

**ORIGINAL ARTICLE**

# Advancing from outsider to insider: A grounded theory of professional identity negotiation in undergraduate engineering

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**Abstract**

**Background:** Engineers' identification with their profession is crucial for persistence among engineering students and career professionals. Significant research has been conducted on various dimensions of identity in the engineering field. However, little is known about the ways students negotiate these dimensions as they construct professional identities within a single engineering discipline such as civil engineering.

**Purpose/Hypothesis:** The purpose of this study is twofold in that we not only seek to enhance our understanding of professional identity formation but also to develop a theory that will allow future research to examine professional formation negotiations and processes through a single, interconnected lens.

**Design/Method:** In this grounded theory study, semistructured interviews with 31 undergraduate students were conducted and analyzed using constant comparative techniques. Frameworks situated within identity theory served as sensitizing concepts and undergraduate civil engineering education served as context to initiate theory development.

**Results:** The result of this study is the Negotiating Equilibrium: Advancing from Outsider to Insider model (the AOI model). This grounded theory model captures the dynamic process through which individuals iteratively integrate definitions of self and profession to develop professional identities during their undergraduate careers.

**Conclusions:** This grounded theory model provides a new framework to capture the complex negotiation process of professional identity formation in undergraduate engineering students. Overall, this work contributes to ongoing conversations that promote the diversity of experiences and backgrounds of students to paint a more holistic and diverse picture of engineering students and of the engineering field.

**KEYWORDS**

civil engineering, grounded theory, identity, qualitative, student development

## 1 | INTRODUCTION

It is well known that engineers' identification with their profession is central to learning and crucial for persistence in the field (Jones et al., 2013; Lichtenstein et al., 2009; Seymour & Hewitt, 1997; Tonso, 2014). Initial studies conceptualized professional identity formation as the accumulation of disciplinary knowledge during passage through a metaphorical pipeline of institutional stage gates, achieving stasis once an individual reached industry (Pawley & Hoegh, 2011). However, drawing from perspectives of situated learning (Johri & Olds, 2011) and the social sciences (Tonso, 2014), engineering education scholars have expanded this conceptualization to include personal and professional dimensions that constitute a more holistic process of becoming a member of a professional community (Atman et al., 2008; Foor et al., 2007; Koul, 2019; Sheppard et al., 2010; Stevens et al., 2008). The more an individual integrates their intimate or personal world with those of a particular discipline (Holland et al., 1998), the more likely they are to adopt the values, behaviors, and norms of that group and persist into engineering careers (Seymour & Hewitt, 1997; Tonso, 2014). Therefore, understanding how students integrate or fail to integrate personal and professional identity dimensions holds significant implications for enhancing recruitment and retention efforts to broaden participation in engineering.

In this manuscript, we introduce and describe the development of a new theory, *Negotiating Equilibrium: Advancing from Outsider to Insider* (the AOI model), which addresses gaps in our understanding of professional identity formation in undergraduate engineering. We focus on undergraduate civil engineering students as an initial study population to identify how students within a single discipline form professional identities. Findings from this work may then be applied to other engineering disciplines to establish a generalized model of professional formation across the field. Overall, the AOI model confirms, aligns, synthesizes, and interconnects existing frameworks to enable researchers to holistically examine diverse negotiations enacted by students that are both traceable across identity dimensions and related to their unique career goals and educational experiences.

## 2 | BACKGROUND

Multiple studies have examined the ways individuals from diverse groups experience engineering culture, form professional identities, and enter into the workforce (Cech & Rothwell, 2018; Du, 2006; Hatmaker, 2012; Jorgenson, 2002; Meyers et al., 2010). Scholars have shown that individual characteristics such as gender (Faulkner, 2000; Geisinger & Raman, 2013; Hatmaker, 2012) and race (McGee & Martin, 2011; Steele, 2011) shape self-concept, belonging, and other factors related to professional identity formation. These and other studies have highlighted normative sociocultural aspects inherent to engineering education (e.g., masculine, White) that students must mediate, navigate, and cope with in addition to their scholarly endeavors (Du, 2006; Faulkner, 2007). For example, Cech and Waidzun (2011) revealed conflicts in which LGBTQ students would pass or cover to cope with and navigate heterodominant environments. Current research is expanding this work by exploring the professional identity formation of groups typically not included nor explicitly addressed in engineering education research such as trans, nonbinary, and gender-nonconforming individuals (Haverkamp et al., 2019) and individuals with disabilities (McCall et al., 2020; Pearson Weatherston et al., 2017; Taylor et al., 2020). By bringing marginalized voices to the forefront of our work, we can challenge existing sociocultural norms that constrain conceptions of what engineering is and who can enter the profession.

To conduct this work, engineering education scholars have utilized a vast array of frameworks in education, psychology, sociology, and student development to explore personal and sociocultural aspects of engineering formation (e.g., Abes et al., 2007; Crenshaw, 1989; Gee, 2000; Jones & McEwen, 2000; Oyserman & James, 2011; Spears, 2011). Examining personal identity characteristics has provided researchers with the foundation to better understand the student experience and enhance engineering education practices (e.g., Cech & Waidzun, 2011; Faulkner, 2000; Foor et al., 2007; McGee & Martin, 2011). One of the most widely used personal identity frameworks is the model of multiple dimensions of identity (Abes et al., 2007; Jones & McEwen, 2000), which illustrates personal identity as a core sense of self influenced by dimensions that become more or less salient as an individual experiences and makes meaning of various contexts and social interactions. Relationships among identity dimensions have been further explored using intersectionality. Intersectionality, which was initially conceived as a social justice framework (Crenshaw, 1989), maintains that identity dimensions (e.g., race, gender, etc.) are reciprocal and simultaneous contributors to identity construction (Collins, 2015).

Other frameworks such as social identity theory (Abrams, 2015; Spears, 2011; Tajfel, 1974), communities of practice (Wenger, 1998), and professional socialization (Cohen, 1981) move beyond the individual and have been used to

examine the influence of social environments on students' development as engineers (e.g., Gilbuena et al., 2015; Keltikangas & Martinsuo, 2009; Rynearson & Rynearson, 2017). According to social identity theory, membership in a group is established through comparisons of values and behaviors that members make between one another and across groups (Abrams, 2015; Spears, 2011; Tajfel, 1974). Similarly, communities of practice and professional socialization situate personal and professional development as learning through a process of iterative interactions with group members and participation in a domain's social practices over time. Together, these frameworks underpin what Stevens et al. (2008) describes as the "double-sided perspective" of identity where individuals position themselves and are positioned by others through socially influenced constructs and ecosystems.

At the same time, engineering education scholars have used a number of identity theories to examine negotiations that individuals use to create a professional identity (Beckmon et al., 2019; Du, 2006; Foor & Shehab, 2009; Hatmaker, 2012; Jorgenson, 2002). Such theories include possible selves and possible identities (Markus & Nurius, 1986; Oyserman & James, 2011), identity negotiation theory (Ting-Toomey, 2016), and identity congruence (French et al., 2000). These frameworks place emphasis on both personal and social conceptualizations of identity that are not fixed but are iteratively altered and revised until a compatibility across dimensions is reached (Oyserman & James, 2011; Ting-Toomey, 2016). These frameworks not only bolster researchers' sensitivity toward different personal and social identity dimensions but also the processes involved for aligning the two, providing valuable insights into the ways identity is enacted or withheld in engineering contexts (Cech & Waidzun, 2011; Dryburgh, 1999; Paretto & McNair, 2012) and enhanced or diminished in engineering courses (e.g., Eliot & Turns, 2011; Faulkner, 2007; Loui, 2005; McNair et al., 2008; Walther et al., 2011).

Indeed, this body of work has been essential for gaining a foundational understanding of the ways engineering students experience and construct personal and professional identities. However, this work has most often been conducted via applied theories that limit investigations to only a portion of identity-influencing factors (e.g., race, gender, social or economic class, sexual orientation, etc.) in relation to sociocultural norms established across the engineering field. Moreover, existing work in this area is often generalized to all or multiple engineering majors (Allie et al., 2009; Dryburgh, 1999; McNair et al., 2011; Meyers et al., 2010; Tonso, 2007), which is problematic due to research indicating nuanced differences across engineering disciplinary cultures (Murzi et al., 2014, 2015). To gain a more holistic understanding of students' professional identity formation within their chosen engineering disciplines, more research is needed to examine the interrelations and interactions across established theories and frameworks (Hitlin, 2003; Morelock, 2017; Rodriguez et al., 2018; Stets & Burke, 2000; Tonso, 2014) while also considering students' evolving conceptions of who they will become as engineers.

In this study, we conceptualize professional identity formation as an identity constructed through formal and informal processes in which an individual learns, internalizes, and maintains the values, behaviors, and discourse of a profession as a result of social interactions with its members and disciplinary practices (Downey & Lucena, 2004; Dryburgh, 1999). To gain a more holistic understanding of the process by which students form professional identities within their chosen engineering disciplines, we ask the following research question: How do undergraduate civil engineering students form identities as professional engineers? To frame and guide our inquiry, we pose the following subquestions:

RQ1: What are students' initial perceptions of the civil engineering profession?

RQ2: How do students' perceptions of the civil engineering profession change as they enter college and navigate undergraduate experiences?

RQ3: What are the outcomes resulting from these changes in perception?

RQ4: How do these perceptions intersect with students' personal identities?

To address these questions, we focus our study on students majoring in civil engineering, the second-oldest engineering discipline (Grigg et al., 2013). We chose this focus for two reasons. First, the demand for civil engineers is on the rise (Bureau of Labor Statistics, 2019), bolstering the need for recruitment and retention of a diverse civil engineering workforce (Ohland et al., 2015). Second, we align our approach with the educational research design identified by Cobb et al. (2003) by limiting our examination to a single discipline. Scoping the study in this way provides us with a contextual frame for meaningfully identifying and operationalizing research findings (i.e., developing means to support learning and identity formation in civil engineering classrooms) prior to pursuing a theoretical model that is generalizable across engineering disciplines.

### 3 | METHODS

To articulate a nuanced process of professional identity formation as influenced by individual backgrounds and changing conceptions of the civil engineering discipline, we chose constructivist grounded theory (GT) (Charmaz, 2014) as the methodological framework for this study. Typically, GT is used when a theory is not available to understand or explain a process (Charmaz, 2014; Creswell & Poth, 2013). In the event that an applicable model does exist for the process under study, GT is also used to further develop the theory for a particular sample population that possesses valuable characteristics of interest (Creswell & Poth, 2013). In this study, we use GT to create a more holistic framework of identity formation that encompasses the assumed interactions and interrelations across multiple identity frameworks that have not yet been articulated. By exploring identity formation in an unbounded way (i.e., without the constraints of existing frameworks), we are able to better understand why and how undergraduate students form professional identities while experiencing perceived civil engineering-related activities inside and outside of the classroom. Interviews were conducted with 31 participants and analyzed using constant comparative methods, an approach typically found in GT studies (Charmaz, 2014).

#### 3.1 | Sensitizing concepts

Sensitizing concepts are used in constructivist GT studies as initial or tentative ideas relating to the research topic (Bowen, 2006; Charmaz, 2014). In this study, we identified three identity frameworks to serve as sensitizing concepts: social identity theory (Abrams & Hogg, 1990; Hogg et al., 2004; Hogg & Terry, 2000; Spears, 2011; Tajfel, 1974; Tajfel & Turner, 1979), Gee's (2000) four ways to view identity, and a multiple identities and identity saliency framework (Abes et al., 2007; Abes & Jones, 2004). Drawing from these frameworks, we conceptualized identity formation as the integration of an individual's intimate and social worlds as a professional-in-training (i.e., an engineering student) within a specific discipline (i.e., civil engineering) during their undergraduate career. This conceptualization enabled us to explore continuous interactions among multiple dimensions of an individual's personal values, beliefs, and behaviors with those established in the culture of civil engineering and vice versa. These sensitizing concepts informed a number of the research procedures employed in this study including the development of data collection protocols (e.g., temporally structuring protocols to capture changes in participants' positioning in relation to the civil engineering discipline—inspired by social identity theory), the identification of follow-up questions during interviews (e.g., asking participants to expand on described individuals, institutions, experiences, or personal characteristics that influenced identity formation—inspired by Gee's four ways to view identity), and the establishment of key themes to consider while analyzing the data (e.g., considering salient identity dimensions in participant accounts that promoted or hindered identification with the civil engineering discipline—inspired by multiple identities and identity saliency).

#### 3.2 | Data collection

Participants were recruited from a single, large land-grant university (LLG) using a combination of snowball recruitment, a survey that was distributed via email and in-person classroom visits. The survey consisted of three options for students to indicate their level of interest in study participation: (1) "Yes! I would like to participate in the study"; (2) "No thanks. I don't really want to participate in this study"; and (3) "Ummm. I need more time to think about this. I'll email you at [researcher email] if I would like to volunteer at another time." Students wishing to participate in the study were asked to provide contact information for interview scheduling. A range of sophomore-, junior-, and senior-level civil engineering students were recruited to gain a broad range of identity-shifting experiences that occur as a student moves up the academic ranks of their undergraduate civil engineering program. First-year students were not recruited for the study at the LLG because they were enrolled in a general engineering program and do not enter their disciplinary major until their second, or sophomore, year. All recruited students who responded to interview-scheduling requests were included in the study sample, resulting in a total of 31 participants (59% men, 41% women; 82% White, 9% Asian, 9% did not disclose; 48% juniors, 39% sophomores, 13% seniors; 100% domestic). These demographics are presented in an aggregated form to protect participant identities. As another form of identity protection, participants were assigned pseudonyms that are used throughout the manuscript. Other characteristics (e.g., LGBTQ,

first-generation college student status, disability status, socioeconomic status, etc.) were captured only if participants discussed these identity dimensions during the interview and were not collected during recruitment.

Data were collected using semistructured interviews lasting between 60 and 90 min and supplemented by a participant worksheet. The goal of the interviews was to achieve an in-depth exploration of individuals' experiences and events with an emphasis on participant perspectives and interpretation. Interviews were conducted using critical incident (e.g., Sattler et al., 2009; Simmons, 2012) and intensive interviewing techniques (Charmaz, 2014). The critical incident technique (Gremler, 2004; Grove & Fisk, 1997) was used to identify any incident, relationship, activity, event, or experience described by participants that either positively or negatively influenced their professional identity formation. Intensive interviewing was used to generate follow-up questions using participant language (Charmaz, 2006). All interviews were conducted by the first author.

The interview protocol was designed to facilitate conversation and explore participants' experiences related to five topics: (1) developing an initial interest in civil engineering prior to college or entering the major, (2) conceptualizing civil engineering while learning about the discipline during college, (3) speculating on future career experiences and goals, (4) describing experiences that informed Items 1–3, and (5) assessing the alignment between current self and anticipated future self in the civil engineering profession. To accompany the discussion, participants were asked to fill out a worksheet (shown in Appendix A), which was used to temporally and chronologically frame interview discussions (i.e., prior to college, during college, and after graduation) and provided participants with a space to record their evolving conceptions of civil engineering throughout their lives. Member checks were conducted at the end of the interview to ensure accuracy of participant accounts of their pathway into and conceptions of civil engineering. All interviews were audio-recorded and transcribed. Field notes were recorded to preserve the context of each interview and the subtle implications of topics discussed by participants and to supplement data analysis.

### 3.3 | Data analysis

Analysis of interview transcripts was conducted using several coding techniques in a constant comparative process directed toward theory abstraction. Constant comparison is a method of analysis that becomes increasingly abstract as the researcher iteratively compares newly collected data with existing emergent findings (Charmaz, 2006). This method was conducted until theoretical saturation was achieved and no new theoretical properties or insights could be identified (Charmaz, 2014). To supplement analysis, a series of initial, advanced, and integrated memos was recorded by the first author. Memos, field notes, and participant worksheets were used to examine initial trends in the data and identify areas warranting further inquiry during analysis and theory generation.

Data analysis consisted of six phases outlined by Charmaz (2014). Here, we summarize this process in three key phases: (1) identifying critical incidents and points of identity negotiation, (2) structuring incidents (i.e., the causes and outcomes) according to GT components, and (3) exploring the relationships among incidents. Final theory abstraction occurred as metarelations were identified across participant experiences. All analytical phases were completed by the first author. To ensure rigor and quality of emergent codes, categories, themes, and theory, the research team iteratively met and consulted with experts in identity and GT methods throughout the analysis process.

#### 3.3.1 | Phase 1: Isolating critical incidents and identifying points of negotiation

Early phases of analysis included open and focused coding conducted using line-by-line and incident-by-incident techniques, respectively (Charmaz, 2014). Based on the sensitizing concepts that underpin this study, the unit of analysis resided not within a single interview itself but within the participants' conceptualizations of incidents and events that served as indicators of shifts in identity (Corbin & Strauss, 1990). That is, while participants did not explicitly recognize their experiences as identity-influencing, these descriptions were conceptualized into emergent actions that were coded using gerunds (Charmaz, 2014) according to the context and meaning communicated by the participant. These early coding phases sought to capture not only “what” participants were saying but what they were “doing” with what they were saying to intentionally or unintentionally construct a professional identity. Open coding yielded over 100 codes that were clustered into 12 groups which captured incidents that conveyed similar meaning across multiple participants. An example of category development is shown in Table 1 (see Appendix B for a complete list of categories and their example codes).



**TABLE 1** Example of code clusters to form categories from Phase 1 analysis (these examples are meant for explanatory purposes only; a complete list of categories and example codes are included in Appendix B)

| Initial code name                 | Example from participant data  | Category name  |
|-----------------------------------|--|--|
| Reflecting on misconceptions      | "I think [my internship] was one of the points when I realized that the majority of engineering is not glamorous, and it's not awesome and cool. It's not nearly as flashy as you think it would be. A lot of it's just tedious and boring and it's a lot of red tape and a lot of upset people until you actually get it right, you know?" ( <i>Jimmy</i> )   | Defining/understanding engineering/civil engineering |
| Identifying societal implications | "Currently, I'm in a club called Bridges to Prosperity. We build bridges in developing countries. A lot of people look at developing countries and they're like, 'Oh, these people need better water systems and better sewage systems.' Yes, that's true, and yes, that's a part of civil engineering, but a lot of the times, they still don't think about the lasting impact of just a bridge over a river." ( <i>Meg</i> ) |  |

### 3.3.2 | Phase 2: Structuring critical incidents using GT components

During the intermediate phases of analysis, preliminary categories were axially coded to organize and structure the data, identify overarching categorical themes across participants, and initiate the development of an emerging theory. To begin structuring data, each category and its associated codes were dissected and assigned one of four GT components (Charmaz, 2006, 2014) according to its role within participants' overarching narrative: (1) causal conditions (i.e., factors that cause the core phenomenon), (2) intervening conditions (i.e., broad and specific situational factors that influence strategies), (3) strategies (i.e., actions taken in response to the core phenomenon), and (4) outcomes (i.e., consequences that result from strategies). Once all category clusters succinctly and accurately reflected both the contextual meaning (i.e., code contents) and role within participants' lives (i.e., assigned GT components), changes in preliminary category definitions and the development of newly created categories/components were recorded by the first author using advanced memos. Organizing the data in this way accounted for each component of GT while fostering a frequent, critical interrogation of the progressing analysis; prompting iterative articulation of emerging categorical definitions and descriptions; and establishing the initial structure of the developing theory.

### 3.3.3 | Phase 3: Exploring incident relationships through multiple perspectives

Upon identifying emerging GT components, we observed that participants experienced critical incidents from multiple identity perspectives that contributed to their professional formation. Therefore, the final phases of analysis included an abstracted examination to articulate categorical relationships among and across emerging GT components in relation to these perspectives. Theoretical categories (i.e., common themes that abstract an analysis to a theoretical level; Charmaz, 2014) were used to cluster critical incidents based on the context of participants' overarching narratives and emergent identity orientations. This coding process was iteratively conducted across all participant interviews, with category names and definitions growing increasingly abstract until all incidents could be classified. This coding phase resulted in three identity orientations and 15 identity negotiations. Each identity orientation and examples of its associated negotiations are included in Table 2. Examples from the data are further discussed in the Results section.

### 3.3.4 | Abstracting theory

During theory abstraction, the emergent relationships identified in prior analytical phases were reexamined according to participant narratives to develop an overarching and cohesive GT of civil engineering identity negotiation. To establish transferability, negative cases (i.e., data that sharply contrast emerging themes accounted for in the majority of the data; Charmaz, 2014) were identified in participants for which the theory did not hold. These participants prompted us to test the robustness of the theory, tweak various GT components, and further articulate relationships among themes.

**TABLE 2** Examples of identity orientations and associated categories identified during Phase 3 analysis (these examples are meant for explanatory purposes only; a complete list of orientations and their associated negotiations are included in Appendix C)

| Orientation      | Category                                       | Category definition  |
|------------------|--|--|
| Self-oriented    | Inverting the definition                       | Incorporating one's own characteristics into the definition of civil engineering                       |
| Learner-oriented | Elevating academic relevance for future career | Realizing the relevancy of learned content and its implications for future career aspirations          |
| Career-oriented  | Expanding the profession through articulation  | Articulating the nature of the civil engineering discipline while simultaneously expanding its meaning |

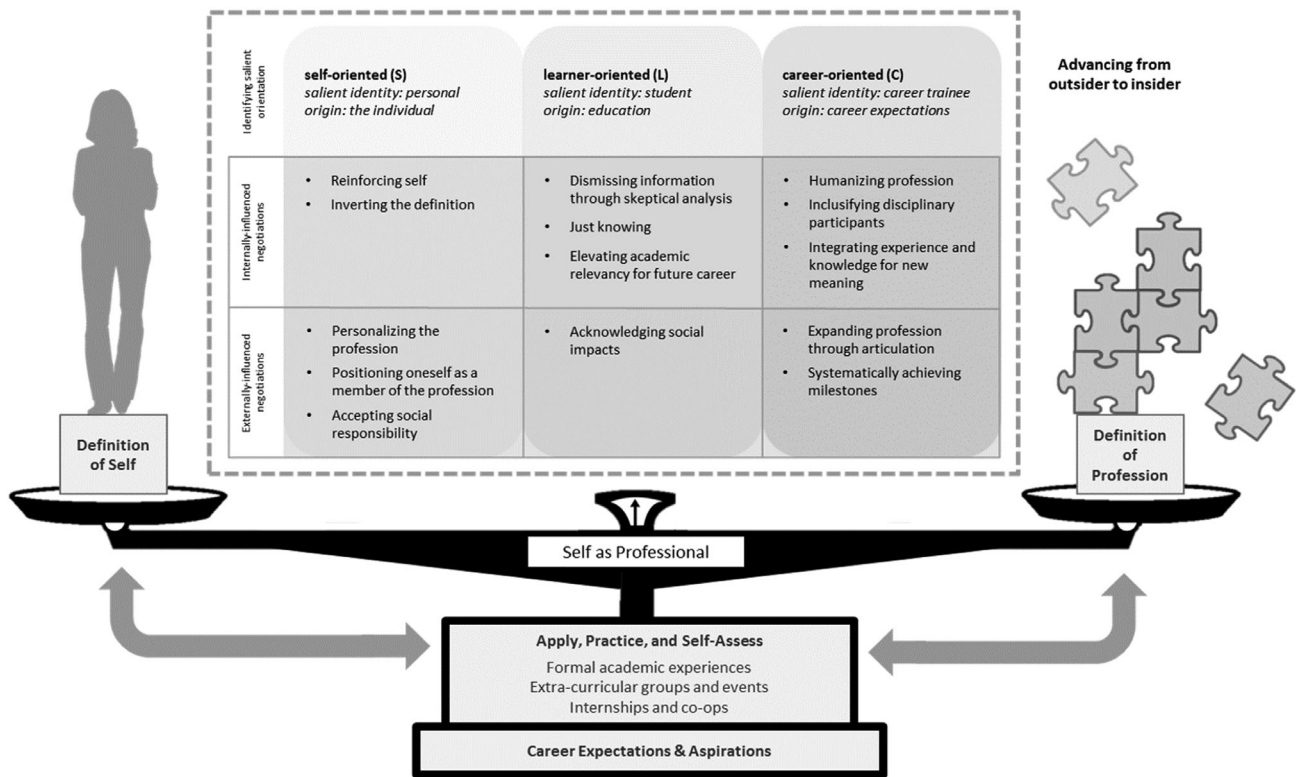
**TABLE 3** Summary of grounded theory components for the AOI model

| Theory component       | Definition  | Component within AOI model  |
|------------------------|---|---|
| Context                | The research context in which a study takes place   | Undergraduate civil engineering education   |
| Core phenomenon        | The central concept or phenomenon on which the process under study is based (Hachtmann, 2012) | Perceiving self as professional; living the definition  |
| Strategies             | Actions taken in response to the core phenomenon (Charmaz, 2014)                              | Negotiating definitions of self, of civil engineering, and of career aspirations and expectations |
| Causal conditions      | Factors that cause the core phenomenon (Charmaz, 2014)  | Learning new or unanticipated information   |
| Intervening conditions | Broad and specific situational factors that influence strategies (Charmaz, 2014)              | Self-assessment, practice, and application of perspectives inside and outside of the classroom    |
| Outcomes               | Consequences that result from the strategies (Charmaz, 2014)                                  | Advancing from outsider to insider  |

This process was iteratively conducted until all negative cases were addressed and the theory could be transferred across all participants (see Appendix C for the final theoretical codebook including identity orientations and strategies).

## 4 | RESULTS

The result of this study is a GT model titled Negotiating Equilibrium: Advancing from Outsider to Insider (the AOI model). This model, shown in Table 3 and modeled in Figure 1, captures the dynamic process of professional identity formation in which civil engineering students advance from an outsider (i.e., an individual not belonging to a civil engineering group) to an insider (i.e., an individual belonging to a civil engineering group). This formation is demonstrated through iterative negotiations between emerging and evolving definitions of self and the civil engineering profession in relation to the individual's future career aspirations. This process is visualized in Figure 1 as a scale by which individuals iteratively compare, negotiate, and align their definitions to remain identified with the discipline. During these negotiations, students utilize three types of identity orientations or approaches (i.e., self-, learner-, or career-oriented) that are either internally or externally influenced (collectively referred to as directionality) to align personal identity dimensions such as gender, family, culture, religion, and personal values with learned information acquired during their undergraduate experiences. Negotiations, listed within the dotted-lined box in Figure 1, are categorized based on identity orientation and directionality characteristics. These characteristics, also shown within the dotted-lined box in Figure 1, are represented as column and row headers respectively. As students continue through this process of negotiation and maintain alignment across their definitions, they begin to take command of and integrate these definitions as their future career goals evolve. Here, we use the term “alignment” to indicate a completed negotiation across definitions in which an individual can reconcile or situate identity dimensions in ways that enable them to maintain an identification with the discipline. In the event that these definitions cannot be aligned (i.e., cannot be negotiated), the model will collapse, indicating that the individual experienced a professional identity crisis and may ultimately leave the profession.



**FIGURE 1** Visual representation of the AOI model. The dotted-line box includes negotiations, categorized via identity orientations (column headers) and directionality characteristics (row headers) enacted by participants to maintain alignment between definitions of self and profession

Definition of self and definition of profession serve as the foundation on which the formal AOI GT model is based. Within the visual representation of the AOI model (Figure 1), definition of self is represented using an image of an individual's silhouette to capture them as a whole, complete with their own background, values, skills, and prior knowledge. Definition of profession is represented using puzzle pieces, indicating that multiple forms of knowledge about the profession are pieced together to create an overall definition that will continuously evolve and shift during the undergraduate experience.

Causal conditions, intervening conditions, and strategies are represented in Figure 1 in three ways. Causal conditions are represented by a scale on which students are attempting to align their ever-changing definitions of self and profession as they learn new or unanticipated information. At the same time, this alignment represents the core phenomenon “self as profession: living the definition.” Intervening conditions are represented as the supporting pedestal of the scale, consisting of the variety of learning environments in which students apply, practice, and assess their definitions in a feedback loop (indicated by the arrows in Figure 1). Strategies are captured within Figure 1 via a large matrix situated between the definition of self and the definition of profession components, outlined by a dotted line. In the strategy matrix, row and column headers separate negotiations by direction and orientation respectively. The appearance of these negotiations does not imply any form of order or importance; rather, it serves solely as a visual representation of the type of negotiations individuals may employ at any given time. As students attempt to align their definitions, they choose to enact any negotiation strategy relevant to their particular situation and context. Career expectations and aspirations were identified as the base of the scale on which negotiation decisions are made.

The core phenomenon is represented in Figure 1 using three components: (1) the scale that represents the relationship between definitions of self and profession; (2) the supporting pedestal of application, practice, and self-assessment; and (3) the foundation of career expectations and aspirations. The outcome of the AOI model is located to the right of the negotiation matrix and just above the definition of the profession component (shown in Figure 1). The position of this outcome was significant in two ways. First, its placement to the right of the negotiation matrix signifies its outcome status as a result of employing definition negotiations. Second, its position above the definition of the



profession component symbolizes individual advancement from outsider to insider as one constructs a more sophisticated definition of the civil engineering discipline.

To develop the AOI model, we used the research questions posed in this study as initiation points of inquiry and benchmarks for theory development. In the following sections, we outline the answers to each research question as situated within the AOI model.

#### 4.1 | RQ1: Understanding students' initial perceptions of civil engineering and self

To gain an understanding of the ways students form professional identities throughout their undergraduate experiences, we identified students' initial, or benchmarking, conceptions of the civil engineering profession and themselves. Analysis of interview transcripts and participant worksheets revealed that the majority of participants associated civil engineering with task-based skills (e.g., math and science) or with characteristics observed in their surroundings (e.g., buildings and bridges) prior to entering college. For many students, these descriptors aligned with their perceived skills and interests, which prompted them to consider civil engineering as a potential career option. Zane and Corey, for example, described civil engineering using the terms "math" and "buildings" that they aligned with their own skills and interests.

Students also offered more nuanced terms that highlighted variations across their diverse experiences. Linda used the words "dad," "structures," and "construction" to define civil engineering prior to college. She then explained that her father was a civil engineer and that he held a job in a construction firm. Similarly, Maynard used the words "regular" and "government" inspired by his father who was an engineer with a routine, 40-h work week at a government entity. Other students utilized words to capture stereotypical engineering characteristics such as "dorky" and "antisocial"; however, they were not viewed as derogatory, as highlighted by Brandon's comments below.

Interviewer: What are five words you would use to describe the field or at least what you thought about it?

Brandon: So, I guess, brutal in high school. Math, science, physics ... um, I heard all the dorky kids do it. So ... dorky.

Interviewer: Do you consider yourself to be dorky?

Brandon: Of course I do. You know, at some point, I do. I get ... I'm very fascinated by kind of ... dorky things. You know? How things fit together and stuff.

Meg embraced her cultural description of "antisocial" in a similar manner. After being asked if she perceived herself as being antisocial, Meg responded, "I'm really an antisocial person. I'm definitely an introvert. And not only an introvert, but I definitely find that I need time to myself often. I can be really outgoing, but it drains me really quickly if I'm doing that for any period of time." By aligning these definitions of profession to their definitions of self, students had already begun to inherently develop their professional identities as civil engineers prior to college.

#### 4.2 | RQ2: Changes in disciplinary and self-perception during the undergraduate experience

As students navigated their experiences, they were exposed to the valued behaviors, symbols, language, skills, and knowledge of the civil engineering discipline. In-class activities (e.g., attending a course, completing homework assignments, exams, etc.) and out-of-class activities (e.g., internships, co-ops, extracurricular activities, professional societies, etc.) provided students with opportunities to apply, practice, and self-assess their evolving definitions of self, the profession, and future career. As a result, their definitions became increasingly sophisticated and abstract. For example, the descriptor of "math"—frequently used by students prior to college—was abstracted to a more general term of "problem-solving" that captured broader engineering processes such as design and systems thinking (e.g., problem identification, solution selection, etc.). Similar shifts occurred for Meg who, after learning about the American Society of Civil Engineers Code of Ethics in a course, utilized terms such as "ethics" and "responsibility" to capture the personal and professional implications of the discipline and further articulated these impacts on her day-to-day life as a college student:

Meg: The meaning of [civil engineering] changes once you understand it better. I wouldn't just describe it as fun anymore because there's more responsibility to it than that. That's a good one, actually: responsibility. It's a huge responsibility to be a civil engineer. You're responsible for people's lives. That's one thing you don't realize until you get into school.

Interviewer: How has that changed you as a person in terms of realizing that responsibility?

Meg: It's definitely made me more careful with my calculations. I'm more likely to calculate everything out perfectly and make sure it's right rather than just being, "Oh, I think this is good." It makes me want to check my work back over.

For Meg, a junior, learning about the responsibility and ethics associated with the civil engineering profession shifted her perceptions of coursework. Rather than positioning her coursework solely as a way to gain and assess her knowledge about the discipline, it also served as an indicator of her professional development. Incidents of learning new or unanticipated information that fostered the negotiation of definitions of self and profession were identified as "causal conditions." The act of this resulting negotiation was identified as a "strategy." In Meg's context, identified strategies such as "acknowledging social impacts" and "elevating academic relevancy for future career" shifted her definition of self from a student navigating a civil engineering curriculum to an emerging professional training for her career.

In- and out-of-class experiences also provided spaces in which definitions were altered or shifted. Such instances were identified as "intervening conditions" in which participants carried out negotiations based on changing perceptions. After learning more about transportation in his civil engineering courses, Sid, a junior, gained a newfound understanding and appreciation for an infrastructure design that he initially "despised" while growing up:

Interviewer: Are there other instances in your life where you've seen just little things like that? That you might not have noticed before you knew what civil engineering was and what you were interested in?

Sid: There's a very confusing exchange. It's called a diamond interchange, and before I was a civil, I absolutely despised it. "Whoever came up with this is a moron. They paid an engineer to design it? It's so stupid." But now that I understand what it is, it's actually a whole lot safer. ... So now that I understand it. I'm like, "it's actually really smart." My mom still hates it. I'm like, "Mom it's actually good. I'll draw you a picture to show you why."

In this instance, Sid's courses served as an intervening condition to influence the negotiation strategy of "integrating experience and knowledge for new meaning." As a result, Sid reinforced his definition of self as a civil engineer, which he further enacted through his offer to explain the benefits of the design to his mother. Similar causal and intervening conditions were experienced by other students through their participation in global service learning and community outreach activities as well as internships and co-ops.

While some participants used these opportunities to define what the civil engineering profession is, others critically identified what the profession is not. Maynard, a sophomore, utilized his experiences in his first-year engineering course to compare and contrast the content he was learning with his conceptions of the engineering field:

It felt like [my instructors] were trying to turn something that wasn't engineering into engineering almost. It's really hard to describe because you could see where that would be engineering but, at the same time, we don't know anything and it's like they're expecting us to know something that we have no way of knowing.

In his explanation, Maynard acknowledges that while he did not have a firm grasp of what engineering is, he still felt as though the class project did not accurately simulate the skills or knowledge he anticipated needing in his future career (i.e., "It felt like they were trying to turn something that wasn't engineering into engineering"). Because of this misalignment, Maynard did not integrate this learned information into his definition of self or profession, rendering his definitions unchanged. This strategy, identified as "dismissing information through skeptical analysis," exhibited a negative case that was used to further distinguish shifts in participants' identities as they accepted—or rejected—new knowledge in relation to their developing identities and conceptions of civil engineering.

Negotiations served as the primary mechanism by which individual perceptions or definitions of civil engineering and the self changed. They can occur randomly (e.g., Sid), simultaneously (e.g., Meg), or not at all (e.g., Maynard)

based on the individual's preexisting definitions, learned information, and anticipated career expectations. In this feedback loop, students engaged in their learning environments to move beyond the passive accumulation of knowledge to iteratively monitor and construct their emerging identities as civil engineers.

### 4.3 | RQ3: Outcomes resulting from changes in perception

Changes in students' perceptions resulted in the identification of the core phenomenon and outcome of the AOI model. The core phenomenon, identified as "perceiving self as profession—living the definition," captures the overarching goal of balancing definitions of self and profession to maintain an identification with the field as students' perspectives change over time. Macy, for example, initially conceptualized civil engineers as men and, after beginning in her undergraduate program, conducted a negotiation to align her definitions. When asked to describe who civil engineers are, she responded, "Definitely not me. Like, I would never say engineer ... (points to self) me. I mean, now I do. But like, when I was younger, I would never be like, 'Oh, the girl.' I would always be male, I guess." To achieve this alignment, Macy employed a strategy identified as "inclusifying participants" to include women in this definition and position herself as a civil engineer. The resolution of conflicting definitions is also captured in the core phenomenon of "living the definition."

The outcome of the AOI model, Advancing from Outsider to Insider, captures an increased sense of belonging to the discipline. As participants gained more knowledge about the civil engineering discipline, they employed multiple identity negotiations that allowed them to accumulate knowledge useful to their future careers and take command of that information. Participants showed early signs of this advancement as they shifted from being an individual who solely received disciplinary information (i.e., an outsider) to someone who could also provide a more articulate explanation about the discipline (i.e., an insider). Indicators of these shifts included discursive changes such as pronoun use (e.g., participants referring to civil engineers as "them" at the beginning of the interview while referring to civil engineers as "us" later in the interview), demonstrations of civil engineering-related content knowledge (e.g., increased use of civil engineering-related terms and in-depth descriptions of disciplinary processes), and in-group/out-group comparisons with others (e.g., Cecilia positioning herself as an engineer in contrast to her roommates majoring in liberal arts). From this advancement, participants developed a professional identity as they learned and internalized these disciplinary characteristics and maintained the ability to enact that identity with regard to individuals inside and outside civil engineering. While the outcome of definition negotiations resulted in an individual's advancement from outsider to insider, the development of a professional identity was the outcome of the holistic process captured by this emergent theory. Exceptions to this concept are students who are not choosing to enter civil engineering of their own volition or see civil engineering as a gateway major to another field; however, all students within this study intended to pursue careers in civil engineering at the time of the interview.

### 4.4 | RQ4: Intersections of personal and professional identities

Characteristics that captured the intersections of students' personal and professional identities throughout the negotiation process were identified, the first of which was directionality. Drawing from the "double-sided approach to engineering identity" discussed by Stevens et al. (2008, p. 360), directionality captures the direction of an interaction between a dominant influence and a participant's perception of self or profession. Definitions controlled by perceptions of the individual were considered to maintain an internally influenced directionality whereas definitions controlled by external influencers were considered to maintain an externally influenced directionality. That is, some negotiations were identified and applied to the individual's definitions (e.g., a woman realizing that women can become civil engineers as she performs well on coursework) while other negotiations were imposed onto the individual by an outside source (e.g., a woman realizing that women can become civil engineers because her classmates tell her that she is a civil engineer). The second observed characteristic was salient identity orientations, which captured the specific identity dimension by which negotiations were approached. Participants enacted negotiations from three identity orientations: self-oriented, learner-oriented, and career-oriented. Definitions and examples of negotiation directionality and orientation are shown in Table 4, and a complete list of negotiations is included in Figure 1.

The learner orientation is situated within the educational context, capturing negotiations that students employ as a result of navigating university systems, curricula, and out-of-class activities that contribute to their general

**TABLE 4** Summary of negotiation orientation and directionality

| Salient orientation                                    | Definition  | Example negotiations   |
|--|---|--|
| Self-oriented<br>Salient identity:<br>Self             | Enacting negotiations that reinforce or shift an individual's personal identity   | "One of the most important values I have is just making sure I do a good job, anything that has my name on it, I always put 100% effort in something that I can be proud of at the end of the day. So now I guess, I sort of see that as being one of the ... an engineer's value sort of."—Neil (inverting the definition, internally-influenced negotiation)   |
| Learner-oriented<br>Salient identity:<br>Student       | Enacting negotiations based on learned information that was received, interpreted, and applied in learning environments to integrate definitions of self and profession | "I thought [engineering] was just going to be a hard thing that you kind of like, people just give you math equations to solve, or equilibrium equations to solve ... but it really is a teamwork thing ... which I think is something I would have not thought of."—Shawn (elevating academic relevance for future career, internally influenced negotiation)   |
| Career-oriented<br>Salient identity:<br>Career trainee | Enacting negotiations that position individual development as a future civil engineer or engineer-in-training   | "It's like once you're in, like once you know an engineer, you know what type. And then it's like now that I'm in civil engineering, it's like, 'What are you going to focus on?' There's water and land development, and materials, transportation, structures ... it just gets finer and finer until you get into what you actually want to do."—Maggie (expanding the profession through articulation, externally influenced negotiation) |

knowledge about the profession. Career-oriented negotiations, in contrast, capture the negotiations students employ to position themselves as a future civil engineer or an engineer-in-training. The distinction between learner- and career-oriented negotiations is based on the overall outcome of the negotiation; in a learner-oriented negotiation, the individual positions oneself as a lifelong learner and enacts the negotiation for the sake of knowing and growing. In career-oriented negotiations, the individual positions oneself for externally defined career purposes and career training. Within this study, participants' broader narratives and goals were also considered when determining learner- and career-oriented negotiations. However, further work is still necessary to better delineate and articulate these orientations, particularly once the student graduates and enters the workforce.

#### 4.5 | Tolerances of the AOI model: Experiencing an identity crisis

While the AOI model captures the dynamic ways students build professional identities, it also provides insights into deidentification, which can occur due to definitions that cannot be negotiated (i.e., definitions of self and profession would be significantly out of alignment and not reconcilable, with one side of the scale greatly outweighing the other). This phenomenon was highlighted by Macy, a sophomore, who realized during middle school that she wanted to be a chemical engineer and began to plan her career trajectory accordingly: "So then I did chemical engineering. So then from 7th grade up until this past summer, I was like, 'I'm going to be a chemical engineer.' I was like, 'That's my job.' I knew what I wanted to do with it, what direction I wanted to go in. I had everything planned." However, as she continued to learn about the discipline, she realized the profession did not align with who she was:

And then this time last year, I realized I didn't want to spend my entire life in a lab by myself. And I had this huge ... basically I had no idea what I'm doing with my life. I almost switched out of engineering entirely. I almost transferred schools. I didn't know what I wanted to do. ... I didn't want to spend the rest of my life in the lab by myself. Clearly, I'm very talkative.

Macy, who defined herself as a sociable person, identified a conflict with her definition of chemical engineering as an isolating profession. As her prior career aspirations in renewable fuels had diminished into a lonely laboratory scientist, her career foundation disintegrated, leaving her feeling lost and unable to negotiate her definitions. This experienced identity crisis almost propelled Macy out of the engineering field entirely. However, Macy redefined her career aspirations and sought out a profession that could satisfy her two guiding criteria: personal happiness and helping others. Through her own research, Macy identified that civil engineering fit these criteria and reestablished foundational career aspirations on which she could begin to negotiate her definitions of profession and self.

## 5 | DISCUSSION AND IMPLICATIONS

The AOI model introduces an interrelated framework that confirms and aligns with prior frameworks established in identity literature. For example, the component of definition of self aligns with existing personal identity frameworks such as multiple dimensions of identity (Abes & Jones, 2004; Abes et al., 2007) and intersectionality (Crenshaw, 1989). This portion of the AOI model holistically captures the multifaceted nature of civil engineering students complete with a variety of identity dimensions (e.g., race, gender, socioeconomic status, etc.) that influence their experiences of and navigation through their undergraduate engineering careers. At the same time, the definition of the profession component aligns with existing frameworks such as professional socialization (Cohen, 1981) and communities of practice (Wenger, 1998) that examine processes of professional formation through iterative and frequent interactions with members of the domain group and their practices, values, knowledge, and behaviors. Similarly, the concept of identity negotiation is also prominent throughout the AOI model, reflecting Ting-Toomey's (2016) identity negotiation theory that identifies the give and take between personal interpretations and constructs with those established in society or, in the case of this study, the civil engineering profession.

While the AOI model confirms and aligns with much of the existing identity literature, it also contributes to it in three significant ways. First, it identifies and articulates the identity negotiations enacted by participants. Unlike broad theories of identity negotiation and professional formation (e.g., Cohen, 1981; Ting-Toomey, 2016), the AOI model names the specific action a participant takes to complete the negotiation, determines the source of the negotiation (i.e., internally or externally influenced), and identifies the salient orientation of the negotiation and its role within the identity formation process (i.e., influencing the self as an individual, as a learner or student, or as one training for a career). Second, the inductive and emergent GT process used to generate the model enabled us to structure and clarify connections among concepts embedded within existing frameworks (e.g., connecting theories of dimensions of personal identity to theories of professional formation via identity negotiation theory and possible selves). Finally, the AOI model provides an initial conceptualization for individuals who experience an identity crisis and leave their intended profession. However, due to the limited number of participants who experienced this phenomenon in the study (i.e., Macy), more work will need to be conducted to further examine this process and determine other variations that may potentially exist.

These contributions yield significant implications for the research community. First, the AOI model provides researchers with a single, cohesive framework that not only captures a variety of concepts presented in existing identity literature but also offers a lens for exploring the complex, interrelated nature of how students construct professional identity. This careful synthesis that was developed through an intentional study of discipline-based professional formation is superior to combining multiple frameworks ad hoc. In contrast, the AOI model enables researchers to holistically examine the reasons for, the enactment of, and the outcomes of negotiations in relation to an individual's overall career goals and educational experiences. Moreover, the negotiations identified in this study provide researchers with an initial point of inquiry to structure and embark on qualitative, identity-based analyses. In contrast to prior frameworks that describe identity negotiations and formation as a process consisting of broad components or phases of development (e.g., Keltikangas & Martinsuo, 2009; Pierrakos et al., 2009; Weidman, 1989), the AOI model identifies the actions taken by participants to enact an identity negotiation, thus providing more insights into the impacts of these negotiations and their origins on professional identity formation. Finally, this study serves as a guide for conducting GT research in engineering education. While the application of this methodology has shown promise in this and other research studies (e.g., Simmons, 2012; Walther et al., 2011), it is not well represented in engineering education research (Case & Light, 2011). As some researchers grapple with the flexible yet systematic framework of GT (Charmaz, 2014), this study provides contextualized insights into the operationalization and application of this method in engineering education.



Notably, the use of GT approaches also posed some unanticipated outcomes for the development of the AOI model. At the outset of the study, we sought to develop a model of professional identity formation that was specific to the discipline of civil engineering. While we accomplished the research aim of model development, the increasingly abstracted nature of GT analyses elevated the description and naming of various components, leaving much of the context at the level of individual interview segments. This abstraction goes against the rationale that professional identity formation would vary across engineering disciplines and lends itself to transfer and application across engineering disciplines. However, we anticipate that there are negotiations present in the existing model that may be more prevalent in student conceptualizations of civil engineering than in other engineering majors. For example, the negotiations of “accepting social responsibility” and “humanizing the profession” may be more commonly discussed in civil engineering than in other disciplines due to the nature of civil engineering work (e.g., highly visible and large scale) and its reliance and emphasis on credentialing. In light of this proposition, however, more work examining the variations across engineering disciplines using the AOI model would need to be conducted to substantiate or refute this claim.

## 6 | LIMITATIONS AND FUTURE WORK

Within GT, data collection and sampling are “aimed toward theory construction, not for population representativeness” (Charmaz, 2006, p. 6). However, methodological limitations of our sampling and data collection techniques prompt further questions and highlight areas for future work, particularly for research on broadening participation in engineering.

First, the AOI model was developed from interviews conducted with 31 undergraduate civil engineering students from dominant identity groups (i.e., White and Asian) located at a single, predominantly White institution in the United States. Therefore, the AOI model is based on professional identity formation as experienced by undergraduate civil engineering students at this location. To address this limitation, future work will include studies that examine variations in professional identity negotiations across identity groups including individuals from nonnormative groups and their varied intersections (e.g., students identifying with minoritized race and/or gender groups, students with low socioeconomic status, students with disabilities, etc.) as well as considering the impacts of contextual influences such as chosen discipline/major and institution type. Gaining deeper insights into these individuals and contexts will enable us to examine and identify potential changes to the existing AOI model and to develop pedagogical practices and interventions to promote professional identity development in the classroom.

Second, while we sought to explore the dynamic process of professional identity formation throughout an individual's life, a single interview was conducted with each participant at a single point in time. To limit the influence of this limitation, we intentionally structured interviews that relied on and prompted participants to reflect on their pasts, describe the present, and speculate on their futures. While this structure enabled us to answer the research questions posed in this study, future work will include longitudinal methods of data collection that will enable us to capture the real-time evolution of professional identity formation. This will allow for a more authentic investigation of formation as an individual changes over time and will further enhance the current version of the AOI model.

## 7 | CONCLUSIONS

While a significant amount of research has been conducted to explore professional identity formation, the majority of studies provides broad components or phases of identity development. To gain a greater understanding of the approaches through which students integrate their personal and professional identities to become civil engineers, we conducted a GT exploration (Charmaz, 2014) to establish a holistic framework for examining students' professional identity formation. As a result, a GT model of professional identity negotiation, *Negotiating Equilibrium: Advancing from Outsider to Insider* (Table 3, Figure 1), was developed. This representation of professional identity formation is significant in that it provides a single, cohesive model that names specific actions taken by participants as they experience their undergraduate civil engineering education and form identities as civil engineers. As participants gained more knowledge about the discipline, they employed multiple identity negotiations that allowed them to accumulate knowledge useful to their future career aspirations and take command of that information. In this study, participants showed early signs of this advancement as they shifted from being an individual who solely received disciplinary information (i.e., an outsider) to someone who could also provide and articulate explanations about the discipline (i.e., an insider).

Students come to know and experience their engineering major in a variety of ways. Similarly, the ways in which they develop professional identities is also varied and unique to the interactions among individual background, perceptions of self, career aspirations, and alignment with a chosen major. Ultimately, we must consider identity formation as a nonlinear, variable process that occurs across time and experiences and consider the interactions of identity dimensions and orientations. This work contributes to ongoing conversations that promote the diversity of experiences and backgrounds of students to paint a more holistic and diverse picture of engineering students and the engineering field.

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**APPENDIX A.**

## Participant worksheet

Name: \_\_\_\_\_

| Prior to College | Now (During College) | After Graduation |
|------------------|----------------------|------------------|
|                  |                      |                  |

**APPENDIX B.**

Initial codebook that includes example codes from Phase 1 analysis. A complete list of open codes may be found in Groen (2017)

| Category name  | Description   | Example open codes   |
|--|---|--|
| Gaining an attraction to civil engineering           | A category containing codes that discussed how participants became interested in engineering or civil engineering.  | <ul style="list-style-type: none"> <li>Getting a jump-start on curriculum</li> <li>Competing for spots</li> </ul>              |
| Defining/understanding engineering/civil engineering | A category that captured how participants came to know engineering and civil engineering.   | <ul style="list-style-type: none"> <li>Reflecting on misconceptions</li> <li>Identifying societal implications</li> </ul>      |
| Negotiating engineering characteristics              | A category that captured how participants negotiated their perceptions of engineering and civil engineering.  | <ul style="list-style-type: none"> <li>Negotiating engineering work</li> <li>Establishing engineering criteria</li> </ul>      |
| Iterative comparison                                 | A category containing codes that captured how participants compared themselves to the civil engineering discipline and vice versa.  | <ul style="list-style-type: none"> <li>Presenting yourself (in vivo)</li> <li>Comparing desire, interest, and skill</li> </ul> |
| Connecting the self to civil engineering             | A category containing codes that described participant strategies used to connect themselves to civil engineering (and vice versa) and the feelings resulting from that connection.   | <ul style="list-style-type: none"> <li>Taking ownership of work</li> <li>Applying civil engineering to life</li> </ul>         |
| Separating the self from civil engineering           | A category containing codes that captured the ways in which participants separated their own skills, values, and behaviors from those traditionally belonging to the civil engineering profession.  | <ul style="list-style-type: none"> <li>Remaining undecided</li> <li>Doubting major choice</li> </ul>                           |
| Shifting perspectives                                | A category containing codes that captured the ways in which participants' perspectives or conceptions of civil engineering shifted as they learned about and engaged in the profession. These shifts could occur holistically regarding their perceptions of the field of engineering or be more localized to the participant themselves. | <ul style="list-style-type: none"> <li>Shifting from altruistic to local perspectives</li> <li>Realizing roles</li> </ul>      |
| Managing life as a college student                   | This category captured those individuals who influenced participants' professional identity formation and the contexts in which they are being influenced.  | <ul style="list-style-type: none"> <li>Getting through (in vivo)</li> <li>Enjoying learning</li> </ul>                         |

(Continues)

| Category name                                 | Description  | Example open codes   |
|---|--|--|
| Identifying overall outcomes and career goals | A category capturing instances in which the participant discussed or identified their overall outcomes or goals for career or life.  | <ul style="list-style-type: none"> <li>Being happy overall in career and life</li> <li>Getting a job</li> </ul>        |
| Being influenced by others                    | A category containing codes that captured how participants handled themselves within the educational context of college. Codes in this category captured multiple strategies that participants employed to be successful both academically and professionally. | <ul style="list-style-type: none"> <li>Relating to others</li> <li>Acquiring passive validation from others</li> </ul> |
| Navigating life decisions and plans           | This category captures the ways in which students navigate making their life decisions and plans based on a variety of contexts.   | <ul style="list-style-type: none"> <li>Mitigating pigeonholes</li> <li>Going with the flow</li> </ul>                  |
| Miscellaneous                                 | A category consisting of codes that captured items that were coded but did not fit into existing categories.   | <ul style="list-style-type: none"> <li>Giving advice to past self</li> <li>Credentialing</li> </ul>                    |

## APPENDIX C.

Final theoretical codebook:

| Self-oriented negotiations    |   |  |  |
|-------------------------------|---|--|--|
|                               | Code  | Definition   | Example  |
| Internal                      | Reinforcing self                                  | Identifying personal characteristics that are nonnegotiable and are integrated into conceptions of civil engineering             | "If you want to live close to a city, then live in the city. If you don't, then don't. But don't waste land that can never be used again. It's just not logical ... I wasn't going to sit there and pretend like [the job interview] was still on. I was like, 'Honestly, there's better ways to do things,' [the interviewer] was like, 'okay,' and then we moved on."—Madison [ <i>describing a disagreement during her interview with a land development firm</i> ] |
|                               | Inverting the definition                          | Incorporating one's own characteristics into the definition of civil engineering   | "One of the most important values I have is just making sure I do a good job, anything that has my name on it, I always put 100% effort in something that I can be proud of at the end of the day. So now I guess, I sort of see that as being one of the ... an engineer's value, sort of."—Neil  |
| External                      | Personalizing the profession                      | Developing a personalized definition of civil engineering by associating learned characteristics to their lives                  | "I never thought about it before, like where I lived and grew up. That was designed by somebody and their considerations and things probably shaped what I did."—Dave [ <i>reflecting on the impact that civil engineers had on his childhood</i> ]  |
|                               | Accepting social responsibility                   | Accepting or assuming a role of social responsibility as an inherent practice of civil engineering                               | "[...] I just know that if temperature rises and water level rises then people are going to have to squeeze up. As a land development engineer, I'm going to have to figure that out or try to help figure that out."—Craig  |
|                               | Positioning oneself as a member of the profession | Enacting discursive moves that exhibit belonging to the civil engineering group or maintaining civil engineering characteristics | "I guess we ... I want to say that a lot of civil engineers do things with structures, but that's not necessarily true I guess."—Linda   |
| Learner-oriented negotiations |   |  |  |
|                               | Code  | Definition   | Example  |
| Internal                      | Dismissing information through skeptical analysis | Dismissing learned information as irrelevant to prior conceptions and future career expectations                                 | "It's such a dumb project, honestly, in my point of view that is just ... I'm trying to think. It felt like they were trying to turn something that wasn't engineering into engineering almost."—Maynard [ <i>describing a project in an engineering course</i> ]  |

**Learner-oriented negotiations**

|          | Code   | Definition  | Example   |
|----------|--|---|---|
|          | Just knowing                                   | Maintaining a feeling that civil engineering is a destined career despite not having a clear definition of it | "I don't know. I didn't really know what else. I still don't know what else I would do [for a career]."—Linda [ <i>describing her continuation in her civil engineering program</i> ]   |
|          | Elevating academic relevancy for future career | Realizing the relevancy of learned content and its implications for future career aspirations.                | "I took the land development class and it was ... I found it really interesting and I liked what we were doing and I really felt that was a class that really was similar to how the real career would be."—Chad  |
| External | Acknowledging societal impacts                 | Acknowledging the social impacts as a result of civil engineering work  | "I would say civil engineers [...] do everything. All the projects are, or most of the projects are, for the public like wastewater, groundwater, everyone's tap water. Engineers are behind that. Bridges to cross over stuff—civil engineers; buildings—civil engineers, geotechnical engineers, and all that stuff."—James |

**Career-oriented negotiations**

|          | Code   | Definition   | Example   |
|----------|--|--|---|
| Internal | Humanizing the profession                            | Describing civil engineering or civil engineering work as being conducted by individual people rather than the profession as a whole | "It took someone to make that sign and it took someone to say that they wanted that sign there, and it took someone to put up that sign. So, it took three people that should know these standards [...]"—Sid   |
|          | Inclusifying participants                            | Demonstrating a belonging to civil engineering despite contradictions with existing perceptions                                      | "Definitely not me. Like, I would never say engineer ... me. I mean, now I do. But like, when I was younger, I would never be like, 'Oh, the girl.' I would always be male, I guess."—Macy [ <i>describing who an engineer is</i> ]   |
|          | Integrating experience and knowledge for new meaning | Integrating civil engineering-related and unrelated experiences resulting in a new meaning of the discipline                         | "It's like one of those things where you look at something and you can't look at it the same way again after you learn something about it. That's sort of me with everything now; like a road or a building or something. I bet it's a truss holding up that bridge or something like that."—Neil               |
| External | Expanding the profession through articulation        | Articulating the nature of the civil engineering discipline while simultaneously expanding its meaning                               | "But it's like, there's so many different things that I can do as a civil engineering that it makes me feel good."—Eleanor [ <i>describing her career options due to learning about the sub-disciplines of civil engineering</i> ]  |
|          | Systematically achieving milestones                  | Systematically achieving goals that are driven by career aspirations and expectations  | "I don't like the idea of leaving something just sort of on the burner and letting it let me stress out about it, like knowing I need to do 'this'. I need to do this. That's what gets me worked up and not enjoying what I do."—Jack [ <i>describing completing requirements to become a civil engineer</i> ] |

**Overarching outcome**

|  | Code                               | Definition   | Example  |
|--|------------------------------------|--|--|
|  | Advancing from outsider to insider | Gaining agency to take command over civil engineering-related discourse and explanations | "A lot of people are ignorant and don't understand. [...] your tax dollars actually go to stuff that you use every day. Some stuff gets frustrating, but I can always bring it up if I need to come at someone. It's like disrespecting engineers."—James [ <i>defending civil engineering</i> ] |