Care and Liberation in Creating a Student-Led Public Interest Technology Clinic

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Abstract—**The emerging field of Public Interest Technology contains the seeds for an engineering practice that embodies the ethic of care and undergraduate engineering educational experiences in the mold of liberatory education. We realized these opportunities by creating an undergraduate, student-led public interest technology clinic. Using autoethnography, we reflect on our effort to create the clinic and find that we prioritized emotions and relationships, embraced slowness and deliberation, and claimed student ownership. These practices define public interest technology and redefine engineering in ways centering care and equity, which enabled us to create the inclusive and effective engineering and public interest technology educational experiences we wanted for ourselves.**

Keywords—public interest technology, engineering education, ethic of care, liberatory education, autoethnography, student-led learning

I. INTRODUCTION

In 2019, we created an undergraduate, student-led public interest technology clinic at Olin College of Engineering. We named it "PInT." We were inspired by the public interest technology (PIT) movement and its forebear, public interest law, which was specifically enhanced by the American clinical education movement of the 1960s [27]. We wanted to apply our technical skills to solve public problems and chart an engineering career path that is deeply responsible to communities and stakeholders and to a more socially just world. This paper is the story of how our experiences creating PInT helped us realize opportunities for centering care and equity while learning, practicing, and actualizing public interest technology.

A. Public Interest Technology

"Public interest technology refers to the study and application of technology expertise to advance the public interest/generate public benefits/promote the public good" [13]. PIT, especially through the advocacy of the Public Interest Technology University Network (PIT-UN), represents a community of practice that prioritizes the common good (as compared to private or commercial interests) and endeavors to integrate technology and policy to achieve public benefits and minimize public harms. Public interest technologists are those who exemplify the ideal of PIT work in their careers, and can include engineers, policy professionals, and other professionals and citizens.

B. Culture of Disengagement in Engineering

In our experience, PIT offers a response to the "culture of disengagement in engineering" [4], which develops during undergraduate engineering education. This represents "a constellation of beliefs, meanings, and practices that frame the way profession members conceptualize their professional responsibility to the public" [4, p. 47]. Specifically and problematically, this appears to inculcate a disengagement between public welfare and the practice of engineering. The pillars of this culture are: the ideology of depoliticization, which frames any "non-technical" concerns such as public welfare as irrelevant to "real" engineering work; the technical/social dualism, which devalues "social" competencies such as those related to public welfare; and the meritocratic ideology, which frames existing social structures as fair and just [4, p. 48]. Others have identified such dynamics and dualisms in engineering [16][25][26].

Real world engineering demands dealing with the messiness of the real world, including its politics and other socio-cultural complexities—it looks more like public interest technology— and undergraduate engineering education should re-engage with those aspects of the practice [6]. The "ethic of care" and "liberatory pedagogy," in which professors "relinquish" some of their power to students so that they can more fully engage with context, inequity, and uncertainty, and connect technical work to their own lives and the lives of those around them, offer models for meeting this need [24][25]. In reflecting on our efforts to create PInT, we found that we had developed some of these practices by prioritizing emotion and relationships,

embracing slowness and deliberation, and claiming student ownership.

II. METHODS

We are four women studying undergraduate engineering (Shreya, Sam, Ruby, and Emma) and a male faculty advisor (Erhardt). In this paper, we use autoethnography (AE) to capture our stories as students creating PInT and analyze them using thematic coding.

A. Autoethnography in Engineering Education Research

"Autoethnography is an approach to research and writing that seeks to describe and systematically analyze (graphy) personal experience (auto) in order to understand cultural experience (ethno)" [15]. "Autoethnographers use personal stories as windows to the world, through which they interpret how their selves are connected to their sociocultural contexts and how the contexts give meanings to their experiences and perspectives" [7]. Collaborative autoethnography (CAE) brings together multiple researcher-participants in a dialogic approach to making meaning from autobiographical data and shared experiences, deepening the quality and enhancing the efficiency of the narrative and analytic processes while also building community amongst the collaborators [7].

While not widely employed as methods of data collection, analysis, and presentation, AE and CAE are present in STEM education research. Relevant examples include: an examination of the epistemological tensions among graduate students as engineering education researchers [11][10]; a description of the experience of a disabled scholar in engineering education research [9]; a proposal for an inclusive and reflexive approach to documenting the early stages of an informal programming school community [8]; records of student journeys in an experimental, semi-formal STEM education program [20]; an exploration of experiences of transgender and gender nonconforming students in undergraduate engineering [19]; a way to animate known factors that lead to underrepresentation of Black men in the IT field [3]; a description of the identity development of an early engineering education faculty member [21]; and a portrayal of personal-professional identity development in undergraduate engineering education [29].

The value of AE and CAE as interpretative methodologies derive from their embrace of the researchers' own identities and intersubjectivity with the people and contexts they are trying to understand. Research agendas are often autobiographical—Hugh Herr's work on biomechatronics exemplifies this truism in engineering [18]. AE is a way to honestly engage with the autobiographical aspects of studying the world, explicitly filtering phenomena through the first-hand emotional, psychological, social, and cultural experiences of the researcher.

CAE is particularly apt as an interpretative methodology in order to understand the value of an educational experience designing, running, and participating in one's own engineering education experiment. CAE allows us to document, express, and analyze our experiential learning journeys as founding organizers of PInT—an experiential learning experiment.

B. Data Collection and Analysis

Our approach started with each of us students individually writing our own reflective narratives from the prompts:

- How and why did I get involved in PInT?

- Who was I before PInT, and how do my personal identities relate to what I bring to PInT?

- What are my most significant memories from my involvement so far, and why were they significant to me? How have these memories affected who I am now?

We chose these questions with the goal of prompting reflection on identity development, memorable epiphanies, and stories that exemplified our involvement in PInT as founders, organizers, and participants. We shared our initial written narratives with each other via Google Docs, and offered written comments on each other's drafts, adding reflexive questions that probed for more elaboration or clarification.

Afterwards, we developed a coding rubric through affinity mapping followed by interactive discussions: first we talked about what we found in our own stories and identified similarities in others' stories. We then self-assigned to read and code another team member's reflection using the online collaborative whiteboard platform *Miro*, which became particularly advantageous when we then drew connections between codes to identify larger themes through discussion and iteration. We coded every narrative looking for these themes and used disjunctures in our coding to prompt further discussion and reflection.

We expanded our narratives with additional description and reflection as we considered the feedback from each other and deepened our own understanding of our personal experiences. We performed two iterations of coding and discussion until we stabilized the coding across the different authors and narratives. Each code was assigned a definition through the creation of a codebook, from which we extracted larger themes. Three meta-themes—Prioritizing Emotion and Relationships, Embracing Slowness and Deliberation, and Claiming Student Ownership—were selected as the most valuable insights from our autoethnographies and are used to organize our analysis in this paper.

C. Ethical Considerations

The focus of this paper is on the student learning experience, so those of us who are students are the subjects of the autoethnographies. The professor served to guide the research and writing process. We are aware of the power differential between our institutional positions and also in our roles in the research process. As [14] notes in her own AE work, we must consider "relational ethics" as central to our research and writing process. We address our power differential by following a few of her recommendations, which also helps address some of the broader relational ethical tensions involved in CAE: we came up with strategies that allowed us to write privately and discuss our narratives together without our professor; any shared stories were held in confidence until there was consensus that we could make them public; and we "created opportunities to change our minds, and to add to or delete" from our stories [14].

Because AE often implicates other people pertinent to our personal stories as we try to tell them, we agreed to reserve disclosure to those experiences that have already been made public or to discuss our individual draft stories with implicated individuals before we shared them with the rest of the authors for analysis and synthesis, allowing those individuals to add or delete anything from those stories. These checks were made again if narratives were expanded during rounds of discussion and coding.

III. INSTITUTIONAL CONTEXT

A. Olin College of Engineering

The autoethnographies in this paper are best contextualized by first discussing our school, Franklin W. Olin College of Engineering, and the key components of our learning environment that allowed PIT engagement to thrive on our campus. Fundamentally, Olin College is a small, undergraduate-only engineering community with 350 students total, and a mission "to educate the next generation of innovators who want to better the world" [32]. This mission is put into practice through a hands-on, project-based curriculum where engineering skills are applied to real world scenarios.

Olin College began with a "partner year" in which 30 recent high school graduates spent a year co-creating the curriculum and campus culture that they would experience alongside their peers, faculty, and staff. The resulting culture at Olin today is one of experimentation, collaboration, and care. At its founding, Olin made a commitment to include a 50% female gender balance [30]. Academic courses at Olin are constantly changing, oftentimes as a course is being taught, because faculty are expected to take student feedback into account at the end of a semester and usually solicit feedback throughout the semester as well. These feedback systems encourage faculty to experiment and enable students to be codesigners of their own education. Student empowerment at Olin extends beyond the classroom to an institutional level as well. Community feedback sessions and frequent "Town Hall" update events with Olin's President, serve to increase the institution's transparency and provide levers for students to create institutional change. Lastly, Olin College's small community is tight-knit and shares a core set of values, documented in the student body's Honor Code [31] and practiced by students, faculty, and staff. These values center care for each other.

B. PInT: a Public Interest Technology Group at Olin

In fall 2018, a small group of students began meeting weekly to discuss civic technology with Erhardt, who had just joined the faculty. The group, initially called Civic Tech Posse (CTP), shared readings and discussed potential modes for change. Going into spring 2019, a subset of the CTP students, three of whom are authors on this paper, decided it was worth taking action beyond reading and discussion. They formed a second group with Erhardt to create a "Public Interest Tech Clinic" that would work to advance the emerging field of public interest technology. We experimented with and designed a variety of programs that could facilitate public interest technology work for undergraduate engineering students like us. We co-wrote and won a grant from the PIT-UN to launch our clinic and programs in fall 2019, calling our effort "PInT."

It is part of Olin's culture and mission to empower students to "Do Something:" to be able to create the change they want to see in the world and to set things right when they are wrong. PIT is a useful and powerful framework for acting on this mission at a large scale. Over the 2019–20 academic year, PInT introduced PIT to members of the Olin community in a variety of ways. We grew tremendously in our presence and impact on campus in that first year, working on consulting projects with community partners, hosting PIT-focused events, running a series of peer to peer workshops referred to as "skill-shares," and even designing and operating a student-driven PIT summer fellowship program. The response to our efforts has made it clear that PIT aligns with the ideals, desired skills, and identities of many Oliners. Moreover, creating and participating in PInT has been personally meaningful and valuable as our autoethnographies indicate.

IV. WHO ARE WE?

Emma: I am currently a senior at Olin studying Engineering with Computing. Outside of my major, I have taken classes in the realms of social entrepreneurship, philosophy, and democracy. I discovered the people who would eventually cofound PInT during my sophomore year, at a time when I had grown some confidence in my engineering competency, and was looking for a way to engage with real problems and real people outside my own community. My role in PInT has primarily been to wear many hats, and figure out which hat is currently needed. I was a co-creator during PInT's founding, and have worked primarily on establishing PInT's culture of care and launching PInT's consulting clinic and skill-share program. Beyond that, I planned meetings, participated in PIT conferences and events, hired a project coordinator, tinkered with our branding/media, and recruited new PInT members from the dining hall.

Erhardt: I am an assistant professor of social and computer science at Olin. I came to public interest technology through civic technology, a field in which I have been researching and designing for many years. Through my PhD research on evaluating civic technology design in terms of citizen empowerment, I came to believe that all technologists needed to recognize the public and civic responsibilities of their work. I wanted to teach at Olin in order to help undergraduate engineering students find that consciousness. In my first year, I organized students to read about civic technology and worked with them to convert their interests into new learning opportunities. Simultaneously, I marshaled Olin's commitment to join the PIT-UN as a founding member and became Olin's designee to the network. I'm proud to have helped create PInT and continue to serve as a faculty advisor, providing the students who run it as much intellectual, administrative, and practical support as they want and need.

Ruby: I am a junior at Olin studying Mechanical Engineering and Business and Finance. I have always known that I want to do work with social, civic, and environmental impact, and spent my adolescence creating and seeking experiences where I could learn what it takes to make the world a better place. This goal led me to adventures in food systems and food security, sustainability and clean energy, feminism and female leadership, and the intersection of engineering, business, and social impact, all through the lens of growing up in Toronto

and Boston. I also spent two summers before Olin working with a corporate innovation team where I was trained in human-centered design methodology, which I applied to my work and taught to others at the company. I joined PInT and the leadership team within my first few weeks at Olin; I saw it as a platform to combine my experiences with engineering. Since then I have been the project manager of a clinic sub-team working with a non-profit, the student budget manager, an author of PInT's strategic plan, and a coordinator of the summer fellowship with Sam. These roles have helped me develop my understanding of public interest technology and create PIT opportunities for my peers.

Sam: I am a junior studying Computing and Design at Olin. I joined Erhardt's "Civic Tech Posse" reading group, a precursor to PInT, in the fall of 2018. I didn't know what "civic technology" meant, except that it reminded me of some research papers I had read and enjoyed. I saw myself as a "technical person" who "used real engineering to help real people." Olin emphasizes engineering ethics, action ("Do Something"), and engagement with real-world stakeholders, and I was invested in these values. My personal goals were connected to using specifically engineering skills to help improve the world, which has now shifted in various ways as I have learned more. Within PInT, I've served in a variety of roles, including co-creating our consulting clinic, website, norms and code of conduct; creating and directing the fellowship with Ruby, working with a few consulting clinic teams, and presenting at the PIT-UN Undergraduate Informatics Education Conference.

Shreya: I'm a current junior at Olin studying Engineering with Computing and joined PInT through Erhardt's co-curricular in Spring 2019. I joined PInT with little idea of what public interest technology was, simply craving an affirming space where I could leverage my technical skills to help people and create tangible impact. I have been part of the core leadership team for over a year now, and have contributed to a number of different efforts, including starting the clinic, leading various skill-shares (one on project management and one on examining what "doing good in the world" really means), working on a couple clinic teams, presenting at the PIT-UN Undergraduate Informatics Education Conference in March 2020, and helping write PInT's strategic plan.

V. FINDINGS

A. Prioritizing Emotions and Relationships

Across our reflections, we noted an active and frequent prioritization of emotional presence and wellbeing within PInT. We each described spaces other than PInT that exemplify situations that are almost the opposite, then drew direct comparisons to moments during PInT's founding. We will share three stories that illustrate this theme: a practice of checking in with each other at team meetings, a reflective deep listening exercise, and changes made in response to a letter from Emma to the other organizers.

Before PInT, all four organizers described "needing a space like PInT to exist." Emma described this feeling after two years contributing to Olin's student government and other campus initiatives:

Emma: I had spent two years serving in Olin's student government, and participated in campus-building initiatives advertised as chances to co-design Olin's future. In reality, these experiences relegated me to executing creative visions that I didn't get to contribute to or see the impact of. I had poured most of my extracurricular time into helping Olin, but it had stopped feeling meaningful, because my work did not feel particularly needed, and I didn't have much agency over what I was doing. I was burnt out, but stubbornly, still wanted to Do Something.

Shreya identified her experience leading her male-dominated robotics team as a source of motivation for wanting to center emotion in technical spaces.

Shreya: For example, while I was the captain of my robotics team, I was the designated lead of the non-technical aspects (the more "feminine" aspects, like event-planning, social media, etc.), and was consistently undervalued for that work. I would write essays and create videos for award applications, without ever being thanked for doing that or asked if I wanted to do that. This was coupled with my technical expertise or desire to grow technically being consistently undervalued. (One of my male mentors once gave me an hour-long lesson on the Pythagorean theorem, despite me never once asking for that). In this way, my robotics team reduced my function to the "non-robot stuff," effectively dehumanizing me.

For Sam, recognizing the need for PInT at Olin and creating caring communities within tech comes from experiences of being recognized and validated in technical spaces, and then losing some of that respect because of experiences with transmisogyny.

Sam: My first experiences in technical roles and spaces were pretty close to automatically uplifting. I was often accepted and welcomed into technical spaces without ever really trying to fit in. There was plenty of toxic masculinity/bro-culture, and I didn't fit into that, but my presence and perceived identity were honored. When I came out as a transfeminine queer person and started showing up to the same spaces, it was really striking (and SO obvious) that I was not welcome anymore in the same way. … It's pretty clear to me now that the shift I noticed is a big part of the reason why I crave affirming spaces. I care about setting norms that radically uplift people who have experience being pushed out of spaces they're excited about because I watched it happen to me.

The lack of humanity we experienced inspired us to make PInT an engineering space centered around valuing others for their technical and non-technical contributions, including their emotions, thoughts, opinions, and identities. PInT represents a series of intentional choices to foster this culture of care. Sam outlines one example:

Sam: We held several reflective group activities where all PInT members were invited to create our culture together. That meant that everyone who was part of our

community had a say. It was democratic in a way that went beyond what I've experienced in other spaces—we weren't just providing hypothetical avenues for input or control. Creating the norms, boundaries and mutual expectations and commitments (the community itself) was a core part of participating, for everyone!

Shreya shares another example of these norms that stands out to her:

> **Shreya:** We start every meeting with a check-in, because we recognize that our members are not brains in boxes but rather human beings with feelings who are dealing with many things at once. In check-ins, everyone is invited to share how they're feeling—not just about PInT, but about life in general—while the rest of the team listens and responds supportively. PInT members often share what they're struggling with, excited for, or confused about.

To improve our ability to truly hear each other and the stakeholders we work with, we held a deep listening skill-share. Deep listening is an activity that walks participants through the experience of non-active, complete listening to another person, hearing that person out until they are finished sharing without offering *any* of your own thoughts [1]. At a PInT meeting, we gathered in pairs on the lawn in the middle of campus and practiced deep listening together, sharing our experiences with moments where we'd faced ethical quandaries. Shreya and Sam described feeling joy and safety throughout the experience and how these feelings enabled them to imagine PIT as an alternative to traditional engineering:

> **Sam:** Deep listening is significant to me because it made me picture a sort of alternate universe where engineering is a contemplative, iteratively reflective process. It filled me with questions. If I'm learning to solve needs for people, why has no one taught me to listen? At basically every hackathon I've been at, why was speed of implementation (regardless of effect) so much more important than mutual understanding of... anything except the technical logic of the software? … just the image of a couple dozen engineers sitting on grass making direct eye contact and asking each other questions made me wonder why the situation felt so surprising, which led me down many rabbit holes. Moments like deep listening forced me to imagine an alternate engineering culture, and I think of some of our work as building that culture from scratch.

> **Shreya:** It felt like there was something revolutionary to center the act of deep listening, especially since in most other engineering spaces I hadn't been listened to at all. I remember feeling a sense of safety, like my feelings were valued and welcomed. And I also took great joy from practicing listening to others; it was an act that made me feel humble and more connected to the people around me, which I see in contrast to the way that I had seen engineering being typically done—in isolation, or with people not really listening to one another but rather trying to one-up one another. Before PInT (and more broadly, the human-centered emphasis of Olin's curriculum), I never would've associated

deep listening as a skill in engineering, let alone a fundamental skill, because I had perceived engineering to be so divorced from people.

As we held more events and skill-shares, our workload as organizers sharply increased, and sometimes the work wasn't distributed according to our needs. Shreya and Emma articulate one example of how our listening practice facilitated honesty, appreciation, and, ultimately, change:

> **Emma:** As the oldest of the student-organizers, I started off feeling an aversion to asking for help, but soon realized that I had much to learn from my peers. I remember a period of time at the beginning of PInT when I felt like I was drowning in the number of small but tedious things that I felt responsible for. The other organizers had all taken mental health breaks at some point, or asked for help when they needed it, but I stubbornly refused. I didn't trust that someone in the team would step up if I stepped down, and this belief trapped me in a dilemma of my own making. In a moment of clarity, I wrote down my thoughts and feelings, and sent it to the leadership team, hoping that the other PInT organizers would know what to do with it. In this moment, I was vulnerable, finally letting go of my control, and trusting the team to act.

> **Shreya:** ...one of my most significant memories is of the letter that Emma sent the organizing team last fall to express how undervalued and underappreciated she felt. When I had been underappreciated and undervalued on my robotics team, my feelings were treated as inconsequential and insignificant. But in PInT, we thanked Emma for her letter and her emotional honesty and vulnerability and consciously made efforts to change the way we worked.

> **Emma:** Looking back, PInT leadership has been operating so differently, for so long, that this memory was hard to recall. I now value my mental health breaks as much as anyone else's, and make efforts to establish a culture in which asking for help is one of the best things we can do, to care for ourselves and each other.

In response to Emma's letter, we thanked her for her honesty and communication, and showed her that we care about her by changing our behavior. We reallocated tasks and scheduled meetings to reassess our working structure, adopted a new task management system, and established more regular check-ins.

B. Embracing Slowness and Deliberation

In each of our reflections, we discussed personally significant PInT experiences in which we discovered the value of acting slowly and deliberately. We each described having a tendency towards action when we first joined PInT and identified this tendency as an opposing force to slowness and deliberation. Below, we share three stories that illustrate what we learned when we instead took our time and thoroughly considered our actions: a consulting project experience in which we ultimately decided not to build the deliverable due to concerns of causing harm, an exercise for the organizing team to better understand each other, and a strategic plan writing process.

Before we became involved in PInT, many of us were not fully aware of the harm that engineering can create and scale, and instead perceived engineering as a tool purely for doing good in the world. This perception along with an intrinsic motivation to take action, or as the Olin community states, "Do Something," led us to embrace an action-oriented mindset. Each of our personal backgrounds had led us to develop a deep moral faith in engineering as a tool for good.

> **Emma**: My early experiences with biology research led me to perceive engineering as a mighty tool for solving technical problems, scaling up processes, and making things easier for people. Having recently developed software skills, I had newly acquired the power to wield this tool, and I couldn't wait to start using it to solve real problems for real people. I naively believed that the intentions of the beholder determined whether or not the tool could become a weapon.

> **Ruby:** My extensive previous experiences with teaching and applying human-centered design (HCD) oriented me towards thinking of engineering, if done in an HCD-focused way, as a tool for the "betterment of society."

> **Sam:** I came to Olin with contradictory ideas about what engineering was, what it did, and what it meant to me. I knew that I believed in the power of applied science and technology, in the bridge between many historic forms of knowledge.

> **Shreya:** My experience participating in a hackathon focused on using technology to prevent human trafficking made me feel like a superhero, and view computing as magic. My conception that technology could solve "big problems" was further reinforced by the fact that I could build a tool to solve a subproblem, and hypothetically repeat for all subproblems until, effectively, the big problem of human trafficking would be solved.

Blinded by the preconception of engineering as a tool for good, Shreya and Emma dove immediately into a high-impact project in the anti-human-trafficking space.

> **Shreya:** The project was basically designed for a tech-utopianist. At the surface, it seemed so simple and straightforward, so clearly good. We were to create a web scraper (which was also, to my satisfaction, an easy tool to show off) that would scrape escort ads for evidence of human trafficking in order to identify potential victims and rescue them more quickly. Thinking about the project gave me the same feeling of being a superhero as the anti-human-trafficking hackathon.

> **Emma:** I was alarmed by how long it took for us to realize that the project, with the best of intentions, could cause harm to the very people we wanted to help.

> **Shreya:** At first, we asked questions about how to keep this data secure, recognizing that we would be collecting very sensitive data. These questions felt like the kinds of questions I had been taught to ask when doing engineering for good—doing our due diligence to ensure that we didn't recklessly endanger people. But these questions were still centered around the technology itself, not the people, and assumed that the tool should be created. It was only when our questions expanded to include questions about who would be affected by the tool that I started to understand why it was so flawed. I felt appreciation that I had slowed down and taken the time to discuss the implications, rather than just acting.

> **Emma:** When we decided not to do the project, I was afraid of people viewing the project as a failure. In reality, the students on the team stuck with PInT and shared that this experience had educational value that they wanted to continue pursuing. PInT leadership did not want to hide or apologize for this project—they wanted to celebrate it, by sharing our story with the greater Olin community. This experience reminded me that PInT's projects are meant to be learning experiences. We're allowed to mess up, we can learn from our mistakes, and we can share this learning with others. I learned that it's ok to say no to a project that I don't feel comfortable doing. I learned to think more critically about the work that I choose to do, and I now make it a habit to ask myself a growing list of questions: Who could be affected by this project, and are they all represented in the design process? Who could be unintentionally harmed? Who is responsible for this project in the long term? How might working on this project affect my worldview, my identity, and my mental health?

We paused to ask critical questions and took the time to deliberate with others and each other before making decisions or moving forward. These steps were crucial to our final decision to not implement the project.

Applying slowness and deliberation within the organizing team led us to be more caring with one another as PInT grew from a small group of organizers to several dozen students. We will share two moments of slow deliberation in our work together as organizers, using tools that helped us to understand each other and our long-term plans.

> **Ruby:** We decided to create a 2x2 and put ourselves as points on the graph in order to visualize where each of us falls on the scale and spark conversation. We considered aspects of our individual approaches, like whether our first instinct is to think/discuss or do/decide, and our communication styles. I had never done an activity like that before, and I realized that my instinct to take action on a task and dive in as soon as possible is my instinct. Others approach problems differently, in equally valid ways. AND the fact that we each work through challenges in our own way makes us stronger as a team. Since that conversation, we've had moments where my instinct was to make a decision and move on, but because one or two other members of the leadership team prompted us to slow down and discuss the task/idea at hand in more depth, we

ultimately came to a more thorough decision that allowed us to move forward in a better way.

Now, after these experiences in which slowness and deliberation helped us steer towards making decisions with care, the way we conceptualize engineering and what it means to be a public interest technologist and leader have fundamentally changed. We applied these changes last spring by writing a strategic plan for PInT, prioritizing activities according to our abilities and working preferences as organizers and the stated learning goals of members of PInT. We shared the strategic plan with the whole team (all PInT members, not just the organizers) and gave them direct edit access to the document, and they shared their input. We are currently part-way through implementing our strategic plan, which will guide us through spring 2021. Importantly, the strategic plan was written entirely by us, the organizers, and the student members of PInT.

> **Ruby:** The strategic plan-writing process made me realize how much I have changed since joining PInT. Six months or a year before writing the strategic plan, I never would have been able to think critically about my work in that way. For someone who loves organization and efficiency, I have never been much of a beginning to end planner. I tend to think about my first step, dive into the work, and then figure out the rest as I go. Collaborating with other PInT leaders has taught me how to plan out a well thought out process and follow through, skills that make me a better leader and a better problem solver.

> **Emma:** Before PInT, my personal mission, which I wrote about in my Olin application, was to "use engineering to create a positive impact in the world." Now, my mission is to "design, implement, and address technology in a way that benefits minorities and actively minimizes harm." PInT, and the classes I've chosen in this space, have shifted my goal from strictly engineering to a multidisciplinary endeavor. The anti-human-trafficking project in particular led me to reframe the self-centered "create positive impact" to the more community-centered "minimize harm."

By practicing slowness and deliberation, we have made our processes more inclusive, distributing ownership and responsibility of the work among PInT members rather than having it reside in a single manager or set of decision-makers. In the next section, we will discuss how this has shifted some of the power dynamics we have come to expect.

C. Claiming Student Ownership

PInT's culture of student leadership and agency over decisions and direction is rooted in the larger Olin culture of student co-creation alongside faculty and staff. This foundation, where the school-wide expectation is that students take initiative and seek advice from those with more knowledge or experience when needed in order to "Do Something" of their own creation, grounds PInT and has allowed us to follow a similar model that defines our group culture of students doing most of the teaching and professors acting more as supportive advisors than as leaders. The following three stories demonstrate how this norm of PInT being student-led has resulted in a sense of

empowerment and allowed us to deconstruct traditional hierarchies, particularly around teacher-student dynamics, establish ownership over our work, and gain confidence in our leadership and decision-making.

Ruby talks about balancing the student-led aspect of PInT with asking for help when questions extend into areas outside of our expertise as students.

> **Ruby**: PInT's first design review served as a critical lesson for us as a leadership team and all members in PInT in learning to balance 'student-led'/'student run' and asking for help from those with the knowledge and wisdom to make our work better. There is so much value in the student-led environment we have created, the ownership leaders and members feel over the work we do, but it is important to remember that we are all still college students. Even though we are all on a different educational path and each bring something unique to the table, there are going to be times when we don't know the answer, and those moments are when it is most important to not be afraid to ask for help. In the past I've refrained from asking for help because I thought that I had to figure things out on my own to learn and grow, but I know that this sometimes holds me back. After sharing our sub-team's progress with professors and other community members, I was amazed by the suggestions and paths for getting unstuck that all came from asking the right questions to community members with more experience in PIT. For my team specifically, they pointed us to faculty and staff at Olin to contact, made suggestions for communication with our partner organization, and praised our progress to date. The direction and support provided new possibilities for next steps and renewed the team's energy for the project.

In this story, the team of PInT members saw that having agency as students includes recognizing and acknowledging when guidance is needed, and as a result they benefited from the nature of Olin's learning environment which supports this dynamic. In her reflection, Sam narrates how an interaction with Erhardt helped her put trust in herself, to overcome fears of being unqualified, and realize her goal of creating a care-centered experience for others.

> **Sam**: I remember feeling so deeply unprepared. I was terrified. At first, I kept on asking Erhardt before sending emails, and I remember a moment in the dining hall when he sort of paused halfway through answering a specific question about how to email a fellow. He said something like, 'Sam, it's your fellowship. You're the student directing it, you know what to do, you'll do fine.' I really didn't know what I was doing, but that was still fine. I remember getting emails from some students who read our process and felt welcomed into it, which is something I still come back to when I'm worried I'm not equipped to run a fellowship. I felt like the care that I (and everyone involved) took to go beyond compliance, equity, and inclusion was actually seen, and had a real effect on other people.

Sam's conversation with Erhardt represents a central component of PInT's student-led design; professors, staff, and other experts are there for support, but it is ultimately our responsibility to make the decisions about the thing we are creating. Shreya recalls how the level of project ownership that our mentors trusted us with defied her expectations:

> **Shreya**: My team consulted a number of professors throughout the semester to seek advice, including a professor at Wellesley who was literally an expert in technology-based interventions to human trafficking. All of these professors had more credentials and expertise than us, but none of them ever told us what to do or claimed that they knew what the "right" or "best" answer was. They trusted our expertise, and acted as guides instead, helping us find the answer we believed was best by asking us the questions they would be asking themselves. I had never been in an engineering environment where a professor told me that there was no "right answer" that would satisfy them. Even in all the project-based courses that I took that were theoretically more open-ended, there still seemed to be a minimal product needed, and deliberation on whether such a product should exist didn't seem to be satisfactory. The fact that any choice we made in the end would've been the right choice in our professor's eyes was revolutionary to me and leads me to imagine the engineering process as far more open-ended than I had previously conceived it.

Each of these stories captures a different aspect of our work in PInT, showing that this shifted trust, responsibility, and decision-making power to students across PInT's endeavors. This consistency is what makes PInT fully student-led and enables students to feel ownership over their work.

VI. DISCUSSION

A. Prioritizing Emotions and Relationships

In our stories, we described experiences before our involvement in PInT that are illustrative of the gendered nature of engineering, which orients engineering towards deprioritizing emotions. For example, we described experiences where we were shut out from technical spaces despite having every right to be there (in Shreya's case, as the leader of her mostly male robotics team, and in Sam's case, as someone who had previously been welcomed when she was perceived as a cisgender man). We also described experiences where our efforts and emotions were completely ignored or deprioritized, as in Shreya's case on her robotics team or in Emma's work in student government and other campus-wide initiatives. One dimension of the gendering of engineering is the historic exclusion of women within engineering [22]; however, the fact that these issues persist even in spaces that are gender-balanced suggest that the gendered nature of engineering extends further than simply a lack of inclusion of women. As [26, p. 22] puts it, "the problem of women's underrepresentation in engineering indicates deeper, more fundamental problems about the nature of the profession and of the engineering education enterprise."

Two hierarchical and gendered dualisms within engineering can be mapped onto our experiences to explain why our emotions were consistently invalidated and why this invalidation was gendered. [16] describes the technical/social dualism, or the separation between the technical work and "people" work, with the former being highly valued and the latter being devalued, despite both being necessary. In Emma and Shreya's cases, their "people" work was essential but completely unappreciated. Underlying the technical/social dualism, as [16] describes, is a distinction between "masculine instrumentalism" and "feminine expressiveness." The devaluation of work with "people" can contribute to the devaluation of people themselves and their emotions, centering technology rather than people and their needs. Although the second dualism, the abstract/concrete dualism, does not directly apply to our experiences, it is directly linked to the technical/social dualism. The undervaluing of the "people" aspects for being messier or less important than the technical aspects can be directly linked to the problematization of emotions within the abstract/concrete dualism as being complicated and not well aligned with reductionist approaches to problem solving.

In our findings, we discuss three stories connected to the *Prioritizing Emotion and Relationships* theme, which each represent an intentional welcoming of our emotions into the space and the work, or an active disruption of the traditional engineering norms described above. For instance, check-ins challenge the technical/social dualisms by inviting and even prioritizing emotion as part of the engineering process. We describe deliberately devoting time at the beginning of our meetings to check-ins, rather than using that time for other more "technical" processes. Furthermore, the allocation of time at the beginning of meetings normalizes check-ins as part of our other beginning-of-meeting rituals: updates, discussing technical issues, etc. In this way, we transform check-ins to be part of the "technical" process. The resulting effect is that PInT members' emotions and wellbeing are prioritized. This prioritization is reinforced and upheld through other traditions like our practice of editing our community values and norms together (mentioned in the *Claiming Student Ownership* theme). We prioritize emotions and relationships by placing our relationships with one another and individual wellbeing at equal or higher priority to the technical aspects and connecting emotions to our work, making our work inherently relational. In this way, we disrupt both the technical/social and abstract/concrete dualisms in addition to pushing against the culture of disengagement's ideology of meritocracy [4], creating a more caring experience in engineering education.

Four phases constitute the ethic of care: caring about, taking care of, caregiving, and care receiving [28]. Check-ins create space for others to express their needs, which is a fundamental first step to being able to care for someone; therefore, check-ins prompt an elevated awareness of opportunities to care for others and begin to operationalize the ethic of care and integrate it to transform engineering. Deep listening and Emma's letter are further operationalizations of the ethic of care. In both stories we can see the four phases of care. The inclusion of deep listening as a critical part of PInT, in addition to all the other norms we set around care, reflects an attentiveness to opportunities for care for others (covering the *caring about* phase). The deliberate focusing of one's attention on someone else within deep

listening and our reception of Emma's letter are examples of assuming the responsibility of caring for the other, covering the *taking care of* phase. Genuinely practicing deep listening and reflecting what one heard to the other and proactively making changes in response to Emma's letter are examples of *care-giving,* as in both cases, we met the other person's expressed need. Finally, in both cases, there was an opportunity for care to be *received*, through Emma's response to our changes and the speaker's clarification or validation of whether they were genuinely heard in the act of deep listening.

Deep listening, as an operationalization of care, presents a form of engineering that is more "contemplative [and] iteratively reflective" [1]. Shreya and Sam describe the space created by deep listening as the opposite of a traditional engineering space. For example, Sam evokes the stereotype of engineers being antisocial ([16] talks about this in terms of the teenage computer hacker/nerd stereotype), through her description of the surprising image of "a couple dozen engineers sitting on grass making direct eye contact and asking each other questions." Shreya goes further to describe how traditional engineering is "divorced from people" and generally does not foster an environment where people really listen to one another but rather "[try] to one-up one another." Sam and Shreya describe how centering truly and authentically listening to one another, an act of care, expanded engineering for them beyond its typical epistemologies and led to a more humanizing experience.

Prioritizing emotion and relationships helped us create a caring space for ourselves. We can draw a line between the stories in this theme and those in other themes to argue that learning how to care for one another and validating each other's emotions helps us become better engineers and better serve the public interest. [26] describes the ways an ethic of care approach could help transform engineering design processes:

> Furthermore, we argue that this framing of the engineering design process within the ethic of care also can uncover an inherent critique of the design process. An identification of "the" engineering design process implies that there is only a single way to proceed through these stages and leaves little room for creativity. The ethic of care approach illustrates that the engineering design process itself must be flexible and open to critique by the "cared for" whose needs are being addressed. [26, p. 28]

In our responses to Emma's letter, we gained experience being "flexible and open to critique by the 'cared for' whose needs are being addressed" to use the words of [26, p. 28]. We could then apply that orientation towards flexibility and openness to the anti-human trafficking clinic project we ultimately refused, gaining first-hand experience challenging the assumption that there is only "one" engineering design process. Rather than "bestowing" a solution upon the groups "receiving [our] care," we chose to "trust the words, authority, opinions, and traditions of the people who need care as they express them," to use the words of [26, p. 30] again. Taken in totality, our stories illustrate how, for us, the welcoming, validation, and prioritization of emotion and relationships allowed us to push against the harmful norms of engineering that we had

experienced in the past, and instead create an experience within engineering education that was more caring and *better*.

B. Embracing Slowness and Deliberation

In our findings, we discussed three moments when we as student leaders made decisions prioritizing contemplation, slowness, and deliberation that added to our learning experience and improved our ability to positively impact the world. Before joining PInT, all four of us experienced engineering ideologies that encouraged rapid work and suppressed forms of thinking not conducive to conventional industrial productivity. These experiences are typical of mainstream engineering education experiences [25], which place a focus on intense and rapid technical expertise and "progress" above other priorities. All of us saw engineering as a powerful tool to "advance social good" and "make the world better." These sentiments are ideals held by engineers, best exemplified by the National Academy of Engineering's Grand Challenges report [23][5], and stand at odds with the "disengagement" that undergraduate engineering educational programs engender in students [4].

In the three stories we share, we made deliberate interventions against entrenched mainstream engineering ideologies of positivism, depoliticization, and efficiency. Before these experiences, all four organizers recounted examples of the belief that our technical engineering skills would improve, fix and/or positively control the world. Emma's initial understanding of power dynamics in software, Ruby's early framing of Human-Centered Design as a tool for "betterment of society," Sam's early optimism about the nature of engineering, and Shreya's experience of a hackathon as proof that tech could solve the "big problems" in the world are examples of a reduced version of critical thinking. Our engineering education has not sufficiently taught critical thinking beyond the reason formand validity of specific implementation details (critical thinking in engineering, but not about engineering, to borrow [12]'s frame). They write that "engineers may have abundant logical thinking skills but no practice of thinking critically about problem framing, power relations within the profession, hegemonic epistemologies of the disciplines, or reproductive practices of engineering education. This leaves society with technologies that replicate power relations of the status quo" [12, p. 32]. The ignorance of the role of power in engineering is further exemplified through the ideology of depoliticization, one of the pillars of the culture of engineering [4].

In the first story, we share an example of this powerful belief in engineering as an inherent neutral good falling apart once under examination. At first, Emma and Shreya were excited to work on a project with the potential to have a major impact and protect victims of human trafficking. On its face, the project was technically feasible, and Emma and Shreya had to question their core assumptions about the nature of the project to see its flaws—they needed to reflect on what the positivist frames that underlie an engineer's presuppositions might exclude [12, p. 34]. Once Emma, Shreya and the rest of the students on the consulting team began to examine those presuppositions more deeply and consult experts, it became clear that the project would be harmful if implemented. It could have been used to track human trafficking victims *and* sex workers, and we would have no knowledge of what would happen next.

The "design refusal" [17] Emma and Shreya practiced in the anti-human-trafficking project resisted the mainstream engineering approach to critical thinking that can limit its practice to solving narrowly defined logic problems. As [12] write:

> When critical thinking is not limited to the logical ability to identify a faulty argument, but includes the reflective and reflexive practice of being ethically and socially responsive, critical thinking becomes not just a way of thinking but also a way of being.... Central to this new kind of situation critical is a focus on power relations, both in terms of how structures of power and structures of knowledge interrelate and in terms of how ethical and social responsibility relies on recognizing and resisting unjust power relations. [12, p. 32]

When we shifted our focus from critically thinking about the tool we were building to critically thinking about the power relations (between all the stakeholders: our partners, victims, voluntary sex workers, and ourselves) that we would be replicating we realized the harm our tool could cause. After implementing this project, we would have no control over how victims were treated by our partner organization, where the data collected by our tool would go, or who could unintentionally be endangered by identification (i.e. voluntary sex workers); in each of these ways, our work could have caused significant harm to already vulnerable people. In this case, the best way to prevent that harm was to not create the software—a solution that did not fit into our initial framing of the problem. [26] writes that engineers, rather than emphasize "solving problems," should ask who they are doing their work for, who their work will help, harm, or miss, and what forms of knowledge they could be missing. We found the best approach to this situation (refusal) by stepping out of engineering mindsets and instead embracing a slower and more deliberative process that viewed the technology we would build as inherently political, combatting the ideology of depoliticization.

This shift in reasoning is deeply connected to the ethic of care. A traditional mainstream engineering ethic might primarily suggest "The ethos of...being 'loyal to the client,' the client usually being defined as the organizations who retained the engineers' services, rather than as the public who eventually used the engineers' work" [24, p. 205]. We rejected that approach and practiced a care ethic that considered our needs, the needs of the people who could be affected (victims of human trafficking and sex workers), as well as organizational/ institutional needs. In this case, the potential harm to victims of human trafficking outweighed the needs of our partner organization and the perceived benefits of our tool. In the other two stories we share in this section, we practiced care for our own needs as student-engineers/public interest technologists, and our own organizational needs as the organizers of PInT.

In the second and third examples, we share how we learned to care for each other's needs and honor our various approaches to our organizing work as we plan for PInT's future. In considering each other as collaborators and practicing work that takes the form of community organizing within an engineering school, we found practices of reflection both necessary and deeply empowering. Being deliberative helped us become more caring by enabling us to understand "the epistemic assumptions underlying the work," and helped us adjust our actions to align with each other and towards "reflection-in-action (self-correction in the process of one's practice in order to alter the performance of power relations toward more socially just ends)" [12, p. 34].

Similarly, our strategic planning process represented an institutionalization of slow, deliberate consideration and planning. While a traditional approach to founding an engineering organization might suggest we "move fast and break things," we chose to pause and consider how to be most effective at our goals. Our strategic plan includes interventions and design practices intended to help us consider the power and knowledge relations at play in our work going forward. By planning our actions over the next few years in advance and structuring them in a strategic plan that can be passed on to future organizers, we hope to avoid the fast-moving tech approach that [2] describes as "Move Fast, Break People, and Call It Progress."

C. Claiming Student Ownership

Engineering traditionally encourages a practice of ceding power to superiors and consequently ceding responsibility and ownership. [25] describes how "Classical cases in engineering ethics (e.g., the Challenger disaster) highlight the problems of expected obedience, when engineers are asked not to think critically but to abdicate responsibility to management." In our findings, we share three moments when PInT's student-led culture resulted in a sense of empowerment that helped us claim ownership of our own educational experiences, embrace uncertainty, and gain confidence in our decision-making power.

Despite the experimental nature of Olin's educational experience, we had all internalized beliefs through "professional socialization" about expertise and traditional educational power dynamics prior to starting PInT [4], and instinctually applied them to the work we were doing. In the first two sentences of Sam's fellowship story, her word choice of "underprepared" reflected her feeling the pressure to be "qualified" in a technical space. Similarly, Shreya described the faculty as having "more credentials and expertise than us," and expected them to tell her what to do.

In each of our stories, professors with expertise and power refrained from making decisions for us, and instead used their experience to ask guiding questions. By doing so, they ceded their decision-making power to the students, and prompted us to think critically about our own responses to complex situations. Ruby reflects that receiving guidance from faculty during a design review "provided new possibilities for next steps and renewed the team's energy for the project." The team was given possible paths that they hadn't thought of before, and the students got to decide which path would work the best for them. Similarly, in the anti-human-trafficking story, Shreya relates that professors "trusted our expertise, and acted as guides… helping us find the answer we believed was best by asking us the questions they would be asking themselves." In both of these examples, students felt the power to decide how to proceed because they were driving the projects. The students were the experts on their own bandwidth, emotions, and values.

When we, the student organizers, had the power to make decisions, uncertainty sometimes held us back. This limitation is actually a shared experience among engineers: "An important part of affirming diverse experiences in the classroom that can be a stumbling block for engineers is the possibility of affirming multiple truths" [25, p. 152]. When Sam was tasked with creating Olin's first Public Interest Technology Fellowship program, she recalls "feeling so deeply unprepared. I was terrified." Sam looked to Erhardt for answers, validated emails with him before sending, and checked in throughout the process. However, expecting an answer implies that there is a singular solution, or sole authority on what is right. [25, p. 152] claims that "To consider uncertainty formally is to recognize with humility that there are limits to what we know." In response to Sam's uncertainty, Erhardt acknowledged and supported her feelings. Sam recognized and owned her own uncertainty, reflecting "I really didn't know what I was doing, but that was still fine." Ultimately, Sam's explicit uncertainty and humility about what a 'right' fellowship looks like led her to interview students and think critically about what a PIT fellowship experience should look like. As a student designing for care of other students, Sam was instrumental in creating a new fellowship that went "beyond compliance, equity, and inclusion."

In the past, embracing ownership and uncertainty led us to ask for help when we needed it. In Ruby's story about PInT's first design review, she describes how asking for help had been a challenge for her in the past, because she felt a need to figure things out on her own in order to "learn and grow." In the context of her project team, Ruby formalizes her uncertainty and recognizes limits to her team's knowledge when she emphasizes the importance of "asking for help from those with knowledge and wisdom to make our work better." Ruby's investment in her team demonstrates the second phase of the ethic of care: *taking care of* [28]. When Ruby asked faculty for guidance, she assumed responsibility to take care of her team's needs for support and resources. As a result, her team was able to consider new "suggestions and paths for getting unstuck." After identifying her state of uncertainty and taking care of her team, Ruby no longer "refrained" from asking for help.

Student ownership and recognition of uncertainty were especially important in the context of the anti-human-trafficking project which could have serious consequences for real, already vulnerable people. Having the agency to explore our uncertainty instead of feeling obligated to deliver a "minimal product needed" provided us with the space to slow down and deliberate. In some cases, not engineering can be the "best solution," when measuring in terms of social justice: "a creative solution is sought to benefit all community members, with the participation of all concerned, and proposed solutions are evaluated based on their contribution to the goal of social justice, recognizing that sometimes the best solution may be to not engineer in the first place" [26, p. 32]. Our uncertainty about what a "right" solution was supposed to look like revealed refusal as a thoughtful and legitimate option. Shreya reflects, "The fact that any choice we made in the end would've been the right choice in our professor's eyes was revolutionary to me." This revolution in thinking put the onus fully on us to decide what success could

look like, in the context of our personal values, our team, and our society.

PInT is powerful because it is student-led. We have discovered, as [25, p. 137] supports, that "When students take active roles in their own learning, they have greater responsibility for the process and a deeper engagement with the material." Ruby's ownership of her team's needs led her to ask for help when she felt her team needed new insights. Sam's ownership of the fellowship process led her to explore her own uncertainty, to create a caring, inclusive experience for her peers. Shreya's ownership of the anti-human-trafficking project pushed her to critically examine which path would center care for potential victims of anti-trafficking technology, her team, and herself. Each of us embraced that we are experts on where our learning experiences should go next, and we each felt a responsibility to center care for ourselves and others in our learning journeys.

VII. CONCLUSION

We started our journey of creating PInT by applying our understanding of and excitement for engineering to PIT projects. Our reflection-in-action, as we created PInT and considered what PIT was and more importantly what we wanted it to be, led us to reconsider and unlearn several traditional engineering paradigms. By creating an undergraduate, student-led public interest technology clinic, we are shifting engineering to embody values we ascribe to the practice of public interest technology, like prioritizing emotions and relationships, embracing slowness and deliberation, and claiming student ownership. We are assuming our responsibilities to public welfare and pushing back on the culture of disengagement at Olin. Although Olin is a small college with a unique commitment to experimenting with engineering education, we believe others could share in our story through similar applications of liberatory education, the ethic of care, and experiential learning.

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