and conferences already exist for engineering faculty to assist in developing more socially aware engineering coursework and help ease the transition. Universities should foster an environment that encourages faculty members to undertake the responsibility of enhancing the engineering community. In their classroom, their research labs, and their actions, universities and academics can demonstrate that they are a part of the solution, not the problem.

Further, professional organizations of each discipline, honors societies like Tau Beta Pi, and other engineering groups which grant awards to high achievers should emphasize the social context and peacebuilding work that is contributed by whom they select to honor. Some awards like this are already present in the engineering community, such as the Constellation Prize started in 2020. Showing the value of peaceful initiatives as an engineering community through recognition would help motivate high achieving professionals to pursue social betterment wholeheartedly.

Engineers are multifaceted and intelligent individuals who are capable of considering a complex array of factors in their practice. By expanding the identity of engineers to *define* and solve complex problems with an understanding of technical *and* socioenvironmental frameworks, resource management and social development conflicts could be resolved without resulting in tension. Resentment and violence could be avoided between those in charge of providing essential resources (like clean, treated water) and the communities they serve. Building peace expands beyond solving complex problems, beyond deconstructing root causes and retributions, and into building the capacity of communities and societies to repeat this process over and over again as problems and conflicts naturally arise. Through the content we present in the classroom, in workshops and seminars, and with the honors we give through professional societies we, the engineering community, can prioritize humanitarian values and promote peace in our practice.