Enginovation: A Social Experiment in Innovating Together

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JUST-US and Enginovation: A Social Experiment in Innovating Together

Introduction

In recent years, there's been an uptick in literature investigating the role of engineers in society and how such has been conceptualized and integrated as critical components of their engineering education. Traditionally, engineering has focused on the technical in isolation and perpetuated ideals of depoliticization and meritocracy (Cech, 2013). However, the dangers of such positionings have motivated scholars to recognize a need for cultivating multifaceted engineering talent that is better able to address the complex challenges facing society. These complex challenges necessitate consideration of both technical and social domains in engineering, or rather, a sociotechnical approach (Reddy et al., 2023; Johnson et al., 2022). Research has demonstrated that sociotechnical thinking—the integration of technical and social dimensions in problem-solving—is often underdeveloped in engineering students (Johnson et al., 2022), leading to technological solutions that fail to consider social and ethical implications. The literature also highlights that sociotechnical integration—the intentional blending of technical knowledge with social, ethical, and contextual considerations—is key to addressing these gaps and must be actively embedded into engineering education (Reddy et al., 2023).

Adopting sociotechnical approaches to engineering involves the intentional consideration of how the full realm of factors—environmental, social, ethical, economical—come to inform the needs of empathy-driven innovation. Of particular importance in this approach is the need to proactively consider what the impact of technologies and innovations will be on people, society and the planet. To date, a host of innovations have failed and/or proven to inconsistently perform as a function of user characteristics (i.e., hair texture in electroencephalography caps) due to inadequate integration of and consideration for the associated stakeholders, their cultures and the environment in the ideation and design process. Such outcomes reflect a dissonance in the education of engineers and their notions of professional responsibility regarding the public good (Cech & Finelli, 2024), which can each in some way be mapped to deficiencies in ethical training, systemic thinking, user-centered design, and sustainability awareness. While the aforementioned deficiencies are all critical components of engineering education, they have often been overlooked in the prioritization of technical skill development. Studies have shown that engineering curricula emphasize technical proficiency while underemphasizing ethical responsibility and broader sociotechnical considerations (Bucciarelli, 2008; Riley, 2017). This prioritization of technical skills over ethical and social dimensions has resulted in engineers who may lack the training to anticipate and mitigate the unintended consequences of their innovations.

Engineering's long-standing focus on technical competence often ignores the broader social implications of its products and innovations (Vest, 2005). By viewing social and technical aspects as distinct, engineers may inadvertently perpetuate inequities. Integrating sociotechnical approaches acknowledges the ethical obligations of engineers, aligning with Kimmerer's (2013a, 2013b) call for wisdom and mutual respect between humans and the environment. As an example, engineering ethics courses are often focused on compliance with professional codes rather than fostering critical engagement with social justice, environmental justice, and human-centered approaches (Herkert, 2001). This gap in ethical education has been linked to real-world failures, such as biased AI hiring tools (O'Neil, 2017), unsafe automation in aviation (Herkert et al., 2020), and environmental disasters like the Deepwater Horizon oil spill (Freudenburg & Gramling, 2011). Furthermore, sustainability is often taught as an optional elective rather than a core engineering principle, limiting its integration into mainstream engineering decision-making (Bielefeldt, 2015). Given these shortcomings, calls for reform in engineering education advocate for a greater emphasis on interdisciplinary learning, public engagement, and ethical responsibility (Leydens & Lucena, 2017). Further, contextualization in engineering education is a crucial tool for helping students recognize the complex relationships between technical work and its social impact, thereby fostering a more holistic approach to problem-solving (Kleine et al., 2023).

Additionally, scholars argue that engineering students need frameworks that help them engage in comprehensive systems thinking to analyze and address the multidimensional challenges of contemporary technological failures (Dugan et al., 2024). Critical infrastructure studies also emphasize the importance of sociotechnical integration as a way to reframe engineering solutions with a broader awareness of systemic vulnerabilities and interdependencies (Winschiers-Theophilus, 2024). Without these reforms, engineering education risks continuing to produce professionals who are technically skilled but ill-equipped to navigate the complex sociotechnical landscapes that define modern engineering challenges.

Conceptualizing the JUST-US Experiment

In this work, the JUST-US (pronounced "justice") experiment, a group of students and a faculty member embarked in an exploratory and participatory research design to study our process of selecting individuals (using student derived criteria) to expand our research team and engage in a 10-week collective research experience focused on sociotechnical innovation. Applying the holistic approach to problem-solving mentioned above, this work seeks with explicit intentionality to observe the process surrounding formation of the team, and specifically, observing what that informs as it relates to a team working together on a sociotechnical research project. We conceptualize this work underpinned by the assumptions stated here: 1) ascriptions to meritocratic and depoliticized ideologies are pervasive across engineering; 2) such beliefs are socialized into and through engineering education; and 3) the values held by an engineer will translate to some extent, at a minimum, into their technologies and innovations. Given the situated assumptions, the "who, how and why" of this process warranted equal consideration as the "what". Appropriately, this work also made meaning of the final criteria deemed important and/or valued in the students' selection process. Insights from this work stand to inform the broader engineering education community of student driven prioritized values as it relates to sociotechnical innovation and what is perceived as important in doing that work.

We believed engaging in a participatory design with current engineering students developing the skills to become engineers would facilitate one way of seeing how various knowledges (ways of knowing and doing) were being embedded within engineering education. This participatory action research design involved multiple levels (Coley et al., 2024)—a team including engineering undergraduate (*n*=5) and PhD (*n*=5) students and an engineering faculty member. This work sought to uncover the critical aspects in a student-led process to expand a team to conduct a collective research project in sociotechnical innovation. This paper will explore the research questions: ***What is the process by which engineering students engage in the selection of teammates for a sociotechnical innovation related research project?***

Conceptual Framework

The impetus for this work emerged from a sociotechnical innovation research experience the Principal Investigator (PI) conducted with undergraduate students in the global context of Amsterdam in 2024. Engineering students (*n*=3) were selected for their identification as an engineer and their expressed communication of interest in sociotechnical innovation and justice. This collective in the field experience included artifact exploration, recorded group discovery conversations (recordings taken as a part of preparation for a particular exposure event (i.e., visiting the Floating Farm) in the field and/or immediately following one), interviews, photographs and video. Having a range of engagement from students across various engineering disciplines had no influence on the fact that none of them had a confident awareness of sociotechnical innovation. Not only did students prove scared to define it, but they also had no idea of exactly what "qualified" as sociotechnical innovation. It was apparent that their engineering educations had not equipped them with this exposure. My initial concern was not that students would not be open to the work or the ideas that ground it but rather a keen awareness that these ideas were seemingly not being encountered as a critical part of engineering education.

Decolonial frameworks challenge engineers to consider how their work impacts historically marginalized communities, advocating for approaches that honor Indigenous knowledge and community-centered practices (Winschiers-Theophilus, 2024, San Pedro, 2018). Recognizing engineering's role in systemic issues, such as environmental degradation and resource exploitation, reinforces the need for a justice-oriented framework within the field. Coupled with my analyses from the field research of the Amsterdam trip, I developed the conceptual framework called the CCRRKT Approach (pronounced "cor-rect"; Coley, 2024) expanding bell hooks' *all about love* (hooks, 2000) to leverage love as a foundational principle for justice in innovation. In 2024, Coley introduced the CCRRKT Approach framework as a tool for revisioning how engineers address social injustices within technical innovation. This framework encourages engineers to develop empathy and prioritize community needs in their work. bell hooks defines love as "the will to extend oneself for the purpose of nurturing one's own or another's spiritual growth" (2000). This ethos of love is crucial for engineers working towards a more equitable society, as it emphasizes the importance of intention and action in creating solutions that genuinely serve diverse communities. Ruha Benjamin's (2022) work on "viral justice" adds that naming positive constructs—like love and empathy—within technical fields can reshape these environments, urging professionals to cultivate relationships rooted in care rather than mere functionality. The CCRRKT Approach situates hooks' love ingredients and contextualizes them with questions centering how Care (C) (What is prioritized?), Commitment (C) (*What is invested in in action? What is stood for?*), Respect (R) (*How will people, society and the planet be treated? Are any of these devalued and/or neglected in the process? How will interactions, products, technologies leave people feeling? In what state will it leave the planet?*), Responsibility (R) (*What will there be accountability for?*), Knowledge (K) (*What knowledge counts? Have Indigenous knowledges been valued and integrated? What assumptions have been made?*), and Trust (T) (*Will the process be operated with integrity? Will there be transparent and clear communications?*) each serve to inform the success of an innovation.

As an example of the sociotechnical aspects students experienced during the study abroad in Amsterdam, the team explored how the city's underground trash system serves as a model for sociotechnical integration. Designed to minimize waste exposure, prevent vermin access, and keep streets clean, this innovation transcended mere functionality. For the students, it demonstrated how solutions can meet both environmental and social needs, a realization that parallels hooks' (2000) vision of love as a binding force that seeks holistic well-being. The study abroad research project revealed that students, particularly those from marginalized backgrounds, often feel isolated by traditional engineering curricula that fail to reflect their lived experiences or address issues affecting their communities. It proved both enlightening and empowering for students to see the impact of comprehensive considerations informing innovation such as that observed at the Floating Farm, which leveraged a system of circularity. This insight aligns with McCloskey's (2020) argument for degrowth and sustainability, urging the field to adopt educational practices that emphasize ethical responsibilities over technical prowess. The CCRRKT framework addresses this gap by encouraging educators to view love, empathy, and justice as essential elements of engineering education, and in this work, has been adopted as the conceptual framework guiding our lens of analysis.

Starting with a team of five engineering PhD students and an engineering faculty member, the process of identifying five undergraduate students to hire in expansion of our team to conduct a sociotechnical research project will be described. We set out to design a tiered mentoring research project interrogating sociotechnical innovation to simultaneously consider the intersection of engineering, technology, equity, justice, and love. Our goal was to bring together engineering students from diverse identities, disciplines, and statuses to inform this investigation. This project aims to trace the deeper cultural beliefs, values, and norms that contribute to the shortcomings of engineering solutions over time in a way that enables us to refine the CCRRKT Approach to innovation while identifying opportunities for innovating through the lens of love in our engineering education. While the components of the CCRRKT Approach will be used to frame analysis of the greater research project, the framework is equally vital in grounding an ethos in the processes of the work, the people co-conducting it, and their relational dynamics and rapport.

Research Design

In our lab, we desired to embark on a tiered mentoring research project at the intersection of engineering, technology, equity, justice and love, where engineering students across various identities, disciplines and statuses came together to investigate the shortcomings of innovation. Specifically, the goal of our larger effort—the sociotechnical research project—would be to catalogue failed and/or compromised innovations over time in the form of a sociotechnical systems failure analysis that uncovers the deeper connections to cultural beliefs, values, norms and other critical implications for engineering education. We realized that we wanted to identify undergraduate engineers who were open to dissolving the imaginary boundaries of the social and technical to truly anchor the responsibility of engineering to people, society and the planet. To achieve this goal, we adopted an intentional recruitment and selection process that prioritized interdisciplinary collaboration and sociotechnical responsibility. Our approach explicitly challenged the traditional divide between the technical and the social, instead framing engineering as an inherently ethical and human-centered practice. Our aim was to build a team of undergraduate engineers who were willing to challenge conventional engineering paradigms and embrace the responsibility of engineering to people, society, and the planet. This effort was essentially a study (investigation of forming a team of engineering students to innovate together) embedded within a study (the sociotechnical systems failure analysis). For the purposes of this work, the study of our process of creating a team through an asset-based approach and the student experience of exploring the world through that lens will be presented.

Methodology

This work adopted a Participatory Action Research (PAR) (Winschiers-Theophilus, 2024) approach to understand the process and perceived value of intentionality in forming a team of engineers to address sociotechnical innovation. PAR methodologies emphasize collaborative knowledge production, reflexivity, and iterative action, ensuring that participants are not just subjects of the research but co-creators of the process itself (Galletta & Torre, 2019). This approach aligns with the study's goal of understanding how engineering students conceptualize team formation, values, and sociotechnical responsibility when given the opportunity to shape their own selection criteria. In PAR studies, participants are involved in all aspects of the research with a main goal of empowering the participants and raising their consciousness. While PAR studies have often been associated with amplifying experiences of the marginalized to position them as "architects of research rather than objects of study," in this study, the participants are graduate and undergraduate engineering students and a faculty member (Galletta & Torre, 2019). We wanted to create a parallel with engineering students being positioned as the architects of a process to identify their future teammates.

Defining this process involved several steps including determination of the application format, curation of the questions presented on the application, development of a rubric to evaluate the responses, and the processes of selection as there were two rounds of selection. The first round identified a set of candidates to be invited to interview. The second round identified those who would be invited to join the team from the interviewed candidates. These steps pushed the graduate students to critically reflect on what they valued and prioritized in selecting a teammate to do the proposed work. This meant challenging notions of engineering and what has typically been prioritized in associated selection processes (e.g., grade point average, status (year in program), engineering discipline, research interest alignment) when given the opportunity to craft their own vision and set of criteria. This process facilitated both an individual and collective consciousness exploration.

This study is distinct in that it was a study embedded within a study—a reflexive examination of team formation as both a process and a research subject. On one level, the research sought to understand how students critically engage with the selection of teammates for a sociotechnical research project. On another level, the research process itself provided insight into how values, identities, and disciplinary perspectives shape engineering collaboration.

Data collection

The doctoral students (*n*=5) in our lab led the design and execution of the selection process to form our expanded research team. The graduate students, representing a diverse team as shown in Table 1, were all pursuing doctoral studies in engineering education.

Table 1. Demographics of graduate student architects.

Gender		**Race / Ethnicity**			**Citizenship**		**Status**	
Men	Women	Black	Latinx	White	Domestic	International	1st year	Year 3+
3	2	2	2	1	3	2	2	3

Data collection for this study entailed documentation of all of the steps of the process and its associated artifacts (i.e., the conversations of the graduate students in deciding the application format). Such discussions presented opportunities for varying values and priorities to not only be introduced but reflected on critically with intentionality. The primary data for this project became the transcripts of meeting recordings, team correspondence emails, the instrument and rubric for selection, the profiles of the chosen candidates, and focus groups conversations with all of the students as a collective research team. Given that the undergraduate students became participants in the process after the hiring step, their demographics will be introduced in the *Unfolding Process as Results Section*.

Data Analysis

It is important that the approach to data analysis in this work capture how the research process itself evolved while also making sense of the emergent values and decisions shaping team selection. The following dynamic, co-created research process applied in this work are captured in six critical steps:

1) Reflexive documentation and decision making. In this step the team detailed records of all key decisions in the team formation process, including how criteria were established, how rubrics were refined, and how interview discussions evolved.

2) Thematic analysis of selection criteria and justifications: In this step the team examined how students prioritized certain values (e.g., collaboration, justice,

interdisciplinarity) in their teammate selection process. In this step a comparison of how initial selection criteria (before reviewing candidates) aligned or diverged from final selection decisions (after reviewing applications and conducting interviews). Lastly in this step, the key themes (e.g., ethical awareness, openness to sociotechnical thinking, etc.) in the rationale students used in justifying their choices were categorized.

3) Sociotechnical Mapping of Selected Candidates: In this step the team assessed how the composition of the final research team reflected sociotechnical values. It was also considered here whether the blind selection process contributed to a more diverse team and whether diversity (e.g., in thought, identity, and discipline) influenced sociotechnical innovation values and priorities.

4) Reflexive Group Discussions & Iterative Meaning-Making: In this step the team conducted group reflections to understand how the team's thinking evolved through the selection process. Guided reflection prompts (e.g., "What surprised you about the final team composition?" or "How did your understanding of sociotechnical innovation shift?") were often employed to catalyze thinking and discussion. The team was also intentional to identify moments of transformation, conflict, or alignment in our collective meaning-making process.

5) Comparative Analysis of Sociotechnical Frameworks: In this step the team compared student-driven selection criteria with existing sociotechnical education literature (Bucciarelli, 2008; Riley, 2017). They also assessed whether traditional engineering selection criteria (e.g., GPA, technical skills) were challenged or reinforced in the participatory process. It was at this point where the CCRRKT (Care, Commitment, Respect, Responsibility, Knowledge, Trust) Approach was introduced to provide an emerging framework to support student decision-making.

6) Iterative Refinement of the Process: In this step the team documented how criteria, methods, and approaches shifted over time. It was also important to identify **lessons learned** that could inform future participatory engineering research projects while also considering how this process could potentially be adapted and scaled for other engineering education or team-building contexts.

Our analysis recognizes that the research process is emergent and reflexive, meaning that as the students further engaged in participatory decision-making, they were not only selecting teammates but also shaping the criteria, values, and frameworks that define the research itself. This work is a beautiful experiment, hence our title JUST-US and enginovation, where engineers create an unknown process in hopes of challenging known pervasive processes that have resulted in failed or compromised innovations.

Unfolding Process as Results

Recruitment Strategy and Intentional Selection Design

The team formation process was structured as a tiered mentoring research project, wherein five graduate students and a faculty member collaboratively identified five undergraduate engineering students to join their research team. This selection process was intentionally asset-based rather than deficit-oriented, meaning that it sought to identify strengths, unique contributions, and interdisciplinary perspectives rather than relying on traditional exclusionary measures like GPA or prior research experience.

Recognizing the historical tendency of engineering education to emphasize technical skills while neglecting ethical, social, and cultural awareness (Riley, 2017), this research sought to redefine selection criteria to prioritize attributes that align with sociotechnical innovation. To accomplish this, the team designed a multi-stage recruitment and selection process that challenged conventional notions of merit and engineering competency.

Phase 1: Defining Selection Criteria and Application Process

The doctoral students in the research lab spearheaded the design and execution of the team formation process. Their first task was to determine the criteria and methods for evaluating applicants. Instead of defaulting to typical engineering selection metrics (e.g., technical skill, GPA, research alignment), the team engaged in critical discussions about what attributes actually matter in sociotechnical research and innovation. These discussions led to the following guiding principles:

- Openness to sociotechnical integration (OSI) – The ability to recognize and engage with both technical and social dimensions of engineering work.

- Ethical and justice-oriented thinking (EJOT) – A commitment to considering the broader impacts of technological advancements on society.

- Interdisciplinary collaboration (IC) – Willingness to work across different fields and perspectives.

- Critical reflection and adaptability (CRA) – Ability to question assumptions, iterate ideas, and refine approaches based on new insights.

- **Commitment to team values (CTV)** – Alignment with principles of respect, care, and responsibility in research.

With these guiding principles in mind, the team designed an application process that included open-ended essay questions. Applicants were asked to submit responses to five open-ended questions designed to assess their ability to think critically about sociotechnical issues. These questions were developed by the students. Each student had the opportunity to provide up to five questions that they believed to be critical in uncovering applicants' perspectives on the guiding principles above. In group discussion, we reviewed each question presented and had a down selection process to eliminate redundancies and questions not shared in significance to the group. Ultimately, each graduate student contributed one question to the collective set, and together, the questions came to touch across the guiding principles well. The resulting questions for the open-ended application were (where SE stands for short essay):

SE1. What role do you believe diversity, equity, and inclusion play in shaping the future of engineering (**addressing EJOT, CRA, CTV**)?

SE2. How are the voices of marginalized communities being included or excluded in the shaping of current sociotechnical innovations (**addressing OSI, EJOT**)?

SE3. Describe a time when you personally experienced an injustice related to some kind of technology use and explain how you responded to it (**addressing OSI, CRA, CTV**).

SE4. With all of the technological advancements in this day and age, what do you feel is missing? For whatever you believe is missing, what is your evidence that proves that it is in fact missing? If you don't feel like anything is missing, what evidence do you have to prove it's not missing? (**addressing IC, CRA, CTV**).

SE5. As an engineer how would you go about solving a problem that seemingly has no end and no right answer? (**addressing IC, CRA**).

A structured rubric was also created to evaluate responses based on clarity of thought, depth of engagement with sociotechnical issues, and alignment with the team's research goals. This rubric ensured that selections were values-driven rather than status-driven. It is important to note that the essay responses were reviewed blindly by the graduate students. The only information that the graduate students had related to the applicants through the first round was their essay responses.

A recruitment flyer (see Figure 1) was distributed across engineering undergraduates at the host institution. A total of 79 engineering undergraduates applied for the research experience in sociotechnical innovation.

Phase 2: Application Review and Blind Evaluation
Once applications were received, the doctoral students conducted a blind review process to minimize bias. Identifying information was removed so that applicants were evaluated solely on their essay responses rather than their names, backgrounds, or affiliations. This removal was done by the PI, and as a result, the PI did not include any ratings in the selection process to mitigate the introduction of bias. in the selection process. Each doctoral student independently selected their top 10 candidates based on the rubric applied to the applicants' essay responses. A collective ranking process was then conducted to identify the highest-rated candidates for the next phase. This approach was particularly important in challenging meritocratic assumptions in engineering selection processes. The blind review helped ensure that equity and inclusion were organically built into the process, resulting in a final candidate pool that was both highly diverse and representative of different experiences, disciplines, and perspectives.

Phase 3: Interviews and Interactive Team Conversations
Following the application review, selected candidates were invited to participate in a face-to-face Zoom interview with the graduate student mentors and the faculty member. These interviews were recorded so that in times when the entire group was unable to attend the interview, team members could still have access to the conversation and be positioned to enter and contribute to the team review discussions. This phase was deliberately structured as a conversation rather than an interrogation, ensuring that candidates had the opportunity to express their ideas freely and engage in meaningful discussions about sociotechnical innovation. Additionally, to prepare for the interviews, the entire team was responsible for reading each candidates' essay

responses to be able to come into the conversation informed of their perspectives and insights. Rather than employ traditional interview questions focused on qualifications and past experience, these interviews were open-ended and customized to the student, encouraging candidates to engage in dialogue about engineering's social responsibilities. Candidates were assessed on their ability to reflect on complex sociotechnical problems, their willingness to challenge conventional engineering paradigms, and their alignment with the project's justice-oriented approach. The face-to-face component proved to be particularly valuable, as students emphasized that interpersonal dynamics and communication styles were key considerations in selecting a teammate. This insight reinforced the importance of human-centered approaches in engineering education and research.

Phase 4: Final Selection and Team Formation
After the interview process, the final five undergraduate students were selected using a rubric-based consensus approach (see **Table 2**). The graduate student mentors collectively reviewed interview insights, re-evaluated application responses, and mapped each candidate's strengths to the overall goals of the research team.

Table 2. Demographics of selected undergraduate student participants.

Gender		**Race / Ethnicity**					**Citizenship**		**Status**	
Men	Women	Asian	Indian Asian	Woman of Color	Mixed Race	Arab American	Domestic	International	1st or 2nd year	Year 3+
2	3	1	1	1	1	1	4	1	2	3

**Race and ethnicity are listed in the words as described by the applicants themselves.*

A particularly notable outcome of this process was that post-revealed identities resulted in a highly diverse team, demonstrating that meritocratic assumptions in engineering often obscure rather than enhance diversity. The final team composition (see **Table 2**) reflected varied perspectives, disciplines, and lived experiences, reinforcing the need for intentionality in forming equitable and justice-oriented engineering teams.

Phase 5: Early Research Engagement and Meaning-Making
Once the team was formed, the research process immediately transitioned into group reflections, introductory exercises, and meaning-making discussions to establish a shared understanding of sociotechnical innovation. The undergraduate students immediately shifted into team member roles, and together, we engaged in:

- Historical and contemporary failure case studies to uncover patterns in engineering shortcomings.

- Sociotechnical mapping exercises to explore systemic biases, cultural assumptions, and power structures in technological design.
- Collaborative discussions and reflective writing to articulate how engineering education can be reimagined to better serve society.
- Co-designing methods for documenting and analyzing innovation failures.

This phase allowed the undergraduate students to become active participants in shaping the research, rather than passive recipients of a pre-defined research agenda.

Discussion and Reflections on the Research Process

The JUST-US experiment offers a transformative reimagining of engineering education, team formation, and innovation through a justice-centered, humanistic lens. Across the integrated reflections of undergraduate and graduate participants, a powerful, collective narrative emerges: traditional engineering cultures, often steeped in technical isolationism and meritocratic assumptions, must be disrupted and rebuilt around relationality, sociotechnical responsibility, and love. Through intentional design, applicant selection, and the integration of the CCRRKT framework—Care, Commitment, Respect, Responsibility, Knowledge, and Trust—this project challenged the epistemic foundations of engineering education and illuminates new possibilities for cultivating engineers equipped to serve a complex, interconnected world.

Central to this work was the reframing of "merit." Rather than defaulting to traditional metrics such as GPA, technical accolades, or research pedigree, the graduate student team intentionally prioritized critical reflection, justice-oriented thinking, interdisciplinary openness, and sociotechnical awareness in the undergraduate selection process. This choice alone challenged the longstanding assumptions of what constitutes engineering excellence. By designing open-ended, socially rooted essay questions and conducting conversational interviews, the team intentionally created space for applicants to engage authentically, inviting vulnerability, critical agency, and holistic thinking into the evaluation process. As several reflections emphasized, this redefinition of merit organically produced a highly diverse team across race, gender, nationality, and disciplinary background—without relying on identity quotas. Diversity emerged not as a performative goal but as a natural outcome of centering justice, empathy, and relationality in engineering evaluation.

Additionally, this process pushed the graduate students to weigh the values and questions that mattered most and to be able to recognize when these ideals were expressed in the applicants. Through this process, the team identified five undergraduate students to join our team in a quest for deeper sociotechnical understanding. We believe this work evolved as a beautiful, student driven process of identifying engineers that together innovate innovation in a way that can be translated and/or modeled to other contexts.

The participatory nature of this research revealed several key insights about engineering education and team formation:

- **Intentionality matters** – When given the opportunity to shape their own selection process, students prioritized values like collaboration, justice, and adaptability over rigid technical qualifications.

- **Face-to-face interactions deepen understanding** – The interview process illuminated the importance of communication styles and interpersonal dynamics in team selection. Students weighed face-to-face communication as a critical component in identifying a potential teammate.

- **Blinded selection promotes equity** – The final team's diversity suggests that removing traditional selection biases (e.g., GPA, prior experience) can lead to stronger and more inclusive research teams. Post-revealed identities resulted in a team of diverse perspectives, trajectories, and experiences.

The participatory nature of the recruitment process also reinforced the agency of both graduate and undergraduate participants. Graduate students, often marginalized from decision-making in academic hierarchies, were entrusted as co-creators of the research environment. Undergraduate students, typically evaluated primarily on technical prowess, were recognized as whole individuals—selected for their lived experiences, ethical commitments, and sociotechnical insight as much as their technical abilities. As hooks (2000) argues, genuine love necessitates extending oneself for another's growth; here, the recruitment design itself became an act of love, fostering the conditions for mutual flourishing across educational levels.

Reflections also highlight a critical theme: engineering education's traditional severance of the technical from the social is not only insufficient but ethically dangerous. A sentiment echoed across the students was the notion that technical objectivity has often been misconstrued as emotional sterility—excluding empathy, relational accountability, and human impact from the design process. In line with Benjamin's (2022) notion of "viral justice," the project's small, deliberate interventions—inviting authentic reflection, centering lived experience, prioritizing love—serve as potent acts of resistance against a system that otherwise normalizes harm under the guise of neutrality. Students recognized that engineering must no longer be conceptualized merely as solving technical problems efficiently; it must be re-envisioned as a communal, ethical endeavor requiring care for people, society, and the planet. By documenting the process of creating a research team, this study not only investigated how engineers conceptualize sociotechnical innovation but also models an alternative approach to engineering team formation—one that can be adapted in various institutional and industry contexts.

Historically, engineering has treated social and technical domains as separate. This approach, as Ruha Benjamin (2022) argues, fails to account for the ethical dimensions of engineering. bell hooks' assertion that love requires intention and action (2000) further serves as a critique of the discipline’s detachment from social accountability. The rigid compartmentalization of "technical" work in engineering stifles empathy and limits innovation, reinforcing Beckert's (2015) critique that the industrial focus on technical growth often overlooks ethical concerns.

Engineering curricula often emphasize technical skills over socio-ethical responsibilities, which reinforces the false divide between these realms. To produce engineers capable of empathy-driven innovation, educational institutions must integrate social justice into engineering curricula. This transformation could foster professionals who understand the intersections of love, justice, and technical prowess. Hickel (2020) describes the National Academy of Engineers to envision engineers as change agents but realizing this requires embedding love as a foundational ethic within educational frameworks.

Tiered mentorship emerged as another vital innovation of the JUST-US project. By pairing graduate mentors with undergraduate mentees within a shared justice framework, the team catalyzed relationships grounded not in hierarchy but in mutual growth, empathy, and collective purpose. Importantly, the reflections reveal how participants' positionalities—across race, gender, and citizenship—influenced how they experienced this process, which is significant when considering the institutional context of the host institution is a Hispanic Serving Institution (HSI) in a highly politicized region of the U.S. Domestic undergraduate women of color emphasized the rare and affirming experience of being valued not just for technical skills but for their full humanity. International graduate students reflected on the resonance between sociotechnical justice and their lived awareness of global inequities. White students, both undergraduate and graduate, described a critical unlearning of inherited assumptions about engineering's neutrality and objectivity. Across differences, students expressed a shared realization: that traditional models of engineering education had failed to adequately prepare them to innovate responsibly—and that justice-centered frameworks like the CCRRKT Approach offered a more expansive, ethical vision.

This relational dynamic powerfully actualized Kimmerer’s (2013) call for knowledge-sharing rooted in reciprocity and mutual respect, rather than extraction or gatekeeping. Rather than flattening difference, the JUST-US project illuminated how embracing diverse experiences and perspectives strengthens collective problem-solving—a direct counterpoint to the growing sociopolitical rhetoric that positions diversity, equity, and inclusion as distractions from "real" scientific and engineering pursuits. In fact, the findings of this project suggest the opposite: sociotechnical excellence depends upon the full inclusion of diverse ways of knowing, caring, and innovating.

The implications of the JUST-US experiment are expansive. For engineering education, it demands a structural shift: justice, empathy, and sociotechnical integration must be woven into curricula, recruitment, and evaluation—not as afterthoughts, but as foundations. Faculty must be trained and incentivized to foster relational, justice-centered environments; admissions and hiring committees must rethink what constitutes merit; and students must be invited, from the outset, to recognize their agency and ethical responsibility within technological systems. As hooks (2000) reminds us, love is a willful choice, an act of responsibility and devotion. Engineering education, if it is to meet the challenges of the twenty-first century, must choose love—not sentimentality, but love as an ethic of care, a political stance, and a foundation for innovation.

The JUST-US project does more than critique existing engineering norms—it offers a living blueprint for a future where engineers are not only technically adept but also ethically attuned, relationally grounded, and justice-driven. This work is novel in that it was graduate-student led, with an emphasis on collaborative mentorship and values-driven selection. It shows that when students are trusted, when they are invited to lead with love and responsibility, they rise—redefining engineering not just as a technical enterprise, but as a profound act of communal care. The process itself serves as a model for reimagining how engineering students can be identified and mentored to prioritize responsibility, justice, and impact in their work. Especially at a time when efforts to advance diversity and equity are being politically maligned, the experiences and outcomes of this project affirm that cultivating justice, relationality, and love in engineering is not a luxury; it is an ethical necessity for the future of the profession. The imposition on current freedoms coupled with the visibility of big tech in the sociopolitical conversation amplifies the importance of ethical innovation. By creating space for undergraduate engineers to contribute meaningfully to the research process, we applied an adaptable framework for fostering sociotechnical awareness in engineering education. This student-driven model of inquiry has the potential to be replicated and adapted in diverse institutional and industry contexts, reshaping how engineers are trained and how engineering work is conceptualized.

Conclusion

In an era where diversity, equity, and inclusion in science and engineering are increasingly politicized and marginalized, the JUST-US experiment stands as a resounding affirmation of their essential role in advancing ethical, sustainable innovation. By centering love, justice, and relational accountability through the CCRRKT Approach framework, this project offers a bold alternative to the technical isolationism and meritocratic hierarchies that have historically defined engineering education. The experiences and reflections of students across diverse identities powerfully demonstrate that sociotechnical integration is not a distraction from engineering excellence—it is its very foundation. As engineering faces the urgent demands of the twenty-first century, from climate crisis to technological inequity, the lessons of JUST-US offer a blueprint for cultivating a new generation of engineers who lead not only with technical prowess but with care, commitment, and responsibility toward humanity and the planet. In the future we envision and are working toward, justice is not an add-on to engineering; it is the heart of engineering's highest calling.

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