Leaving Civil Engineering: Examining the Intersections of Gender, Disability, and Professional Identity

Dr. Cassandra J. McCall, Virginia Tech

Dr. Cassandra McCall is a post-doctoral researcher in the Department of Engineering Education Virginia Tech. Her primary research interests include professional identity formation in undergraduate civil engineering students, grounded theory methods, and theory development. Currently, she is principal investigator on an NSF sponsored project exploring the professional identity formation of civil engineering students who experience disabilities. In particular, she is interested in examining the ways this identity is influenced by students' academic relationships, events, and experiences, and vice versa. Dr. McCall holds B.S. and M.S. degrees in Civil Engineering from the South Dakota School of Mines & Technology.

Dr. Marie C. Paretti, Virginia Tech

Marie C. Paretti is a Professor of Engineering Education at Virginia Tech, where she directs the Virginia Tech Engineering Communications Center (VTECC). Her research focuses on communication in engineering design, interdisciplinary communication and collaboration, design education, and gender in engineering. She was awarded a CAREER grant from the National Science Foundation to study expert teaching in capstone design courses, and is co-PI on numerous NSF grants exploring communication, design, and identity in engineering. Drawing on theories of situated learning and identity development, her work includes studies on the teaching and learning of communication, effective teaching practices in design education, the effects of differing design pedagogies on retention and motivation, the dynamics of cross-disciplinary collaboration in both academic and industry design environments, and gender and identity in engineering.

Dr. Lisa D. McNair, Virginia Tech

Lisa D. McNair a Professor of Engineering Education at Virginia Tech and Director of the Center for Educational Networks and Impacts (CENI) at the Institute for Creativity, Arts and Technology (ICAT). She develops integrative education projects that transverse perspectives within and beyond the university. Her currently funded NSF projects include revolutionizing the VT ECE department, identifying practices in intentionally inclusive Maker spaces, and exploring professional identity development in Civil Engineering students with disabilities. Her work in CENI focuses on building networks between the University and multiple community sectors and supporting engagement in science, engineering, arts, and design. ORCID: https://orcid.org/0000-0001-6654-2337

Dr. Ashley Shew, Virginia Tech

Ashley Shew, Assistant Professor in the Department of Science, Technology, and Society at Virginia Tech, works in philosophy of technology at its intersection with disability studies, emerging technologies, and animal studies. She is author of Animal Constructions and Technological Knowledge (Lexington, 2017) and co-editor (with Joseph C. Pitt) of Spaces for the Future: A Companion to Philosophy of Technology (Routledge 2017). Shew is a recent awardee of a National Science Foundation CAREER Grant, running from 2018 to 2023, to study narratives about technology from the disability community that often stand in contrast to dominant media and engineering narratives about disability. She keeps her teaching materials on technology and disability at http://techanddisability.com.

Dr. Denise Rutledge Simmons P.E., University of Florida

Denise R. Simmons, Ph.D., PE, LEED-AP, is an associate professor in the Department of Civil and Coastal Engineering in the Herbert Wertheim College of Engineering at the University of Florida. She holds a B.S., M.S., and Ph.D. in civil engineering and a graduate certificate in engineering education – all from Clemson University. She has over ten years of construction and civil engineering experience working for energy companies and as a project management consultant.

Dr. Simmons has extensive experience leading and conducting multi-institutional, workforce-related research and outreach. She is a leader in research investigating the competencies professionals need to compete in and sustain the construction workforce. Dr. Simmons oversees the Simmons Research Lab (www.denisersimmons.com), which is home to a dynamic, interdisciplinary mix of graduate researchers and postdoctoral researchers who work together to explore human, technology and society interactions to transform civil engineering education and practice with an emphasis on understanding hazard recognition, competencies, satisfaction, personal resilience, organizational culture, training, informal learning and social considerations. The broader impact of this work lies in achieving and sustaining safe, productive, and inclusive project organizations composed of engaged, competent and diverse people. The SRL is supported by multiple research grants, including a CAREER award, funded by the National Science Foundation (NSF).

Dr. Simmons is a former project director of the Summer Transportation Institute (STI) at South Carolina State University and Savannah River Environmental Sciences Field Station (SRESFS). Both programs were aimed at recruiting, retaining and training women and minorities in transportation, environmental science and engineering and natural resources-related fields of study. As SRESFS director, she led a board composed of 29 colleges and universities.

Ms. Courtney Zongrone, Virginia Tech

Courtney Zongrone is a second year doctoral student in the Counselor Education and Supervision Program at Virginia Tech. She earned her BA in English Literature and M.Ed. in Counselor Education from Lynchburg College. Her primary research interest includes examining the lived experiences of individuals who have been mandated to receive substance use disorder treatment. Currently, Courtney serves as a graduate research assistant in the Department of Engineering Education at Virginia Tech. In this role, she conducts qualitative research to expand and deepen existing literature related to the experiences of civil engineering students who identify as having a disability.

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Abstract

As the need for civil engineers continues to grow, so too does the need to broaden participation and increase diversity in the field. While researchers in civil engineering (CE) education have identified the need for more intentional recruitment and retention of women and people of color in the civil engineering field, few studies have considered disability status in these contexts. To address this gap in the literature and enhance the recruitment and retention of minoritized groups in civil engineering, we explore the intersections of gender and disability in civil engineering to better understand why individuals choose to leave the discipline. We focus our discussion on the experiences of Sammie, Shawn, and Natalie, three white women who identify as having disabilities and are no longer enrolled in CE programs. As part of a larger, longitudinal study examining the professional identity formation of undergraduate CE students with disabilities, semi-structured interviews were conducted with each participant and analyzed using open and focused grounded theory coding techniques. Findings revealed four overarching themes that capture participants' pathways out of civil engineering: 1) experiencing conflicts with dominant CE culture; 2) encountering barriers within the CE curriculum; 3) navigating intersecting stereotypes and compounding marginalization; and 4) leaving while remaining peripherally identified with the CE discipline. While participants' identification with the discipline were altered, they were not eliminated; in leaving, all participants chose to pursue careers that are peripherally related to CE. These findings point to potential strategies and opportunities for supporting students who may leave the major, but do not intend to leave the profession altogether and highlight the cross-functionality of engineering workplaces not always acknowledged in academia. Overall, this work contributes to ongoing efforts to intentionally lower and remove barriers that serve to marginalize any group in civil engineering education and engineering education, broadly.

Introduction

One of the oldest, most codified, and most public of the engineering disciplines [1]–[3], civil engineering continues to remain a high-demand field. The total number of civil engineering jobs in the US has experienced a steady increase from 207,080 in 2000 to 287,800 in 2016, constituting approximately 18% of all engineering jobs in the nation [4]. Many researchers have attributed this growth to the discipline's focus on and ability to continuously adapt its practices to meet changes in technology, industry practices, and societal needs [4]. At the same time, national agencies such as the National Science Foundation [5] and the American Institute for Research [6] have underscored the need for the engineering profession to also adapt to evolving demographics and sociocultural needs (including social justice concerns) by calling for broadened participation and diversification of the engineering workforce [1], [2].

Toward this end, researchers have long examined factors that influence the recruitment and retention of individuals from diverse backgrounds within engineering broadly [7]–[10]. These factors include contextual characteristics such as academic climate [11] and access to resources [12] that intersect with individual factors related to identity that are often focused on race and

gender. Recent work in engineering education has begun to expand on this research to examine contextual differences and nuance across engineering disciplines [13]–[15] and broaden studies to include students from low socioeconomic families [16], veterans [17], [18], first generation college students [19], and the LGBTQ+ communities [20]–[22]. However, research in these areas have not yet been integrated into civil engineering. While Ohland and colleagues [1] have identified the need to more intentionally recruit women and people of color specifically into civil engineering, studies for individuals belonging to non-dominant diversity groups (e.g., socioeconomic status, sexual orientation, religion, etc.) in this field are limited. The majority of inclusion-related work has been applied across the engineering field in its entirety with little to no emphasis on disciplinary context.

Across this body of work, students with disabilities still continue to be understudied in engineering education. Despite the fact that the Americans with Disabilities Act (ADA) was passed 30 years ago, studies examining participation in engineering by students with disabilities have only recently begun to emerge and are still in exploratory phases [2], [23]–[26]. The lack of attention to these individuals, their voices, and their experiences is problematic because cognitive, physical, and learning disabilities can significantly impact students' perceptions of and experiences in school, their professional identity development, and their engineering workforce matriculation [27]. Ultimately, these impacts shape retention, potentially limiting the diversification of the engineering workforce and creating socially constructed barriers that keep individuals from work they want to pursue.

Across the engineering field, diversity has been linked to enhanced innovativeness, intellectual engagement, and innovation [1]. Because of the benefits to the field, some view it as imperative that we more intentionally include students with disabilities within the civil engineering context because they can provide nuanced and important insights to advance the accessibility of infrastructure and the field of civil engineering design. While we agree that diversity itself can be advantageous, however, we believe it is equally, if not more, imperative to address inclusion from the perspective of justice and equity. That is, we believe that as a field, engineering education is morally and ethically responsible for lowering and removing barriers that serve to marginalize any group.

In this paper, we draw from prior retention and persistence work focused on gender [28], [29] to explore the intersections of gender and disability in civil engineering to understand why these individuals choose to leave the discipline. Specifically, we ask the following research question:

- What experiences related to gender and disability identity influence a student's decision to leave the civil engineering discipline (i.e., disidentify with civil engineering)?

To answer this research question, semi-structured interviews were conducted and analyzed as part of a larger grounded theory exploration of professional identity formation in undergraduate civil engineering students with disabilities. In the present study, we focus our discussion on the experiences of Sammie, Shawn, and Natalie, three White women who identify as having disabilities and are no longer enrolled in a civil engineering program, though all three remain interested in civil engineering-related careers.

A Note on 'Small *n*' Research

In focusing our study on the experiences of three undergraduate women with disabilities who are no longer enrolled in a civil engineering program, we are following Pawley and Slaton's calls to pursue and learn from research on small numbers. Pawley and Slaton remind us that such "small-n" studies are essential in enabling us to better understand the experiences of individuals who may otherwise be lost or subsumed into majority experiences of large quantitative studies [30]–[32]. This approach to engineering education research is particularly useful in the context of this study for two reasons. First, it allows the engineering education research community to explore the experiences of individuals not widely represented in engineering but still present in our classrooms. Approximately 13% of college students identify as having a disability, with only 6% of those students pursuing undergraduate engineering degrees [33]. Even fewer of those students are enrolled in civil engineering programs, and only 26% of all CE students are women. Second, this approach enables the engineering education community to gain nuanced and unknown insights of individuals who are not easily accessed in research. Recruiting students with disabilities can be particularly challenging due to sociocultural stigma surrounding disability status [26] and prior studies that have treated disability as a 'sickness to be cured or treated' (for more information about medicalized perspectives of disability, see [34] and [35]). As landmark studies by Secules et al. [36], Foor et al. [37], and others have demonstrated, these "small-n" studies can have an exceptionally powerful impact on the ability of engineering education scholars and practitioners to think beyond the experiences of the apparent majority.

At the same time, given the small number of participants in this exploratory, qualitative study, the findings are not meant to be generalized across all individuals with disabilities in engineering education. Rather, we align this work with that of other small *n* researchers, such as Secules et al. [36] and Foor et al. [37], who bring marginalized voices to the fore and remind us of the marginalized experiences that still occur in our educational system. That is, these perspectives are valuable precisely because they foreground the voices of marginalized individuals who are currently not well-represented or understood. In this study, the findings are used to build awareness among university faculty regarding the experiences of women with disabilities who leave civil engineering at their own institutions.

To ensure research credibility, a quality measure for qualitative research [39], we communicate our findings using quotes that capture participant perspectives related to the aims of the study. We encourage readers to evaluate the extent to which these findings may be transferred to their own university contexts, particularly if they seek to inform necessary change for making civil engineering education inclusive for all students.

Sensitizing Concepts

Charmaz defines sensitizing concepts as "initial, but tentative ideas to pursue and questions to raise about their topics." [39, p. 30]. In this study, we utilize two sensitizing concepts: 1) multiple dimensions of identity [40], and 2) intersectionality [41], [42]. The Multiple Dimensions of Identity framework posits that a core personal identity or sense of self, while remaining unchanged, is influenced by a variety of dimensions (e.g., gender, ethnicity, religion, class, sexual orientation, profession) that become more or less salient through various contexts

and social interactions as the individual makes meaning of them. From this perspective, identity salience is the importance of a given dimension relative to an individual's core personal identity. Our second sensitizing concept is intersectionality. Initially conceived as a social justice framework used to draw connections across interlocking oppressions, community organizations, coalitional politics, and identity politics [41], [42], intersectionality has since evolved to provide researchers with a lens for exploring interrelations among various aspects of a single individual's identity and the compounded oppressive forces that may be experienced as a result [43], [44]. This framework maintains that factors such as gender, race, sexuality, disability, and ethnicity are not isolated and distinct, but rather they reciprocally and simultaneously interact to contribute to identity construction [41], [42].

We use these two sensitizing concepts to focus on the interactions between three dimensions of identity: gender, disability, and profession. Specifically, we focus our inquiry to examine the ways experiences with gender and disability influence and are influenced by students' identifications with civil engineering, ultimately impacting their retention in the field.

Methods

To gain a greater understanding of the ways gender, disability, and profession intersect and influence student retention within civil engineering, semi-structured interviews were conducted as part of a larger grounded theory study exploring the professional identity formation of undergraduate civil engineering students with disabilities. Details on data collection, including participant recruitment and semi-structured interview content and length, are included in [2]. Out of the 30 students enrolled in the larger nationwide study, 3 participants disclosed that they had already left or were in the process of leaving the civil engineering field. To fully capture this experience, the interviews included questions regarding participants' pathways both into and out of civil engineering. Here we present an initial examination of these experiences and their influences on students' decisions to leave the discipline. Table 1 summarizes the three participants.

Table 1: Summary of Participants

Pseudonym*	Gender	Major	Academic Level	Disability	Diagnosed
Natalie	Woman	Math Education	Sophomore	Epilepsy	Prior to College
Sammie	Woman	Industrial Engineering	Junior	ADHD	Prior to College
Shawn	Woman	Management	Sophomore	Autism	Prior to College

*Pseudonyms were chosen by participants for individual representation in the study

Interviews were transcribed and field notes were recorded to preserve context and capture subtle implications of topics discussed by participants. Each transcript was analyzed using grounded theory coding procedures as outlined by Charmaz [39] and summarized in Figure 1.

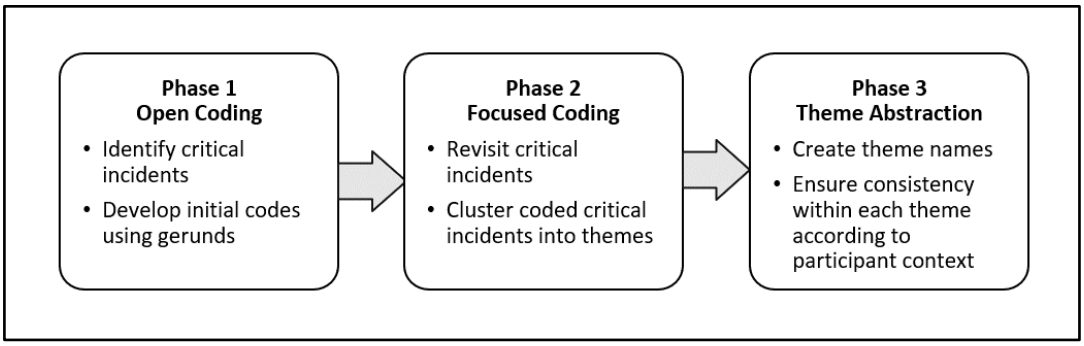

Figure 1: Summary of analysis process

Open coding (i.e., the early process of engaging with and defining the data) [39] included an initial review of participant transcripts. During this open coding process, critical incidents [45] were identified in which participants experienced a negative influence on their professional civil engineering identities. That is, incidents where interactions among an individual's professional identity, gender identity, disability identity, or combinations thereof, resulted in an increased disidentification with the civil engineering profession. Initial codes were assigned to each critical incident in the form of gerunds [46] that captured actions experienced or performed by participants related to professional, disability, or gender identity dimensions. During the focused coding phase of analysis (i.e., a coding phase in which the researchers focus on prominent codes or events trending in the data) [39], each critical incident and its associated code was revisited and clustered into themes according to common meaning across participant contexts. Aligning with Bowen [47], themes were identified as underlying concepts indicated across participants in a variety of contexts, rather than concrete segments directly described by participants.

Leaving Civil Engineering: Disidentifying with the Discipline

This analysis revealed four overarching themes that explicate participants' decisions to leave their civil engineering programs: 1) experiencing conflicts with dominant CE culture; 2) encountering barriers within the CE curriculum; 3) navigating intersecting stereotypes and compounding marginalization; and 4) leaving while remaining peripherally identified with the CE discipline. These themes depict an overarching phenomenon of disidentification as participants encounter, unpack, and navigate identity conflicts across disability, gender, and professional identities.

Theme 1: Experiencing conflicts with the dominant CE culture

The first theme linked to participants' decision to leave is *experiencing conflicts with the dominant CE culture*, which captures cultural expectations and assumptions that are embedded within either civil engineering specifically or engineering broadly. In her interview, Sammie, a junior in industrial engineering with Attention Deficit Hyperactivity Disorder (ADHD), described cultural expectations that positioned the nature of civil engineering education and work as individualistic and competitive. As an individual with a learning disability, these expectations conflicted with her values of community, collaboration, and support. Notably, since Sammie switched into industrial engineering, this culture was one she associated specifically with her university's civil engineering program rather than all of engineering.

Shawn, an autistic sophomore, identified a similar conflict as a woman in a masculine and male-dominated field, and this conflict took her out of engineering entirely. Early in the interview, Shawn initially aligned her disability identity (i.e., autism) with her professional identity (i.e., civil engineering) by describing herself and other autistic individuals as being logical, analytical, and systematic. However, later in the interview, Shawn identified a critical cultural conflict in civil engineering that ultimately led to her to transition out of the discipline:

> [. . .] I would hear stories of people that know engineers, and I would talk to people that are in the engineering field, and I talked to women in the engineering field, and especially women that are attractive. I consider myself a pretty person, but they're always put in a situation where they always have to prove themselves. Women are not, especially in the STEM fields, they're not generally accepted, and that's unfortunate, and it's not something that people are going to admit right off the bat. But my mom is dating a welder, and he basically said "[Shawn is] obviously a very smart girl, she would do well in the situation." But, even a couple of months ago [he] had a woman that was transferred into his section, and he basically thought, "Who did she sleep with to get here?" A lot of men aren't going to admit that, but that's something a lot, that they do. I don't want to necessarily be in that situation where I always constantly have to prove myself.

As Shawn identifies in her comments, biases and discriminatory practices that women experience in civil engineering can be so embedded within educational and workplace cultures that they cannot be overcome (i.e., “a lot of men aren’t going to admit that”). For this reason, Shawn perceived these gender dynamics as ever-present and believed they would impact how others perceive her in a work role for the rest of her career. Iteratively experiencing this dynamic throughout her interactions with individuals both inside and outside the civil engineering profession ultimately led her to transition out of civil engineering.

Theme 2: Encountering barriers within the CE curriculum

The second theme associated with leaving is *encountering barriers within the CE curriculum*. Barriers described by participants included course-related barriers (e.g., failing a required course) and personal barriers (e.g., feeling underwhelmed or a growing disinterest in CE curricular content). For example, Natalie, a sophomore with epilepsy, experienced both of these barriers as she began her undergraduate career:

> My friend [in] construction management had said that, "Statics is the most important," and then somebody else had told me [that] as well, and then the professor said, "If you are going to need a class, then it's going to be this one," and he said, "If you don't get this class, you can recover, but the content is still going to be very important." Well, the first couple of weeks I wasn't really getting it, but I was going to all the study sessions with one of the tutors. Then, after some of the tests that happened every two weeks, I wasn't getting it and they were still building off of each other and ... Yeah, I just … I was starting to ask myself ... at

> first it was asking myself, "Is this really for me? Am I sure about this? Do I really love this?"

A significant outcome of this barrier was the way Natalie began to question her competency as a future civil engineer. For Natalie, this questioning was spurred by feedback from her friend who was perceived as being associated with or knowledgeable about the civil engineering profession. Because statics is identified as a required skill for civil engineering, not acquiring this skill simultaneously means that one cannot, or should not, become a civil engineer.

She continued to question her interest in civil engineering in her introductory engineering class. After learning about a variety of engineering disciplines, she realized that she was not as interested in the civil engineering-related content as she expected or wanted to be:

> [. . .] in my Intro to Engineering class, we had a unit on each general type of engineering ... of electrical and mechanical, and it was a little more civil, but structural-based. And [. . .] we had an electrical area of that class, and it lasted for a lot longer than some of the other units that we had. [. . .] I don't know if it was me and my group that had kind of said, "When are we going to get a civil one? [. . .] and [the instructor] said, "Weren't you excited about the popsicle bridge?" [. . .] After reflecting about what that person I asked me, I thought, "Wow, I didn't really go as far as I should have if I really would have been passionate about structural or civil engineering as some of these people are about what they're doing."

For Natalie, ultimately hitting these barriers related to interest and technical content prompted her to navigate out of her civil engineering program.

Theme 3: Navigating intersecting stereotypes and compounding marginalization

Third, participants' decisions to leave were also linked to *navigating intersecting stereotypes and compounding marginalization*, which captured a compounding effect that participants described when experiencing stereotype threat [44] or marginalization due to their disability and gender identities in civil engineering contexts. This theme was most clearly articulated by Sammie, who describes the anxiety she experiences in class due to intersecting disability and gender identities and perceptions of her classmates:

> When people see females in engineering, they automatically think, "Oh, she's really smart. I need to go work with her." [. . .] A lot of girls that I talk to often feel like they're being taken advantage of because guys think they can get into a group with a girl, and they can just kind of freeload. But with that, I really, really struggle with the whole impostor syndrome thing, of feeling that, because I have a learning disability, and because I'm a female, I don't belong here. So then, boys see me, and they're like, "Oh, girl, smart, got to go with her." And then they freeload, and I'm struggling to keep up sometimes, and I'm worried that I'm going to be the dumbest one in this group.

In contrast to research that captures perceptions of women as being less competent in technical engineering content than men [48], [49], Sammie described an environment when she is expected to perform well at school because she is a woman. In this instance, Sammie's gender and professional identities conflicted with her learning disability identity and prompted feelings of impostor syndrome (i.e., fear that even though she is "supposed to be" smart as a woman in engineering, she is actually "dumb" because she struggles to keep up with the material) [50].

While Sammie's experiences reveal the intersectionality across gender, disability, and professional identity, other incidents identified under this theme revealed conflicts between disability identity and the civil engineering profession (i.e., Shawn needing to communicate with colleagues as an autistic engineer in the workplace) and the engineering student norms (i.e., Sammie using self-deprecating humor so that no one could "make fun of" her about her testing accommodations). This concept of navigating stereotypes and compounding marginalization was also inspired by the larger grounded theory study underpinning this work in which the majority of participants described their experiences with disability as having to work twice as hard as individuals without disabilities in order to achieve the same outcomes of success [27].

Theme 4: Leaving while remaining peripherally identified with the CE discipline

Our final theme focuses on participants' experiences of *leaving while remaining peripherally identified with the CE discipline*. While all participants had chosen to leave the major, they still maintained an identification with the civil engineering field broadly. Because of the stigma and prejudices that Shawn anticipated she will experience in the workplace; she relegates her interests in civil engineering to a hobby:

> Maybe this isn't, no matter how much you like the material, how much you really understand it, you can always look at it as a hobby. You can always learn how things are built for yourself, but if this isn't the type of, these aren't the type of people you want to work with ... If you don't want to work with this type of people now, you probably aren't going to want to work with those people in a lifelong career. You know?

Her peripheral identification with civil engineering becomes prominent in her decision to switch to a business management major that, while not in engineering specifically, is highly related to the CE subdiscipline of construction management. Similarly, Natalie describes that, despite no longer being enrolled in a civil engineering program, she still receives communication from the American Society of Civil Engineers (ASCE) and maintains an interest in the SmartBrief articles:

> One of the classes I took, Case Studies, it was called, and we had to sign up for emails from [ASCE] SmartBrief, and I still get those. I love the emails that we get because I'm still interested in all that kind of stuff. I'm still interested in airplanes. I'm still interested in all that kind of stuff; it's just not the area for me.

Natalie's peripheral identification with civil engineering has culminated in her choice to pursue a career in math education, a degree that she identified as still allowing her to engage with civil engineering students, but not necessarily at the disciplinary level.

Sammie's peripheral identification is the most easily recognized due to her career interest in transportation. Even though Sammie switched from civil engineering to industrial engineering, her career goals remained the same. With aspirations to be a transportation engineer, Sammie explained that the industrial engineering department at her university was fairly active in the transportation sector and provided her with mentorship and community among her professors and peers, which was something that she was not experiencing in her civil engineering department. This finding points to implications for future work of examining the cross-functionality of engineering careers, highlighting that receiving a degree in industrial engineering does not necessarily imply that an individual will pursue a career in industrial engineering [8].

Iteratively Experiencing Indicators of Dis-Identifying Not Belonging

Prior research has clearly demonstrated that identification with the profession and professional identity development is crucial for persistence and retention among engineering students and professionals, particularly for those belonging to minoritized groups [13], [51]. Findings from the present study echo those from prior work and underscore the importance of identity as it relates to retention and persistence in the engineering disciplines. Moreover, these findings highlight the ways identity is explicitly and implicitly communicated to students throughout their undergraduate experiences and demonstrate their impacts on students' identification with the field.

In this study, participant dis-identification with the civil engineering discipline came after experiencing iterative events that they perceived as indicators of not belonging in the civil engineering discipline. For Natalie, civil engineering was a career option that piqued her interest at the beginning of college; however, her true interests shifted to teaching. As she began to struggle in core civil engineering courses, she interpreted that performance as an indicator of not belonging and began to question her competency as a civil engineer and its plausibility as a career path. Shawn highly identified with the civil engineering discipline at the beginning of college due to her analytical and logical "ways of thinking" as an autistic individual; however, once she began to interact with others in the civil engineering field, she realized that her gender identity as a woman would pose significant issues for her throughout the remainder of her career, serving as an indicator of not belonging. Therefore, Shawn opted to pursue a career where she could still utilize her skills and talents without experiencing the gender dynamics often associated with civil engineering and, more specifically, the construction field. For Sammie, a lack of belonging in civil engineering was communicated through interactions of feeling undervalued in the department (i.e., feeling like 'just a number') and her own misalignment with the "cubicle culture" she experienced in her civil engineering internship. Therefore, when she encountered an impasse within her dynamics course, she opted to switch to an engineering major where this course was not required and where her needs for collaboration and community as someone with a learning disability could be met.

While not explicitly examined in this study, academic level also appeared to influence the ways participants negotiated across their identities and described interactions between their gender, disability, and professional identities. Out of the three participants in this study, Sammie was the only student to move beyond the second year of her civil engineering curriculum. Therefore, she could more easily articulate the ways her disability, gender, and professional identities interacted within the culture of her civil engineering program, as evidenced by the quotations drawn from Sammie's interviews in the previous sections. In contrast, Shawn and Natalie had limited experience with their civil engineering programs and had only taken one or two civil engineering related courses since coming to college. Because of this limited exposure to civil engineering, it was more difficult for them to articulate interactions between disability, gender, and professional identity. While Shawn and Natalie experienced conflicts similar to those described by Sammie, as suggested by the quotations in the previous section, one conflict typically mitigated – or overrode – the other, and in some instances, did not include disability. For example, Shawn experienced significant conflicts between her gender and professional identity (e.g., defending herself as a woman in civil engineering), whereas Natalie experienced a significant conflict between her personal identity and professional identity (e.g., becoming disinterested in technical civil engineering content). These nuances highlight the complex and dynamic influence of intersectionality and identity salience across contexts; however, future work will need to be conducted to further unpack these variations, particularly for the participants in the present study.

Conclusions and Implications

In this study, we used grounded theory approaches to conduct and analyze interviews with three women who identify as having a disability and have recently left or are transitioning out of a civil engineering program. The findings revealed four themes that illuminate why participants became dis-identified with civil engineering and ultimately left the discipline: 1) experiencing conflicts with dominant CE culture; 2) encountering barriers within the CE curriculum; 3) navigating intersecting stereotypes and compounding marginalization; and 4) leaving while remaining peripherally identified with the CE discipline.

Overall, this work contributes to ongoing efforts and broader conversations that seek to intentionally recruit and retain students into the civil engineering profession and into engineering in two ways. First, the themes identified in this study underscore the importance of how the explicit and implicit ways of belonging, or not belonging, are communicated to and interpreted by students. While one may argue that this feedback is purely part of the engineering education process for all students, regardless of discipline, we posit that their impacts on students belonging to minoritized groups may be greater due to the compounding effect of intersectional marginalization, as identified in this study. However, work that explicitly examines the difference in belonging between students from normative and non-normative groups using intersectional perspectives still needs to be conducted. Second, although participants in this study experienced altered or decreased identification with the civil engineering discipline, they remained peripherally identified with it. That is, while participants left the civil engineering discipline, they chose careers in math education (i.e., Natalie), management (i.e., Shawn), and industrial engineering (i.e., Sammie) to stay in the STEM fields. This finding prompts an examination of civil engineering curricula and how we communicate opportunities for different career paths that require civil engineering knowledge and skills and are outside of the sub-

disciplines. Approaching recruitment in this way may be useful in retaining students with diverse skills, interests, and goals that move beyond traditional expectations of what civil engineers do.

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