Change | Makers: What can come next in engineering design?

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Jennifer Howcroft is an Associate Professor, Teaching Stream in the Department of Systems Design Engineering at the University of Waterloo and is currently the Associate Chair, Academic for the Department of Systems Design Engineering at the University of Waterloo. She received her PhD from the University of Waterloo. Her pedagogical research focuses on engineering design, holistic engineering education, stakeholder interactions, and empathy in engineering education. Her technical research focuses on naturalistic driving and older driver fitness assessment.

Dr. Kate Mercer, University of Waterloo

Dr. Kate Mercer graduated with a Master of Information from the University of Toronto, and a PhD in Pharmacy from the University of Waterloo, focusing on communicating health information. Kate is the liaison librarian for Systems Design Engineering and Biomedical Engineering at the University of Waterloo where her job includes collaborating with faculty, staff, and students to effectively provide instruction and support and conduct research. By providing support around subject-specific and interdisciplinary research Kate both supports and collaborates in driving research forward. At the University of Waterloo, Kate works on strategies related to information and misinformation, understanding the research landscape, and building innovative partnerships that span disciplines.

Dr. Julie Vale, University of Guelph

Julie Vale received her Ph.D in Electrical and Computer Engineering from the University of Waterloo. She joined the University of Guelph in 2012 as a teaching focused faculty member and is currently Associate Director Undergraduate Studies for the School of Engineering. Originally trained in electrical engineering as a systems and control theorist, Dr. Vale's current research focuses on engineering education and pedagogy. Her research has two aspects. The first focuses on the development of a tool to assist instructors in building assessments that promote problem solving skills rather than promoting memorization. The second is about how and why values-based learning outcomes should be scaffolded into STEM curricula and capstone experiences.

Dr. Vale believes that building student and faculty appreciation of the intersections between social justice and engineering is crucial to empowering engineers to fulfil their mandate to serve the public. She brings this view to the classroom, to curriculum design and development, and to her research.

D'andre Jermaine Wilson-Ihejirika P.Eng., University of Toronto

D'Andre Wilson-Ihejirika is currently a PhD candidate at the University of Toronto within the Institute for Studies in Transdisciplinary Engineering Education & Practice (ISTEP). Prior to that she worked for many years as an engineer and project manager in the Oil & Gas industry. She is originally from Nassau, Bahamas, and completed her B.Eng in Chemical Engineering at McGill University and her MASc. from the Centre for Management of Technology and Entrepreneurship (CMTE) at the University of Toronto. She also currently sits as the President of the Board for BrainSTEM Alliance and is the Executive Director of Work Integrated Learning at the Calgary Economic Development.

Stephen Mattucci, University of Guelph

Mattucci was raised in the traditional territories of the of the Mississaugas of the Credit First Nations, Anishinaabek and Haudenosaunee Peoples (Southwestern Ontario, Canada). He has strong core values around continuous personal improvement, and love for learning. His post-secondary education includes three technical engineering degrees (two mechanical, one biomedical). Mattucci's post-doctoral work shifted to focus on collaborative change management and communities of practice in engineering education at the national level in Canada, before beginning a faculty appointment in 2022 with a teaching focus. Mattucci's favourite courses to teach are engineering design, mechanics (solids), dynamics, and anything related to leadership and professional / transferable skills. His favourite things to do are backcountry camping, and going on adventures with his family.

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Introduction

There have been growing calls for engineers and engineering educators to take more complete responsibility for their role in society as technological developers and technically literate members of society, the exclusivity of their practice, and the impact their work has on the world both socially and environmentally. These calls appear in various forms including Sustainable Development Goals (SDGs) [1], calls to action [2], and academic literature [3-5]. However, change in engineering often comes slowly. While some change has been seen, for example, in some engineering codes of ethics and graduate attributes, others have been slow to change [6]. Everywhere we look, the world is asking us as educators and engineers to design, innovate, address global issues, and prepare future engineers to meet the needs of tomorrow. This suggests that traditional ways of practicing and teaching engineering design are not enough and that new strategies are needed. Important changes have already been made but more is needed to ensure that tomorrow's engineers are well prepared to work and design with the rest of society to ensure a sustainable, just, and equitable future for our planet.

Taking a non-traditional approach to an academic paper, this paper will use a combination of storytelling, reflection, and commentary in which the authors will be having a conversation with readers. Our goal with this paper is to offer reflections from the Canadian perspective on integrating social justice, Indigenization, Equity, Diversity, and Inclusion (IEDI), and empathy into engineering education [7]. Authors will share not only their practices, but their lived experience, so that the full context of their personal contexts, locality, journey, and work are presented as one to elicit deeper meaning and insights [5, 7, 8, 9]. Conversations about decentralized participant focused reflections in Engineering education exist: the goal of this paper is to expand on this to continue the conversation [10].

While very close to the American perspective, Canada does navigate a different context – one that is more restricted due to budget rather than governmental influences. There are approximately 40 universities and colleges in Canada with accredited engineering programs, all of which are publicly funded. Additionally, the Canadian accreditation process (managed by the Canadian Education Accreditation Board (CEAB)) is slightly different than ABET but is part of the Washington accord.

Our goal is to share learning, thinking, and practical suggestions, offering our lived experiences as paths that can be adapted, or inspire change in different contexts. The authors will speak to the change they are pushing for in the engineering context, the progress they have already made towards their goals, challenges they have faced, and advice they have to offer to others with a passion for change. This paper focuses on the perspectives of people currently living and working in Canada. Authors in this paper all work in, or adjacent to, the engineering context but include folks who are and are not Engineering faculty members.

Methods

This paper was conceived as a panel – leading to the question of then how do we fully translate a panel to be a formal academic paper inclusive of perspectives, worldviews and values? The authors discussed different evidence-based approaches but had concerns about various ways these approaches could be exclusionary of different ways of knowing and communicating. We decided on a middle ground approach – the people we approached to participate in the paper were given several options for participation. Authors agreed the ways of approaching this would be to tell a story, write a reflection, follow provided prompts, or write a commentary.

Contributors were given a series of prompts, that they could use formally, informally, or choose not to use. They were told to write in a way that was meaningful to them, reflected who they were, and how they wanted to communicate to other people. There are five reflections included in this paper, but we had a total of 11 conversations with potential participants. Each of these individuals was enthusiastic about the vision and goal for the paper. However, six were unable to commit to contributing to this paper. The reasons given for not participating included funding, discomfort being this transparent, concerns regarding career stability, and other reasons more detailed below under *Missing Perspectives*. The order of the authors' stories was debated, but for equity reasons the order they were received is the order in which they are presented. While some authors chose to add a positionality statement, we did not intend these to be traditional positionality statements, nor did we require them of the authors.

The authors did not see or read the other pieces until the paper was sent for one last look prior to submission. The authors of the paper strongly debated if they wanted to share the stories with each other, interject questions, or do a final analysis. We decided that this could place constraints on or influence how people wrote their pieces. It inherently changes perspectives if people know they will be critiqued. It also shifts our intention from personal reflection into a conversation. While the conversation with readers is deeply important, and there is a place for participant centered reflections, the authors of this paper feel that right now the stories speak for themselves and offer a starting point for these becoming dialogues in the future.

While reading the contributions of the authors, we ask you to step away from the traditional academic perspectives, and question your thinking. Consider your reaction. What is your comfort level with this non-traditional paper and the shared viewpoints? Most importantly, we want you to think about what drives your reactions. What is your perspective when it comes to academic writing, engineering education, and values?

Reflections, Perspectives, & Commentaries

Missing Perspectives

We want to begin by leaving space for the perspectives we were not able to include. The authors debated listing the groups who we reached out to, but that feels performative at best. Instead, we hope that the reader will take a moment while reading the following reflections and think about not only whose voice is not included, but perhaps more importantly why. Budget constraints,

institutional funding, community, conference fees, capacity, family, and timing all impacted people's ability and willingness to participate in this paper. These all impact our ability to be present in our careers, our professions, and our families. Compromises must be made, especially for projects which do not fall neatly into the same boundaries that other academic work does.

Jennifer Howcroft (She/Her)
Much of the time in academia, we define ourselves by our academic roles and place a lot of value on our academic titles and accomplishments. While I am guilty of this myself and will share my academic role in good time, I want to start more personally. I am mother to a wonderful, chatty, loving boy who plays the drums (loudly) and enjoys reading. I am married to a loving husband who has a spinal cord injury and is wheelchair bound. I am fortunate to have supportive family, friends, and mentors. I was born in Canada but moved overseas for junior high and high school, attending international schools in the United Kingdom with classmates from all over the globe. While moving was not easy, I had a privileged childhood and the opportunity to pursue the career path of my choice.

I chose to study engineering after learning about biomedical engineering, which combined my desire to work in the health field with my interest in understanding 'why' things work – as opposed to 'what' diagnosis a person might have. My grandfather and father were also engineers, making me a third-generation engineer.

Now, I am an Associate Professor, Teaching Stream and Associate Chair, Academic in the Department of Systems Design Engineering at the University of Waterloo. Last year, I was honored to receive the Ron Britton Engineering Education Vanguard Award and the Boyce Family Award for Teaching Excellence. While I value the traditional and more technically focused engineering curriculum, I believe I received these awards because of the work I am doing to advance engineering education in non-technical areas. I believe that technical expertise is not enough to meet today's global challenges, future challenges, or what society should and will expect of their engineers. Engineers need to be more than technically proficient. They also need to be socially proficient – able to evaluate the complex socio-technical and enviro-technical considerations of their work and empathize with users, colleagues, stakeholders, and rights holders.

I do not pretend to be alone or unique in these thoughts. They aren't new or groundbreaking. However, the technical focus of engineering is rooted deep in the culture, stereotypes, and curriculum of engineering, and it will take the sustained work of many to effect lasting and meaningful change towards a truly holistic curriculum that will train technically and socially proficient engineering students.

For engineering students to be socially proficient, they must develop empathy skills. However, integrating empathy into engineering education isn't as simple as 'just' teaching student. It starts with convincing engineers that empathy should be associated with engineering. I have had academic engineers tell me that the inclusion of empathy in engineering curriculum is ridiculous, that empathy has no place in engineering or an engineering journal, and that my work would be easier if I just called empathy something else – something more acceptable and palatable like

user-centered techniques. And of course, empathy when applied to the design process does present as specific techniques relevant and necessary for user-centered and human-centered design processes. But why shouldn't I use the term empathy? What is the harm or risk in engineers who empathize?

If I want to convince engineers that empathy skills are needed in the engineering curriculum, then I cannot shy away from using the word. Instead, I embrace the word 'empathy'. When I integrate empathy-focused design techniques into my first-year design course, I frame them as part of a user-centered design process. But I also emphasize the importance of empathy in engineering design, define empathy for the class, and teach students to use empathy-focused techniques, like personas and empathy maps, as part of their design project. I take every opportunity to talk about empathy and its relevance in engineering with the goal of normalizing the use and relevance of empathy in engineering contexts.

In addition to integrating and highlighting empathy skills and techniques in my design courses, I am also working on understanding empathy attitudes, perspectives, and self-perceived skills of faculty and students in engineering. This has been an eye-opening area of work that has helped me better understand the value that some of our faculty already place on empathy as an engineering skill but also the many barriers to integrating empathy into the engineering curriculum. One barrier that is commonly identified is a lack of ability or understanding of empathy techniques and how to teach them. In response to this, I worked with collaborators like [Anon] to develop a workshop that introduces instructors to empathy techniques that can be integrated into a design course, gives them a chance to try out these techniques, and consider how they could integrate them into their own courses. I see this as a critical part of making meaningful and sustained change to engineering education – enabling others to be a part of that change.

I have focused my conversation with you on integrating empathy into engineering education, seemingly neglecting the socio-technical and enviro-technical considerations I mentioned earlier. It is not because I think these considerations are less important. I think they are critically important to addressing the global challenges we all face regarding climate change, local and global injustices and inequities, and sustainable development. I believe that training engineering students with empathy skills will equip them with the tools they need to better appreciate and fully understand these challenges and the importance of meaningfully addressing these challenges in their work.

Empathy at its core is the ability to understand another person's ideas and feelings – not how we would feel if placed in the situation of someone else. Engineering practitioners and students typically do not reflect the diversity of our populations both locally and globally, across many dimensions – socioeconomics, vulnerability to the impacts of climate change, gender, sexual orientation, and disability status. While greater diversity in our profession is another area where change is needed, until that change is realized, empathy will aid us in appreciating the challenges and burdens faced by those with different lived experiences from our own and prioritize these needs in our work. To evaluate and integrate socio-technical and enviro-technical considerations in our engineering work, we need to resist the temptation to design for ourselves and truly

embrace our responsibility for upholding the public welfare by designing for everyone – locally and globally – while also keeping in mind the needs of future generations and the global boundaries of what our planet can sustain. Without empathy, we will not be able to meaningfully engage our students in learning these skills or practice them ourselves.

D'andre Jermaine Wilson-Ihejirika P.Eng. (She/Her)[1]
I am a Black woman, born and raised in the Caribbean. I moved to Canada to study engineering at McGill University as an international student. With that transition, I had my first significant experience being in a predominantly white space. Since my undergraduate degree, I have gone on to complete a master's degree in engineering, work in the oil & gas industry, pivot into working in higher education and edtech, founding a nonprofit focused on STEM outreach, and now, completing my PhD in engineering education with a focus on EDI (Equity, Diversity and Inclusion).

Reflecting on my journey through engineering and beyond, I see how pivotal my experiences as an undergraduate shaped not only my career, but my research. As a Black woman, navigating a predominantly white space like McGill University in Canada presented challenges of belonging, which I countered through deep involvement in student clubs. These counterspaces in the National Society of Black Engineers (NSBE) and Women in Engineering clubs were transformative. They provided leadership opportunities and networks that significantly influenced my professional trajectory and underscored the importance of community in academic and personal growth.

My undergraduate experiences also highlighted systemic inequities, such as the challenges I faced securing internship opportunities, and the fact that I did not have a single professor who identified as Black. This further informed my focus on underrepresented groups in engineering for my PhD research. My methodology and conceptual framework—rooted in Social Cognitive Career Theory and informed by Critical Race Theory—are shaped by my positionality. I saw firsthand how a sense of belonging, mentorship, and exposure to opportunities could profoundly impact career pathways, as they did mine.

As I transitioned into higher education, industry roles, and entrepreneurship, I carried with me the lessons of adaptability and resilience forged during my student years. These experiences sharpened my ability to empathize with participants in my research and to acknowledge the biases I bring. From my early struggles with homesickness in first year, to my passion for outreach and advocacy developed through NSBE, to finally securing my first internship in the Oil Sands during my master's degree which I felt ultimately validated my identity as an engineer, my career pathway has been shaped and informed by the experiences in my undergraduate degree. These reflections ground me in focus of my PhD research: to illuminate the factors shaping diverse career paths in engineering and to foster environments where all students can thrive.

[1] The author identified she used ChatGPT as part of her writing process for this section to synthesize similar writings she had previously done on similar topics, as a starting point.

When I reflect on my own experiences in the context of engineering design, I believe it is important to consider the positionality of the engineer or engineering student, and how they relate to the design problem. As a Black woman from the Caribbean, a region that is impacted by hurricanes and tropical storms every year, when you ask me to engineer solutions to climate change, for example, my lived experience will shape the solutions I design. Are we allowing our students to bring those aspects of themselves into the way they learn? Are we creating spaces for students to share their identity and experiences with others and find a sense of belonging in engineering? Are we removing the barriers that prevent marginalized students from developing their engineering identity? To truly address the global challenges of our world, I feel that we must address these questions for all future engineers.

Julie Vale (She/Her)

When we proposed this panel, I was planning to write one story, something befitting of an administrator who oversees the whole engineering curriculum at their institution, who has institutional supports (financially limited as they are) for their initiatives and who is trying to be a good role model for her colleagues and students. With the current situation in the US and the rise of alt-right ideologies in Canada and the rest of the world, I feel the need to write a totally different story, something much more personal. I no longer want to talk about the things we have done or still need to do to transform Engineering Education. If you're reading this, you probably already know those things.

I'm secure in my role. I'm a white, tenured, full professor at a public research university in Canada. I do not fear for my job or my family. I know this puts me in a position of privilege and I know that I don't fully understand what my more precarious colleagues or our most vulnerable students are experiencing right now. Still, I want to offer a message of hope and solidarity.

I feel very old lately. I grew up in a time where ideas like hidden bias didn't exist in the general lexicon. I don't think I heard the acronym EDI (or DEI) until I was in my late twenties, whereas today (at least until recently), EDI initiatives are openly discussed across industry, in the classroom, and in many households.

Today, political idealogues are tearing away the tools, pathways, spaces, and places that support some of our most vulnerable students. I thought we had come further, that what was built would be ingrained enough that it would be harder to dismantle. I'm devastated to see how easy it is to tear it all apart, but I am also reminded of the ways that some of us did this work when we didn't even know what the work was.

So, in this story, I want to talk about how to do the work anyway. When you have little or no positional power. When it seems that there is no hope. With no money, no direct administrative support, and powerful people actively trying to stop you.

The order of this story may not make sense, and I ask you to bear with me. I promise there's a point to all of this.

I am Gen-X, born in the late 1970s. My dad is a mechanical engineer, and my mom was one of the few moms I knew who worked. She was also an immigrant, arriving in Canada when she was 18 from the tiny island of Sao Miguel, Portugal, with no university or college education. Not only did she work, but I recently found out that she was one of the first female bank managers in Canada before I was born (our banking system has 5 very large national banks – she worked at one of them). She did this at a time when Canadian women had only just been given the right to have their own credit card without needing a man's signature.

My dad is the reason I knew engineering existed and chose it for my undergraduate degree (against the strenuous advice of my high school guidance counselor, who insisted that I'd be better off in math because engineering isn't for girls), but my mom is the one who taught me everything she knew about surviving in a male dominated space. Key word: surviving. What the advice boiled down to was 'be one of the boys', which I mistakenly took to mean beating them out at their own toxicity.

It did work, in a way. I made it through my electrical engineering undergrad as one of less than 10% women in my class, feeling strong and in control, with high grades, great friends (all male), and in a strong relationship with my now husband. Never once did I even entertain the idea of having a female lab partner or group study mate. When any kind of opportunity (scholarship or otherwise) directed only at women became available, not only did I not apply for it, but I also denigrated it. I needed the money, but it didn't matter.

I couldn't see that I was harming myself and other women. I was too busy surviving.

My dad saw it though… during grad school (mid 2000s) I was talking to him about the 1989 Montreal shootings and that women were being held back in engineering. He didn't disagree with me. Instead, he challenged me. You see, I had a bursary that I automatically received because I was a female grad student in electrical engineering, and I always complained about how much it frustrated me that such a bursary existed and that I couldn't refuse it. He told me that, if everything I was saying about those 14 women and the challenges women still face in engineering was true, then I deserved every penny of the bursary because I clearly had an unfairly tougher time getting to where I was. He was talking about barriers, but neither of us knew the term at that time. It took me another five years before I truly understood and accepted what he was saying to me.

Why tell this part of my story? Because I accept who I was, and I know the old me is exactly who I am trying to reach in the work I do now. We don't need to convince the people who already know that we need to do better. We need to convince the people that have convinced themselves that we're fine and that these changes are not necessary. And if we explicitly use terms like EDI, those people are likely to shut down, stop listening, and maybe even fight against it – I know I did.

So how do I reach those people?

I call it ‘sneaky pedagogy’ and I use it a lot. When trying to instill or elicit values-oriented behaviors or self-understanding, I ignore best practices of learning outcomes in the sense that I don’t tell the students the real goal of the lesson. Instead of telling students that I’m going to talk about EDI, or decolonization, or hidden bias, I set them up in scenarios that (on the surface) are about something technical, but in reality are designed to elicit biased and exclusionary responses. And when the task is complete, I probe their results in ways they don’t expect. If it is a group task, I may regroup them based on task assignment instead of group membership and ask them why they assigned or took those tasks and if they see anything interesting in new task-based groupings. For an exam, I might ask the class why 60% of them chose to assign a gender to the character in the problem who was only ever referred to as ‘they’. The reaction is visceral. Students who would otherwise fight against EDI discussions, who would swear that they are ‘color blind’, who fall prey to the model minority myth, or any of the myriad biases or justice related barriers can’t help but challenge their own beliefs when they themselves did the thing that they swear they would never do or that they don’t even believe exists.

This approach can be leveraged without ever using the words equity, diversity, inclusion, or justice, which may become an unfortunate necessity for some educators.

I think of this approach as an unexpected poke in the arm that can throw someone off balance just enough to change their course forever. Like when my dad challenged me on my scholarship. Or when, as a very new faculty member, one of my Indigenous students called me out with deep love and kindness on language I didn’t know was offensive. That student simultaneously showed me how to help others begin their own self reflections while starting me on my decolonization journey.

Our words, our breath, our movement in the spaces we choose to occupy, our absence from the spaces we choose to (or are forced to) leave, these things have an impact whether we are explicit in our intentions or not. They create tiny eddies and currents that are invisible but can have momentous impact. Like the story of the butterfly flapping its wings and creating a hurricane.

More about me: I have late diagnosed ADHD (just in the last month, only started suspecting last year). I have navigated almost all of my life as a woman with undiagnosed, untreated ADHD. In electrical engineering no less. I am only now beginning to realize how many challenges I faced and opportunities I lost because I can’t stop interrupting and steamrolling, because I experience task paralysis (I still struggle to not call it procrastination, not to blame it on some kind of personal failing), and because being on time is hard in a way that few neurotypical people understand (its why I’m almost always 15-20 min early).

The coping tools I developed make me seem on top of everything and completely unstoppable most of the time, but oh boy when they fail, it is truly catastrophic (think along the lines of not showing up to your PhD advisor’s presentation when you’re the one that has the laptop with his presentation on it… the fallout from that was spectacular).

Why does that matter? Because I made it where I am today in spite of the ADHD. Because I’m privileged to also be very gifted. To be white. To have a father who is a Canadian engineer who

understood the profession, saw my aptitude, and could guide me. To have a powerhouse of a feminist mother. To have a feminist husband who understood my ADHD decades before I did and who found ways to make my life easier (even though neither of us knew or suspected that I have it) and who is the primary parent to our two kids.

But what does this have to do with my role as an educator, my work toward changing the narrative in engineering education, or any other I-EDI work? Because all of this means that I'm very very good at hiding what I really am while at work. I mask so well that only people who are ND or have loved ones who are ND can see it (although to them, it is super obvious).

As much as we would like everyone to be who they are without needing to hide, the unfortunate reality of the world we live in is that, sometimes, hiding is important. Because sometimes it is the only thing that keeps us safe, and if we're safe, we can keep doing the work.

We don't need to call it I-EDI to teach it or to live it.

I feel like now is one of those times when many of us may need to do the work in hiding, and there is no shame in that. Sometimes, hiding the true nature of the work or working from within is as much defiance and resistance as screaming from the rooftops.

Now is a time when we will see who our true accomplices are in this work, versus those who change their allyship to fit the political winds. We will recognize each other without needing to say explicit words, just like how neurodivergent people can see each other a mile away. We can bide our time, rebuilding what we can and when we can. We may need to go back to some of the old ways, but we don't need to stop.

We can't stop, because the work is too important, and it is too heavy to carry alone.

Many hands.
Many breaths.
Butterfly wings.

Stephen Mattucci (He/Him)

<u>What brought you to engineering?</u>

Honestly, the typical message in high school "you're good at math and science, go take engineering". I was really into mountain biking, and especially fixing bikes. I liked working with my hands and problem solving. I did not have an engineer role model. I could not tell you the first time I remember even meeting (let alone knowing) an engineer… maybe even UBC after I had started my undergrad.
What keeps me in engineering? Believing that engineers are capable of changing (saving) the world and I can help to make them better.

<u>Positionality and personal statement</u>

I am a white, straight, cis-gendered male who was raised in the traditional territories of the of the Mississaugas of the Credit First Nations, Anishinaabek and Haudenosaunee Peoples (Southwestern Ontario). I have been fostering my teaching practice and philosophical values since my undergraduate days (mechanical engineering) and have been heavily involved with teaching and learning centers at most institutions along the way. Being trained as an Instructional Skills Workshop facilitator during my PhD (biomedical engineering), I have embodied values related to learning from others, experimenting, and being adaptive in the classroom. I am very intentional about my practice, which has strong theoretical grounding. Following four years in post-doctoral roles exploring engineering education, I am in my third year of a professorial faculty role. I strongly believe that the best way to prepare engineers for a complex future is to develop them into proficient self-directed learners. I've been experimenting with a graph of who I am, please see Figure 1.

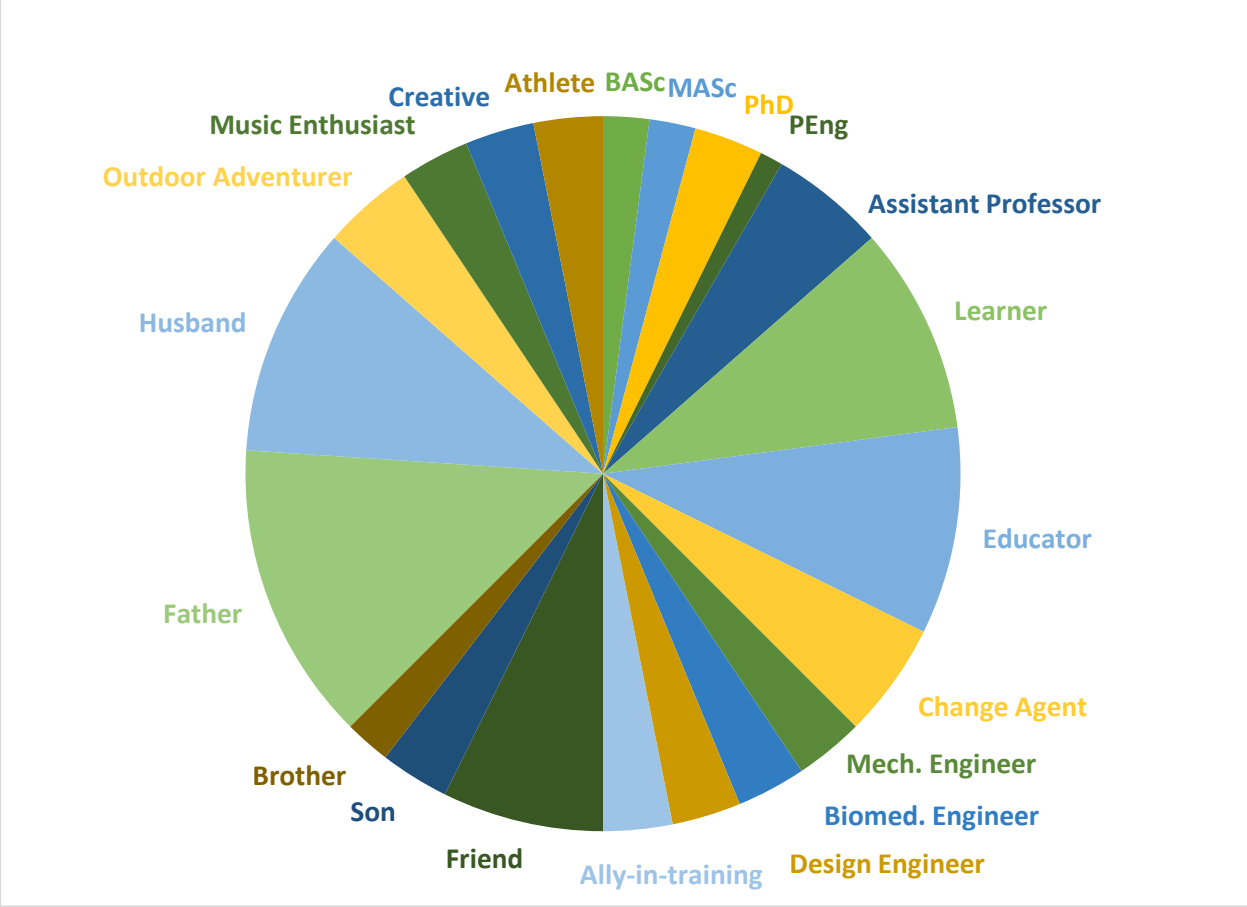

Figure 1: Positionality Pie Chart. Shout out to colleague Dr. Franz Newland, where I stole this approach from his keynote at the 2024 ASEE St. Lawrence Section Annual Conference.

<u>Your role in academia</u>

My role on paper: Assistant Professor

What am I doing here? I have followed a path that has led me to the opportunity to train and educate engineers of the future. I understand the positive impact that engineers have on the world. If I can make hundreds (or even thousands over a career) of future engineers all a little bit better, what if I can help to make them much better?

Using the framework of my DOE (distribution of effort – assigned work): Teaching 70% – My primary duty is to teach courses, including everything from curriculum development, the classroom and course experience, and the learning environment and community. Service 20% – Function as part of a team with colleagues to maintain the academic structures. But also, to change these structures so that they might better help us achieve our goals (and not go obsolete) … My goals will usually tie back to improving the student learning experience. Research 10% – I usually leverage my research to enhance my teaching practice, understand and develop leadership skills, and build relationships with colleagues. I see teaching, service, and research as fundamentally connected, and working complementary with each other. At least, that is the goal.

<u>Anything else you think is relevant</u>

A reflective piece wouldn't be complete without the ideas I am currently reflecting upon… This is the heaviest teaching load I've experienced in this role. I feel I can do a great job but am stretched so thin that I can't do my best. I struggle with this but am learning to accept it. I came from a very privileged postdoc where I was able to learn and 'upskill' when it comes to SoTL, education research, leadership, change management, and building a strong and diverse network. I feel like I am only scratching the surface of being able to apply what I've learned.

This is the first time I have been teaching the same students both Design I and Design III. I also taught many of these students Mechanics I and Machine Design III. I am viewing my role very differently. Instead of being a teacher for a course, where the course drives the relationship… I am a steward to the students on their journey to learn how to be an engineer. This view helps me see the bigger picture of their time in the program and allows me to make very strong connections across engineering design. In case it isn't clear, I see design as the essence of engineering.

It strangely took me a very long time to realize what one of my most dominant characteristics is: love of learning. I am also a hard worker and have resilience. I think this aligns very well with engineering and academia. I feel like I am just getting started. I can now fully appreciate why change is so slow, and the importance of building and fostering good relationships.

Kate Mercer (She/Her)

When I was in high school, I was told I wasn't good at science. I was "strongly encouraged" to stick with the humanities, where I was told I was smart. It was the first time hidden biases hit me, mostly because it wasn't hidden at all. I did my undergraduate degree in history and Canadian studies, at a very small liberal arts school in New Brunswick. I loved it there.

Then I dropped out after my first semester.

Looking back, I don't have a good reason for dropping out. I made something up about not feeling well, and being homesick, but the real reason was I felt something was off. I rallied, after a semester and summer off, went back, and finished on time, largely due to being lucky and privileged enough to do two summers abroad – one in China objectively to learn Mandarin, and one in Italy on an archaeology dig where I spent a summer drinking wine and cataloguing roof tiles (they all looked the same). I graduated, moved to Toronto, and ended up in the Library Science program at the University of Toronto.

The trap with that program, is in it I realized I didn't think I fit with libraries, but I did love Data. Figuring out patterns, finding complex information, telling a story with numbers? I loved it. So I did the Master of Information degree, and before I graduated I was hired at a huge company as the "Manager of Strategy and Decision Making" which basically meant my job was to do the most random things I could have imagined. I loved this job. It was creative, everyone was smart, and it challenged me in the best possible ways.

Then I got fired.

In fairness to me, we all got fired, it wasn't personal, but it felt personal. I couldn't get a job in the same field, so I went back to Waterloo. Then, much like so many people in their mid-20's do when they don't know what to do, I started a PhD. In yet another pivot, this degree was in Pharmacy – in what world was I a scientist? Making a long few years short, I ended up getting a job as a Librarian at University of Waterloo while I was finishing my PhD and ended up *loving* being a Librarian. I also started teaching in engineering, mostly first year communication courses but some human factors one, like my doctorate was actually in. I didn't have a plan; I had a very unlucky series of events that in the end ended up being very lucky.

Turns out, science wasn't as scary as I thought, and I'm a really good scientist.

At work, we like to define ourselves in boxes. I know my privilege. I'm white, female, a scientist, a librarian, I have a PhD. My mom has an MBA and was an executive, so I had a lot of support through my degrees. I know my privilege, as much as I can. But it's the sneaky stuff that makes it clear how we need to drive change, question our own biases. My mom was also a single mom, in the 80's, and was an executive. She had to sacrifice a lot to let me have no clue how hard it was for her. She was also a refugee, she came to the United States, on a ship, with nothing except her family. If you look at my mom you would never guess that's her story. As much as I want to tell you it didn't shape us, it deeply did – but it never solely defined us.

I try and approach how I teach like a story, not as a series of tick boxes – information itself is, fundamentally a story, even if how we tell it changes. It's about the stories we have, making small changes, quiet changes alongside the loud changes. I hope my small contribution to teaching is that I want to stay focused on making progress in steady and small ways. I want to stay hungry for science, learning, being creative and I want my students to stay the same. I want them to do good, and stay open to learning, even when we're all at the mercy of a flood of

information that's not good. I want them to know their lives aren't a series of check boxes – it's who so many of us are, where we've come from and what we've gone through. I want my students to be more than their degree, and more than their profession. I want them to be ok with life taking a different direction than they thought, and that when they fail they realize that even if they never expect what comes next they'll be open to the possibility. One of the hardest lessons I've had to learn, personally and professionally is the only change we can truly make is in how we respond to things. Use data, build technical skills, but in my classes and in my work I want students to see that it's not just the technical skills, it's not just the soft skills, but it's the people on the way that help us do good in the world.

I wasn't going to give my story to this panel – I'm not an engineer; I'm not even engineering faculty. I have a two-year-old daughter who deserves the world, and what little free time I had I wasn't sure I wanted to write another paper, instead of spending it with her, or my husband (who is, of course, a mechanical engineer). But during the revision process and reading through, I realized the core of what I wanted to say and reflect on is all our stories are complicated. I wanted to tell mine because we don't talk enough about failing or not knowing what to do, and then getting back up and trying something new. Our students think we're infallible, and that's not healthy. Change is hard, but it's good.

Final Thoughts

We must start by acknowledging that this paper does not fully represent the diversity of peoples and perspectives working towards the future of engineering education in Canada. Our intention was to capture greater diversity in this paper so that it would include Indigenous knowledge keepers, information specialists, and a wider diversity of faculty perspectives. As previously discussed, due to employment, budget constraints, travel, the educational and political climates, we are missing perspectives we know are important to include. We found ourselves faced with a decision – to proceed with those who had the capacity to contribute or pull the paper and have none of these viewpoints presented. We decided to proceed, acknowledging that this paper is only the beginning of the sort of sharing that needs to happen on a broader scale and with much greater frequency in conjunction with building a system that enables and empowers those who face barriers of inclusion to feel welcome and supported to share. This sharing may need to take various forms to facilitate the sort of broad and inclusive sharing that is needed whether that is additional non-traditional papers like this one, panels, circles, or other forums for conversation.

We encourage everyone in engineering education to self-reflect on your own journeys to engineering education and what your own contribution would be to a paper like this. There is an inherent value to reflecting on the pedagogy you use, how your journey informs that, and how who you are shapes how you teach, interact with students, and navigate engineering education. These stories show that education is not value neutral but is a value laden practice. To ignore this not only ignores who we are but arguably more importantly the intersection of who we are with how and what we teach.

Future Work

There is a clear need for this to become a series of papers, or conversations in various forms, so that a greater diversity of perspectives can be shared, but more importantly to give people the time, space, and support needed to share their perspectives. While there are instances of these in the engineering education literature, the authors for this paper and this context want to keep the conversation on what people are saying, without analysis, without further reflection, and opening the door to giving the reader the opportunity to search for themes, tensions, and provocations that they see emerge in these, and that they further perhaps see reflected in themselves and their own work and lived experiences. As this work continues and a larger number of contributors join the conversation, this sort of analysis, reflection, thematic analysis, and tensions will become part of the work.

Conclusion

The above perspectives begin a conversation in a new direction, about what is coming for engineering education, diversity, inclusion, and how we can be the change. What started as a paper giving insight into how the authors are working on practical ways to embed new ways of thinking, navigating the world, and understanding into the engineering curriculum, turned into a paper on who the authors are and how this led to their realization of the need for specific changes in engineering education. Perhaps most impactfully it begins the discussion on how who we are shapes how we educate. Each perspective is different. The writing style is different, with different emphasis, different styles, and different goals. We hope that your active reflection while reading these perspectives led you to consider your own perspective and values, your own journey in engineering education, and inspired you to think about the future of engineering education in a new way.

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