

NEW ENGINEERS' PERCEPTIONS OF THEIR TRANSITION TO PRACTICE

by

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ABSTRACT

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The transition from student to engineering practice is complex, ambiguous, and critical for new engineers. New engineers are typically moving from a highly structured curriculum into a highly unstructured work environment, making it essential to understand new engineers' perceptions and experiences throughout the transition to practice. This understanding can help improve the development of new engineers and the organizations that will benefit by supporting them. Given the relatively incomplete understanding of new engineers' transition to practice experiences, the goal of this study was to explore how new engineers perceived their transition to practice throughout their first two years as professional engineers.

This study followed an inductive interpretivist research design, using semi-structured interviews to gain access to information shared by participants. I interviewed 10 new engineers who worked for companies across the Midwestern and Northeastern United States. I used latent thematic analysis to code the transcripts' and to identify themes. New engineers shared perceptions about wide range of experiences that may inform stakeholders how to more effectively support future engineers transition to practice.

Findings demonstrated that new engineers' transition to practice occurs across a systematic process where they Move In, Move Through, Move Out of the transition to practice and Move On to engineering practice. The process captured elements of Schlossberg's Transition Process Model (Anderson et al., 2012) and Benner's (1984) Novice to Expert Competency Model captured new engineers' transition to practice. The findings differed from Schlossberg in two significant facets of transition: (1) engineers moving out of the transition to practice do not move onto a new situation, and (2) new engineers perceive skill development as a coping resource throughout their transition. Other contributions include finding that new engineers take control of their transition early in the process and that engineers use transversal skills to develop their technical skills.

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To

Bill and Marie,

Tyler and Elizabeth

Wim and Diane

and especially Nathalie.

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CHAPTER 1: INTRODUCTION

Over 135,000 engineers graduate from bachelor's and master's degree programs in the United States every year (Bureau of Labor Statistics, 2019). New engineers experience multiple changes while attempting the shift from higher education to the world of work (Trevelyan, 2019; Korte et al., 2019). The transition to practice signifies a critical junction in their lives as it presents challenges characterized by disparities between expectations and reality (Lutz, 2017). New engineers encounter changes in personal, economic, and societal situations as they grasp their new role's performance-related skills (Kovlachuk et al., 2017). The transition to practice presents challenges involving the acclimatization to organizational norms and values, adapting to workplace culture, establishing social connections, and meeting employer expectations (Brunhaver et al., 2015).

Many consider engineering an exclusively technical discipline; however, almost all engineers work within an entirely social environment (Trevelyan, 2010). Engineers use technical problem-solving supported, informed, and aided through social collaborations; however, at school, student engineers commonly work on self-contained, solvable problems that rarely incorporate the challenges outside the textbook's narrowly defined parameters (Sunderland, 2015). As a result, new engineers face unfamiliar challenges as they transition from school into the workplace and develop necessary technical skills. They also need to foster soft skills acquired through socializing with others in and out of the workplace (Robles, 2012; Cimatti, 2016; Craps et al., 2018). Therefore, new engineers learn across a technical and sociocultural continuum.

Another transition for new engineers involves meeting employer expectations (Aleryani & AlMunifi, 2019). Berdanier et al. (2014) have observed a disparity between the technical and

transversal skills required by employers and the technical and transversal skills which recently hired engineers ought to possess upon entering the workplace. Employers accept that engineering candidates will often lack the technical skills they want for the hired positions (Janhonen, 2017; Head, 2019). Therefore, employers hire engineers with the expectation that they will develop and learn the technical and transversal skills necessary to succeed in the positions for which they were hired (Gokuladas & Menon, 2014).

Engineers will continue to graduate and enter the workforce every year (Roy, 2019; BLS, 2019). Therefore, there exists a challenge to understand their perceptions as they transition to practice. They must adapt to meet their employers' expectations while adjusting to changes on and off the job. The engineering field could benefit from a better understanding of new engineers' perceptions as they transition to practice.

Problem Statement

For the new engineer, their transition to practice is challenging technically and socially and requires a significant time for multidimensional adaptation to the new environment (Korte et al., 2015; Hawse & Wood, 2019; Trevelyan, 2019). Employers consistently notice the lack of preparation demonstrated by new engineers in skills like collaboration, communication, creative and critical thinking, and other technical and social skills (Warsame, 2017; Berdanier et al., 2014). At the same time, employers continue to hire new engineers despite this apparent misalignment of expectations (Blom & Saeki, 2012; Korte et al., 2015).

Transitioning into the workplace requires social, economic, and environmental challenges that surpass the traditional conventions of engineers' tasks and responsibilities (Trevelyan, 2019; Korte, 2019). Employers want engineers who can work technically and socially inside and outside engineering practice (Korte et al., 2015). Consequently, new engineers are required to

have the ability to develop, access, research, understand, analyze, synthesize, and apply their technical and social skills (Trevelyan. 2019). Therefore, it is essential to understand the critical strategies and support that new engineers need as they transition into the workplace so educators can better prepare a curriculum to meet engineering students' needs. At the same time, employers can tailor onboarding programs to support the new engineers' transition to practice.

Purpose of the Study

This study examines the perceptions of the strategies and supports new engineers used during their transition from engineering school into the engineering workplace and how they self-identified throughout this transition as they developed the technical and transversal skills required for career advancement.

Research Questions

This study attempted to answer the following research questions:

MAJOR QUESTION: What were new engineers' perceptions of their transition to practice?

SUB-QUESTIONS:

- (a) What everyday situations did new engineers experience as they moved into, moved through, and moved out of the transition to practice?
- (b) What resources and strategies did new engineers use as they navigated the transition to practice?
- (c) What types of support did new engineers use to navigate the transition to practice?
- (d) How did new engineers develop and manage their personal and professional self-perceptions through the transition to practice?

Research Design

I used the inductive interpretivist approach to access new engineers' perceptions of their experiences (Schwartz-Shea & Yanow, 2012). This approach provided an opportunity to generate contextual and unanticipated data for new engineers' transition to practice and represented the perceptions, experiences, understandings, reflections, and choices.

The goal was to understand the socially constructed reality of new engineers' perceptions. I recruited and interviewed 10 participants using semi-structured questions that lasted approximately 45-90 minutes. I combined latent thematic analysis with thematic networks to code and analyze the generated data, after which I interpreted this data based on the codes and analysis.

Participants in this study shared their perceptions of their transition to practice. This study revealed insights into the perceptions of the progress made since the participants started their transition from school to their first professional workplace. Generating insights into participants' perceptions of their development helped them understand the skills and experiences that benefited novice engineers. Using their experiences, participants identified the moments they demonstrated learning and applied it to their development.

Definition of Terms

Listed below are the definitions of terms used throughout the study:

Table 1.1

Definition of Terms

Terms	Definitions
Transition to Practice	Because transitions to practice are context-specific, the beginning, middle, and end can change depending on the required education and chosen career path (Nilsson, 2019). I defined the transition to practice as

Terms	Definitions
	a degreed engineering program through the first two years of regular employment for this study.
New Engineers	For this study, I defined a new engineer as one who earned a bachelor's or master's degree in engineering and worked in their first role as a practicing engineer.
Situation	Any facet of an engineer's setting that influences the perceptions and ability to manage the school-to-work transition, for example, an engineering degree, provides a context to manage their transition. A situation may include the following facets: timing, control, role change, duration, previous experience, and other sources of stress (Schlossberg, 1981).
Strategy	A strategy is an integrated and holistic set of coping resources employed to manage the physical and emotional impact of the transition from school to work. Strategies may include decisions made to modify the new engineer's situation, gain control help manage stress during the school-to-work transition (Evans et al., 1998). Based on this definition, strategies involve technical and interpersonal skills to manage the transition to practice effectively.
Support	Support is the assistance provided to new engineers in or outside the workplaces that aided in transitioning to practice. Support included intimate relationships, family members, friends, mentors, coworkers, professional organizations, communities, and institutions.
Self	The self-included the perceptions influenced by personal and demographic characteristics and psychological resources (Anderson et al., 2012). In addition to different characteristics and resources, engineers also brought liabilities to their transition experience. As a result, the perceptions varied depending on an engineer's characteristics, resources, and disadvantages.

Terms	Definitions
School	The new engineer will have graduated from a bachelor's or master's engineering program within a year before employment with the host company.
Workplace	Each physical and virtual location where a new engineer conducted and facilitated business activities constituted a workplace. This approach accommodated engineers that worked on-site or remotely.
Technical Skills	The abilities, techniques, and essential competencies necessary to function as an engineer were quantified and measured. Technical skills were concrete, task-oriented abilities that involved proficiency in methods, processes, and procedures that support engineering practice. Examples include computer science fundamentals, data modeling, probability and statistics, and system design.
Transversal Skills	These adaptive and constructive performance capacities help new engineers effectively manage challenges in and out of the workplace. Transversal skills include identified the following domains: Critical and Innovative Thinking, Inter and Intrapersonal Skills, Global Citizenship, Information Literacy, and one more to cover health and values (Care & Lou, 2016).
Transition Shock	This shock is the unanticipated surprise to the interactions, responsibilities, obligations, comprehension, and performance expectations within an academic setting with those required within the engineering workplace (Duchscher & Windey, 2019). New engineers may experience unanticipated shock to their emotional, social, cultural, intellectual, and physical comfort. The ability to adapt to the personal and professional changes during the transition to practice may differ between engineers.
Skills Acquisition	The term divides acquisition into three contexts: cognitive, psychomotor/autonomous, and affective/associative. Cognitive skills

Terms	Definitions
	include learning, processing, applying knowledge, providing analysis and reasoned explanations, assessing information, and making informed decisions. Psychomotor/autonomous skills involve the ability to perform routine job tasks instinctively. Affective/associative skills include personal and professional comportment and connected managing attitudes and emotions in different situations, impacting challenges positively, and achieving the preferred outcomes.
Cisgender and Gender Fluidity	Cisgender means that a person's gender identity matches the designated gender on their original birth certificate (Molin et al., 2020). Gender fluidity refers to a person's gender expression or gender identity changing. This change can be an expression, an identity, or both (Molin et al., 2020).

Summary

While many employers provide specific examples of the recently graduated engineers' lack of preparedness, they still hire them, hoping they overcome their perceived shortcomings (Blom & Saeki, 2012). This chapter introduced the problem resulting from a deficit of insight and understanding of new engineers' perceptions of the transition to practice. I provided an overview of the research methodology. I described the interview process and how I inductively interpreted the interview transcripts to access and generate an understanding of participants' perceptions and experiences of their transition. The chapter concluded with a definition of terms used throughout this study. Before describing the specifics of the research methodology, it is critical to review the literature that uncovered the conceptual frameworks and studies revealing the research questions concerning new engineers' transition to practice.

CHAPTER 2: LITERATURE REVIEW

Engineers are not limited to slide rules and protractors to solve problems (Moss, 2017). The tools and techniques used by engineers today require skills in contexts in progressively hybridized work environments (Fields et al., 2019). These skills require communication, collaboration, critical and creative thinking, and problem-solving abilities for working in real-time worldwide with teams, customers, and subject matter experts (American Management Association, 2012). However, most new engineers enter the workplace without developing these skills in college (Kövesi & Csizmadia, 2016; Salleh et al., 2015). Harris (2019) noted that despite the growing numbers of engineers, there is a need to research what happens to engineers once they enter the workforce. In this chapter, I review the literature on recent graduates transitioning to practice, including the transition from engineering theory to practice, the transition to competence, and the transition experiences of engineers.

Literature Review Methodology

I used a systematic qualitative approach to conduct the literature review (Snyder, 2019) using English language publications ranging from 2012 to 2020, with exceptions made for oft-cited studies and primary research dating back to 1981, which served as foundational research. I gathered publications from the following academic disciplines: Science, Technology, Engineering, and Mathematics (STEM), Nursing, Human Resource Development (HRD), Education, and Psychology. I identified the articles cited in this dissertation using electronic indexes (Elton Bryson Stephens Company [EBSCO], Elsevier, and ProQuest). These indexes provided access to multidisciplinary databases (Academic Search Complete, Google Scholar, and JSTOR) and content-specific databases (ABI/Inform, Educational Resource Information Center [ERIC], Educational Research Complete, and ScienceDirect). Since there is little research on

new engineers' perceived transition to practice experiences, the database indexes provided a means of narrowing searches to the most appropriate databases to find articles that met the research criteria. The keywords search included "transition to practice," "transition," "recent graduates," "new employee," "first job," "school-to-work," "employer expectations," "21st century skills," "key competencies," and "employability."

Peer-reviewed journals provided the foundation of research for this literature review. In contrast, textbooks introduced transition research's primary theoretical and conceptual underpinnings. For example, textbooks gave me a better understanding of transition research, identified transition researchers, and helped develop this research study. Government publications provided statistics on the number of engineers graduating with a bachelor's or master's degree entering the workforce every year.

The search results returned more than 50,000 peer-reviewed articles, dissertations, conference proceedings, and grey literature (research that is not formally published) on the initial, unfiltered searches. The classification process to determine the inclusion of relevant and exclusion of irrelevant publications encompassed transition, development, and retention studies. Such a limitation could have yielded an incomplete picture of recent graduates' experiences and perceptions within their first 24 months of employment. However, conceptual papers on transition research, employer expectations, acquisition of skills, and engineers' experiences in the workforce generated a more authentic representation of this body of knowledge.

Throughout the search process, I evaluated material to ensure relevancy and focused on newly degreed engineers' experiences with their transition during the first 24 months of employment. I considered studies about high school graduates in their first full-time job post-graduation unconnected to the research topic. Also excluded from the search results was

literature focusing on the performance of new employees. After applying the criteria for inclusion and exclusion, respectively, 97 publications met the requirements for exploring transition experiences.

Transition Experiences in the Workplace

Focusing on the transition experiences of recent graduates in their first professional role, I found three themes related to workplace transition experiences emerged: (1) the transition to practice, (2) the transition to competence, and (3) the transition experiences of the engineers. The chapter concludes by identifying the gaps in the literature and the need for the current study.

The Transition to Practice

Engineering is a multifaceted field that incorporates multiple disciplines as part of engineering practice. Engineering programs provide students with the intellectual and technical foundations of the discipline and engineering practice fundamentals. Upon graduation, there exists an expectation that new engineers will become practitioners and apply their social and technical skills across multiple engineering disciplines to meet the basic requirements of their employer (Trevelyan, 2019). However, employers and educators do not often address the social aspects of the transition to practice (Jungert, 2013). Nevertheless, the new engineer experiences multiple changes that can impact their capacity to practice (Korte, 2018). Many changes cannot be recognized and understood until experienced (Anderson et al., 2016). The stress of fitting into the workplace and meeting employer expectations comes with pressures that educators and employers may not perceive as clearly as the new engineer (Gewirtz et al., 2018).

Moving into the workplace

New professionals face numerous challenges of varying complexity upon their entrance into the workforce (Parker et al., 2014; Phillips et al., 2014; Duchscher, 2012). Unprepared and

ill-equipped describe most engineers who transition to practice (Lutz, 2017). According to Murphy et al. (2010), recent graduates anticipate moving into a workplace; however, most do not anticipate the challenges accompanying the transition to practice: paying bills, getting along with coworkers, learning new skills, and fitting into the workplace. Lutz (2017) observed that new engineers described off-the-job events that impacted the school-to-work transition. Participants in this study reported unexpected challenges, such as buying a car or learning how to drive a stick shift, managing finances, and moving into a place of their own. The transition into the workplace presented novice professionals with complex patterns of diverse situations, where it was common to experience multiple and concurrent transitions for the first time (Meleis et al., 2000). Anderson et al. (2012) emphasized that simultaneous transitions could make coping with change difficult. Canney and Bielefeldt (2020) observed that engineers who lacked workplace experience underwent more difficulties during their transition than those who had workplace experience.

Transitioning to practice requires a departure from a familiar or recognizable set of roles, relationships, routines, and assumptions to establish new ones (Duchscher, 2012). A sense of loss and even shock can accompany a transition (Kramer, 1974; Duchscher, 2012). This sense of loss can trigger stress (Anderson et al., 2012; Duchscher, 2012). Korte et al. (2015) explained that new engineers in transition had expectations dissimilar to their employers, making the transition ambiguous and disorienting. Multiple studies observed new professionals experiencing challenges they neither felt prepared to face nor possessed the ability to handle (Walker et al., 2017; Ortiz, 2016; Wolsky, 2014; St. Clair, 2013; Duchscher, 2008, 2009, 2012). Riordan and Goodman (2007) found new engineers who experienced a shock as they transitioned from school to their first job post-graduation. Duchscher (2008) defined this as transition shock:

The experience of moving from the known role to the relatively less familiar role.

Important to this experience is the apparent contrast between the relationships, roles, responsibilities, knowledge, and performance expectation required within the more familiar practice setting environment to those required in the academic setting. (p. 3)

Duchscher (2008) identified the entry into the workplace and the subsequent orientation phase as the period where recent graduates experienced considerable confusion, disorientation, and possibly transition shock. Duchscher provided a theoretical basis to help employers support and facilitate new nurses' adjustment to the workplace. Her goal was to find a way to integrate new nursing professionals into professional practice successfully.

Although the transitions affecting nurses and engineers are not identical, evidence shows that change is central to the development and growth in both fields (Adams et al., 2016). The nursing field provides a suitable foundation to investigate the initial shock engineering graduates can experience as they enter the workforce. While the expectations and responsibilities will be different, the meaning of expectation and responsibility will still bring value to respective employers (Adams et al., 2016).

Riordan and Goodman (2007) found that the engineering profession recognized the need to formally train new graduate engineers to transition from the classroom to the workplace. They provided the lone research on the shock engineers experienced during their initial transition into the workplace by obtaining qualitative data through in-depth interviews with 16 participants with less than five years of work experience in a large utility organization in South Africa.

Participants in Riordan and Goodman's (2007) study reported a disparity between expectations concerning reality and what they learned in the classroom. Participants reported reality shock regarding their responsibilities, work environment, and perceived career mobility.

Participants expressed astonishment that their talents were underutilized and indicated they wanted to take on engineering projects that met their perceived skills. Another area of shock was the work environment. Participants experienced bullying from senior staff. Phillips et al. (2014) reported this aspect of workplace intimidation as a challenge that recently graduated nurses experienced during their transition to practice. In Riordan and Goodman's (2007) study, participants repeatedly referred to the work environment as limiting and oppressive, which may have influenced the shocks revealed in Riordan and Goodman's study. Participants found it challenging to reconcile the slow pace of work assignments and the slower pace for advancement.

Warsame (2017) explored the skills gap between school and the workplace through the experiences of 15 chemical, civil, mechanical, and electrical engineers employed by the oil industry. While this study did not address transition shock phenomena, Warsame's study participants reported shock concerning their work environment and work responsibilities. Participants were unprepared to meet the demands of "design calculations as well as the industry tools, rules of thumb, software used for sizing, and the industry standards that governed the specifications for the design of equipment (Warsame, 2017, p. 77). Although the participants in Warsame's study learned about the oil industry's equipment, this knowledge was primarily theoretical and limited to pictures and symbols found in textbooks. Participants reported that they did not make visits to the oil fields as students or during onboarding; as a result, when they first saw the actual size of the equipment they were working on in their new roles, they were shocked.

Much of the research framed transitions to practice unfavorably. Focusing on the disparity between school and work and the failures of external support strategies (i.e., supervisors, employers, education) used to prepare engineers for the workplace rather than

examining the strategies new engineers conceived and engaged in during their school-to-work transition. Further, this research primarily focused on the disparities between academia and industry's ability (or lack thereof) to prepare new engineers for the workplace. The study focused on preparing engineers in the future rather than on how engineers managed to transition in the present. Despite the reported transition challenges, most recent graduates overcome a transition's initial trials and tribulations to persevere as professionals in their respective fields. As several researchers have made clear (Riordan & Goodman, 2007; Duchscher, 2009; Fox, 2011; Kehrhahn & Peterson, 2014; Lutz, 2017), the initial transition into the workplace is only a phase. Duchscher (2008) maintained that once new nurses gained experience, their feelings of anxiety dissipated once they settled into their new role and applied their education to practice.

Transitioning from theory to practice

For many recent graduates, applying theory to practice is challenging (Sheppard et al., 2011; Brunhaver et al., 2017). Trevelyan (2019) maintains that transitioning from education to the workplace can be problematic for new engineers because incongruent expectations, poor work habits, and conflicting values clash with the reality of the engineering workplace. Lutz (2017) observed that practicing engineers solve complex, intricate, and unclear problems with no clear solution collaboratively with engineering practitioners and non-practitioners alike. Lutz reported that student engineers often worked on well-defined challenges with a single answer. Thus, professional engineers work in progressively unstructured environments and perform multifaceted tasks. Trevelyan (2010a) posited that new engineers must also learn to integrate the workplace's human factors—such as socio-political dynamics, the environment, and economic considerations—when transitioning from theory to practice. The vast differences in engineering practices, markets, functions, occupations, and technologies used across the multiple engineering

fields prohibit the specialization of education because it would limit student engineers' opportunities (Korte, 2018).

Kovalchuk et al. (2017) conducted a qualitative multi-site case study with 21 engineering graduates. The participants worked at four engineering companies in Ontario, Canada.

Kovalchuk et al. limited their research to participants who secured employment six months after graduation. Participants in the Kovalchuk et al. study reported difficulties applying theory to practice upon entry into the workplace. Some participants felt that they lacked an understanding of using their education in a real-world setting. However, participants also reported that their engineering education provided them with the ability to continue to learn. One participant thought their advanced communication skills separated them from candidates with similar skills for the same position—the ability to communicate served as an advantage in both the interview and their transition to practice. The crosswise analysis provided by Kovalchuk et al. showed that social skills benefitted engagement outside of engineering work. More critically, transversal skills aided new engineers in transitioning from theory to practice. Because engineering practice is collaborative and new engineers can get help from coworkers, it helps fill the gap from theory to practice.

Kovalchuk et al. (2017) also provided some insight into the elements of a successful transition to practice. However, their research did not consider the experiences of engineers that struggled with the transition. Further, participants reported that a family member or a friend connected to their employer facilitated the initial job interview. This lack of diversity of experience does not reflect the challenges that can accompany a transition. Nor does it provide insight into how novice engineering practitioners can overcome adversity during the transition to practice.

In other research, Okuma (2016) explored the school-to-work transition experiences of recent college graduates. Okuma conducted a six-month, qualitative, phenomenological study exploring 13 higher education student affairs administrators' experiences in their first professional assignment. Her findings showed that new student affairs administrators relied on previous transition experiences to manage their transition from school to professional practice. Like Kovalchuk et al. (2019), participants in Okuma's study reported that communication was essential during the transition. Further, participants agreed they enjoyed their work despite the challenges they faced through their transition.

Participants in Okuma's (2016) study reported experiencing a steep learning curve and an adjustment period. However, as participants became more accustomed to their workplace and new surroundings, stressors became strengths. Still, participants expressed frustration with their transition but did not convey it to their colleagues. One participant captured the frustration of transition with the following journal passage:

Rolling with the punches. I think that when you are getting hung up on small details or small speed bumps, you can easily get overwhelmed. But if you take it one day at a time, you can get through the transition. I want this to be over. (p. 119)

Okuma's (2016) findings are similar to other research studies on the same topic in different career fields (Kehrhahn & Peterson, 2014; Takase et al., 2012). New graduate mental health nurses in Cracknell's (2018) study experienced frustration at the lack of supervision. Participants felt this impeded their ability to develop their nursing skills. In Warsame's (2017) study, engineers expressed frustration at their lack of preparation and guidance to meet their chosen industry demands. Wong et al. (2018) found that new engineers struggled without guidance. Regardless of the career field, new professionals reported frustration with their

transition to practice. The reasons may differ; however, the frustration revealed a disparity between education and practice, expectation and reality, or both. According to the reviewed literature, the transition to practice is not without struggle.

Trevelyan (2009, 2010a, 2010b, 2014, 2019) observed that engineers devoted most of their time communicating with coworkers, subject matter experts, and their management team. Trevelyan (2010b) conducted interviews and field observations at engineering companies across Australia and Southeast Asia. His goal was to understand better how engineering practitioners perceived achievement and satisfaction with participating engineers across multiple disciplines and experience levels. Trevelyan (2010b) argued the need to reframe the conventional model of engineering practice from the solitary figure to a community of practice. Involving “combined human performance, in which expertise is distributed among the participants and emerges from their social interactions, exposes the social at the core of technical practice” (p. 176).

Trevelyan’s research (2009, 2010a, 2010b, 2011, 2014, 2019) emphasized the significance of communication in engineering practice. However, Trevelyan found that engineering practitioners often relegate communication to the periphery. Similar to Kovalchuk et al. (2017) and Hawse and Wood (2018), Trevelyan (2010b) observed that engineers in his study spent more time communicating with others than they spent on traditional engineering practices. Trevelyan (2019) argued that a collaborative understanding of engineering practice improved the transition from theory to practice. Trevelyan maintained that an engineer’s obligations should serve society and not the role of a lone problem solver. This obligation, according to Trevelyan, is the goal of a community of innovators.

Trevelyan’s (2010b, 2014, 2016) explorations of the misalignments between engineering education and practice demonstrated that new engineering graduates developed

misunderstandings about the nature and expectations of their work. Trevelyan (2019) argued that engineers must possess the following (p. 831):

technical knowledge and foresight [to] conceive, plan and [organize] delivery, operation, and sustainment of man-made objects, processes, and systems that enable productivity improvements so people can do more with less effort, time, materials, energy, uncertainty, health risk, and environmental disturbances.

Trevelyan saw engineering practice as a system that began with a student's declaration to become an engineer and extended beyond technical ability to include the world impacted by engineering practice.

While the research exploring how new engineers perceived the transition from theory to practice is limited, the study identified the collaborative skills essential to engineering practice as Trevelyan advocated (2010b, 2019). Hawse and Wood (2018) argued that new engineers' professional identities are deeply social as they are always “developed and refined based on feedback from peers, mentors, and role models” (pp. 21-22). Trevelyan (2009, 2019) advocates for engineering programs to implement engineering practice as a social system where students interact across disciplines to engage in a hidden curriculum—effectively learning to communicate, collaborate, and think critically and creatively with non-engineers. Korte et al. (2015) described how early-career engineers lacked access to their managers, thus relying on their coworkers for support during the transition from theory to practice. New engineers developed and fostered social networks within the workplace to train and develop, emphasizing “initiative, negotiation, and social and political interaction” (Korte et al., 2015; pp. 203-204). Thus, learning how to fit into the workplace was an integral part of transitioning from theory to practice (Korte et al., 2015; Hawse & Wood, 2018; Trevelyan, 2019).

Fitting into the workplace

Research has shown that establishing strong social bonds with coworkers has benefitted new engineers' transition into the workplace (Korte et al., 2015; Hawse & Wood, 2018; Trevelyan, 2019). However, fitting into the workplace is an essential element of professional success (Shipman, 2014; Moore & Cagle, 2012; Malouf & West, 2011). Participants in multiple studies expressed that establishing secure and meaningful social bonds in the workplace was significant to their perceptions of success (De Fruyt et al., 2015; Kehrhahn & Peterson, 2014; Moore & Cagle, 2012; Malouf & West, 2011). Takase et al. (2012) considered this aspect of fitting into the workplace fundamental to understanding a given workplace community's norms, culture, and values.

Alfrey and Twine (2017) examined how technically-skilled women negotiated to fit into male-dominated environments. Their qualitative study of 50 women engineers in 50 organizations identified a "spectrum of belonging" that delineated forms of inclusion or exclusion experienced by women depending on their race, sexuality, and gender presentation (p. 30). Alfrey and Twine found that White and Asian women successfully navigated workplace hostilities if they distanced themselves from conventional heterosexual femininity norms. This success eluded women who did not present as gender-fluid or could not change their skin color. Alfrey and Twine's (2017) study revealed the existence of "a gendered spectrum of belonging" (p. 45).

The difference is that White and Asian LGBTQ women who identified as gender-fluid or presented as gender nonconforming had a much easier time achieving a sense of belonging than their Black and Latina counterparts. Study participants' underlying theme was that it is best to fit into an engineering workplace if individuals present as gender fluid and racially dominant.

Alfrey and Twine's (2017) study presented the challenges and obstacles non-cisgender and non-racially dominant women can experience during their transition to practice. While Alfrey and Twine did not offer solutions to overcome the obstacles and barriers to fitting in, their study highlights the importance of fitting in and how not fitting in can marginalize new engineers.

The engineering workplace must create environments where new engineers feel as if they matter because mattering produces a sense of relevance (Schlossberg, 1989; Alfrey & Twine, 2017; Fouad & Santana, 2017; Clark, 2018). According to Schlossberg (1989), it is reasonable to feel left out; however, feeling marginal can lead someone to conclude that they do not matter. Schlossberg states that it is common to feel this way when taking on a new role. However, feeling needed and valued and connecting with others can impact an individual's success during a transition (Schlossberg et al., 1991). According to Schlossberg (1989), mattering is dependent on only one factor, "whether right or wrong, that we matter to someone else (p 7)."

Korte et al. (2015) investigated the social processes experienced by new engineers and managers in real-life settings in three different U.S. organizations. The study involved a purposeful sample of 41 newly hired engineers and 15 managers. The new engineers had begun working in their first engineering jobs within the previous 6 to 18 months (about one and a half years), and the managers supervised teams of approximately 8 to 20 engineers. Fitting into the workplace was an essential expectation of all participants. While new engineers made efforts to engage with their coworkers, mentors served as facilitators to help new engineers gain acceptance into the workplace (Korte et al., 2015). Participants in this study expected to fit in with their workgroups immediately. However, few participants experienced such camaraderie, and some did not fit in. Aligning with Alfrey and Twine (2017), Korte et al. (2015) reported that age and lifestyle impacted a new engineer's ability and effort to integrate socially into the

workplace. While age and lifestyle can be obstacles to camaraderie for most recent graduates, Korte et al. found that being respectful, understanding seniority, and even attempting to interact socially with peers while maintaining good workplace relationships mitigated these challenges. The critical finding from Korte et al. was that fitting in was more than learning the basics of the job. A new engineer must also learn to reconcile the complexities of social interactions and integrate multiple expectations and beliefs about the workplace.

Much of the research exploring how new employees fit into the workplace did not offer strategies to gain acceptance. Studies examined fitting in related to retention (Parker et al., 2014; Kehrhahn & Peterson, 2014; Alfrey & Twine, 2017). However, these studies addressed the ramifications of the inability to fit in—specifically quitting. Hawse and Wood (2018) argued that higher education and the workplace must focus on a holistic approach to engineering knowledge to support new engineers and the future of their engineering careers. Like Trevelyan (2010b; 2014; 2019), Hawse and Wood (2018) advocated the familiarization of engineering through multidisciplinary, social, ethical, and political contexts. They argued that this connects formal education with the practice of engineering. However, this approach did not provide new engineers with strategies to aid their transition to engineering practice.

Trevelyan (2010b; 2014; 2019), Hawse and Wood (2018), and Alfrey and Twine (2017) underestimated the importance of new engineers' agency in negotiating employer expectations and the multiple social interactions they faced throughout their transition to practice. Regardless of academia and the industry's ability to establish a collaborative community of engineering practice, ultimately, the process of fitting in rests with the new engineer as they alone perceive their transition (Anderson et al., 2012). Korte et al. (2015) observed that new engineers would

have to learn through trial and error to eventually develop good working relationships to meet their employer's expectations.

Meeting Employer Expectations

New graduates face a future no longer separated between specialists and generalists. Garner (2005) and Schleicher (2011) argue that the 21st century requires a new type of worker—the versatilist. Versatilists anticipate change and make the adjustments necessary based on their ability to incorporate relevant knowledge with a broad range of experience. Gartner (2005) and Schleicher (2011) stated that versatilists apply diverse skills to a wide range of situations and experiences; they are as comfortable with technical issues as they are with social situations. Versatilists may specialize in a particular discipline. However, they can fill multiple roles as situations demand, thus, preventing their obsolescence and making them an asset to their employer.

According to Schleicher (2011), this versatility is paramount for new graduates. Korte et al. (2015) argued that engineering requires multi-disciplined engineers to balance social, political, and civic landscapes with technical expertise. Hawse and Wood (2018) observed that engineers work within unstructured environments and perform multifaceted and multidimensional tasks. Trevelyan (2019, 2010a) maintains that engineering practice involves an awareness of social and political contexts, transversal skills, and environmental and economic insight.

Demirkan and Spohrer (2015) stressed that engineers must adapt and apply multiple skills to varied situations. Further, they argued that new engineers must consistently acquire new competencies and capabilities, foster diverse relationships within and outside of their field, and collaborate with a global workforce.

In their study, Kövesi and Csizmadia (2016) suggested that engineers must be able to adapt, learn, and grow with the ever-changing world of the 21st century. They stated that the skills identified for the 21st century need to be flexible and adaptable. Multiple researchers identified critical/creative thinking, collaboration, communication, civic/cultural awareness, and interpersonal/intrapersonal skills as essential (Binkley et al., 2012; Kivunja, 2014; Tan et al., 2015; Cameron & Devitt, 2016; Lutz, 2017;). Binkley et al. (2012) defined the skills for the 21st century to prepare for the future in educational standards and assessment: (1) Ways of Thinking (Creative and Critical Thinking, Problem Solving, Decision Making, and Learning to Learn); (2) Ways of Working (Communication and Collaboration); (3) Tools for Working (Information Communication Technology Literacy); and Living in the World (Global and Local Citizenship, Life and Career, and Personal and Social Responsibility).

Kivunja (2014) interviewed and surveyed employers to determine the skills most beneficial to new hires. Another researcher, Tan et al. (2015), developed a framework for better preparing students' entrance into the workforce. Through an industry survey, Cameron and Devitt (2016) identified the essential skills for new engineers. Lutz (2017) examined the skills experienced engineers reported would be most beneficial to new engineers. Further, Soulé and Warrick (2015) maintained that as technology flattens the Earth by eliminating physical boundaries through virtual connections, the need for an adaptable set of skills is an equitable commodity. It will afford individuals possessing these skills the versatility to succeed in a myriad of situations in work and civic life.

Gokuladas and Menon (2014) explored how employers select candidates at campus recruitment events in a different study. Their findings showed that nontechnical skills were better predictors of employment than technical skills alone. Gokuladas and Menon concluded that

companies hire candidates based on their social skills and trust to teach them to do the job. Finch et al. (2016) arrived at a similar conclusion by examining the skills employers want from graduate recruits. Participants in Finch et al.'s study reported that employers' preferred an adaptable candidate with a pleasant personality to candidates who have exceptional technical skills but lack adequate social skills. Finch et al. found that employers wanted a candidate that fit in with their organization. Artha and Hidayat (2019) explained that employers hired for organizational fit because it limited the opportunity for turnover and employee burnout. Researchers Sharma and Stol (2020) examined the importance of newly hired engineers' ability to fit in with an organization. They identified two critical factors to organizational fitness: their capacity to meet the job requirements and how well they fit socially within the workplace. According to Sharma and Stol, employees hired for organizational fit had a better transition into the workplace. Their study dovetails with Gokuladas and Menon's (2014) study, which found that employers hire candidates based on their work ethic, teachability, and cultural awareness attitude and then train them on requisite skills.

Carnevale (2020) sums up employers' expectations clearly and concisely: "When employers hire fresh out of school, they are often hiring strangers and therefore use academic qualifications (attainment, selectivity, and concentrations in particular knowledge domains) as signals for potential job performance" (p. 51). Trevelyan (2019), Korte et al. (2015), and Hawse and Wood (2018) all maintained that individual engineering potential is dependent upon their possibility as learners, innovators, and contributors to already established organizations. From this perspective, Carnevale (2020) stated that an employer's only expectation for a new engineer is their potential to develop and grow their skills to become an asset to the hiring organization.

Transition to Competence

Theoretical knowledge cannot take the place of real-world knowledge because expertise requires context and experience (Benner, 2001). Experience enables individuals to engage with their work environment, find solutions to overcome challenges, and develop a sense of understanding (Benner et al., 2011). Individuals with experience exhibit “habits of thinking” that inform them on how to respond to multiple situations (Benner et al., 2011, p. 43). These habits of thinking allow for adaptation if presented with unfamiliar challenges or if there is a lack of communication (Benner, 2001). Benner (2001) also recommended that different stages of proficiency align with distinct levels of career development.

Engineering work is multifaceted, dynamic, and globalized. The competent engineers of today must develop a wide range of skills to meet engineering practice demands. Benner (1984, 2001) observed that the transition to competence occurred by acquiring skills across a continuum of capabilities during a new practitioner’s transition toward independence. First, a new employee moved from reliance on abstract concepts to more tangible experience-based concepts (Benner, 2001). Second, novice learners’ perceptions of situations changed as they acquired new and varied experiences throughout their transition. Through real-world experiences, individuals expanded their perspectives. Benner et al. (2011) called this phenomenon thinking-in-action. In the final concept, novices transitioned from being spectators on the margins to becoming active participants (Benner, 2001). The real-world experience allowed engineers to challenge themselves and develop a sense of mattering within their workplace (Benner et al., 2011). Benner’s (1984) Novice to Expert model of the skills acquisition theory guided the implications and recommendations for this study.

Novice

Benner et al. (2009) classified the novice as an absolute beginner. Novices have no familiarity with their new situations (Benner, 1982). Their lack of experience resulted in context-free decision-making to guide their actions (Benner, 1984). This lack of experience meant that they could not apply independent analysis and focused on the parts of a problem rather than the whole (Benner, 1984; Dreyfus & Dreyfus, 1980, 2004). The novice used their academic experience to employ engineering practices (Trevelyan, 2019). Lutz (2017) observed that the goals and tools used in the workplace were unfamiliar to new employees; thus, they relied heavily upon their managers and senior engineering staff for guidance. Hawse and Wood (2018) noted that “traditional university curricula develop ‘expert students’ or engineering researchers, rather than novice engineers” (p. 18). However, the expert student fits in with Benner’s (2001) novice to competent transition as they both have limited experience on the job. This lack of ability to make independent judgments or decisions about the best approach to workplace challenges meant that they had to rely on their coworkers because they did not have enough work experience (Holland et al., 2018). However, Benner et al. (2009) observed that novices could apply prior experience from other domains to solve problems.

Advanced beginner

Advanced beginners demonstrate “marginally acceptable performance” (Benner, 1984, p. 22), can identify reoccurring problems, require direction setting priorities, and cannot see the entirety of a new situation. Advanced beginners have experienced real situations and recognize some significant challenges based on similar situations (Benner, 1984, 2001). They start to internalize their experiences but are not likely to distinguish subtleties that indicate an existing or impending problem. Advanced beginners spend more time focused on what they have learned in the past instead of differentiating between what is and is not essential. Advanced beginners need

ongoing support from more experienced engineers to manage strategies and recognize the critical challenges in their workplace. Advanced beginners demonstrate increased attentiveness to their work responsibilities; however, there is a lack of knowledge assimilation. Advanced beginners rely on their coworkers and seek strategies to identify reliable support sources. Advanced beginners may experience stress and burnout because they have difficulty strategizing the responsibilities required in a given situation (Benner et al., 2009).

Competent

The competent engineer can recognize the development of situations and patterns holistically. Decision-making skills come with direction, time, and guidance and provide perspective about work-specific aspects of their job (Benner, 1984). Benner et al. (2009) posited that with competency, individuals can plan for “what are now more predictable futures” (p. 193). Since competent engineers have more experience with different engineering situations, the competent engineer interprets and attempts to predict the immediate future demands to limit unexpected challenges. The competent engineer recognizes multiple aspects of a given situation and identifies that some solutions will require critical and creative thinking to predict what may happen in a given situation. The competent engineer has developed strategies to cope with stress by determining which factors to address and which to disregard. The competent engineer has established support structures, increased self-confidence, and has developed strategies to navigate almost any situation.

Throughout the transition to competence, individuals experience personal growth (Benner, 1982, 2001). Engineers transform from reliance on independence. When making an engineering decision, novice engineers look to a mentor to assist with decision-making; the advanced beginner looks to their manager to guide decisions; the competent engineer bases their

decisions on work-life experience. As recent graduates gain experience with their colleagues and their organization, they transition from being on the margin to becoming a team member that matters to organizational success.

Petkau (2014) conducted a quantitative descriptive study to identify the gap between new and experienced engineers. The findings indicated that new engineers spent a great deal of their time under the senior staff's supervision. The study showed that socialization was one of the most critical engineering skills. New engineers spent most of their time communicating and collaborating with senior staff. Senior staff reported that new engineers lacked a firm grasp of engineering knowledge. However, new engineers self-reported their engineering skills higher than their superiors. Petkau interpreted this disparity as new engineers' lack of experience. Senior engineers could better identify their weaknesses and engage in lifelong learning to improve areas they determined deficient. New engineers lacked perspective beyond their workplace expectations.

A limitation of Petkau's (2014) study is that only expert and novice engineers responded. Without participants representing the different proficiency levels, as observed by Benner (1982), there was no way of knowing how engineers who had not achieved the expert level engaged with their engineering practice. However, that was not the goal of Petkau's (2014) research. He identified a skills gap between senior and new engineers. Moreover, experienced participants reported that the socialization of engineering practice was the best way for new engineers to close this gap. While Petkau did explore other skills, participants did not provide enough feedback to draw anything more than a preliminary exploration for future research. However, the interaction between new and experienced engineers in Petkau's (2014) study connected with

Wong et al.'s (2018) exploration of workplace mentorship. Evidence showed that novice engineers benefitted through collaboration with and learning from senior engineers.

Transition Experiences of Engineers

Upon graduation, the engineering student becomes an engineering practitioner (Korte, 2018). The practice of engineering exists on a bridge of possibilities connecting a web of domains beyond the technical (Hawse & Wood, 2018). Engineers connect social, political, economic, and environmental contexts through concrete, collaborative, and complex work (Elgert, 2019). Thus, the transition from school to practice is critical for engineering graduates entering the workplace (Trevelyan, 2019). Engineering programs provide students with fundamental engineering principles and analysis to drive the future of technological change (Korte et al., 2015). However, Pramila and Muthukrishnan (2019) stated that engineering students graduate without the transversal skills necessary to meet industry demands. They observed that engineering schools often overlook the importance of communication, design, and technical problem-solving (2019). Further, Pramila and Muthukrishnan found that student engineers do not learn to communicate within a workplace inhabited by engineers and non-engineers alike. Korte (2019) emphasized that engineers must effectively interact with engineers and non-engineers. Thus, new engineers need a combination of technical proficiency (technical skills) and transversal adaptability (interpersonal and intrapersonal skills) to develop their engineering competency (Korte, 2019; Trevelyan, 2019; Hawse & Wood, 2018; Lutz, 2017).

Transition to technical skills

Historically, technical skills are the basic skills required for employment, known as hard skills (Robles, 2012). Technical skills can be general and specific (Hendarman & Cantner, 2017) and are methodical, academic, tangible, and measurable (Agarwal & Ahuja, 2014). Deepa and

Seth (2013) observed that “so-called hard skills soon become outdated when there is no motivation to keep learning new ones” (p. 16). Technical skills are competencies that employers use as a filter to screen candidates for hire. In contrast, transversal skills (for example, communication, collaboration, analysis, and lifelong learning) enhance technical skills to help individuals advance in their careers (Henville & Smith, 2014). Dixon et al. (2010) maintained that technical skills are easy to identify because they are demonstrable and verifiable through testing, allowing them to compare individuals quantifiably.

Florea and Stray (2019) investigated online advertising to identify the essential technical skills and assessment tools software engineers needed to test software. They found that employers needed testers that could demonstrate an ability to write and execute automated and manual tests. The majority of testers were requested to have an average of 10 testing skills and a broad spectrum of testing tools.

Florea and Stray (2019) observed that the need for highly qualified software testers with solid technical skills benefits the globally distributed working environment. Software engineers who could write and execute testing frameworks facilitated collaboration with similarly skilled engineers allowing for greater control of the testing process. This study’s limitation was the restriction on software engineers specializing in writing and executing testing software. According to Florea and Stray, the testing industry values technical ability above social skills. This value is not the case across the industry (Trevelyan, 2019), as each discipline places different values on specific skills. Florea and Stray (2018) conducted an earlier study focusing on the engineers’ transversal skills to meet the software developers’ demands. They observed that transversal skills augmented technical skills; thus, they argued that transversal skills are essential to employers and employees.

Transition to transversal skills

Engineering practice requires a blend of multifaceted technical and social competencies (Trevelyan, 2019). Transversal skills, or soft skills, exist within the multidimensional interactions across all aspects of engineering practice. These competencies describe the non-iterative, interpersonal, intrapersonal, and professional skills required for engineering practice (Collet et al., 2015; Pennington, 2015; Stewart et al., 2016; Rao, 2014; Robles, 2012). These competencies empower engineering practitioners to leverage collective technical skills to anticipate, strategize, organize, and coordinate numerous contributions, maintaining task objectives and operational integrity (Korte et al., 2015; Hawse & Wood, 2018; Trevelyan, 2019). Again, the literature presented evidence supporting that engineering practice required integrating interpersonal and technical skills.

Researchers have created multiple lists of non-iterative, interpersonal, intrapersonal, and professional skills that share a common outcome for aiding personal growth, skills development, project management, learning, and professional success (Robles, 2012; Gibb, 2014; Trevelyan, 2014; Lou & Care, 2016). Employers have reported a wide variety of transversal skills that benefit employees and the workplace (Blom & Saeki, 2012; Cimatti, 2016; Parasuraman & Prasad, 2015; Vyas & Chauhan, 2015). These skills included a nebulous web of interconnected skills from the following domains of competence: analytical, interpersonal, intrapersonal, adaptive, cultural, critical, civic, and performative (Griffin et al., 2012; Care & Lou, 2016; Craps et al., 2018). Brungardt (2011) argued that the future of engineering practice would exist within more autonomous environments, and employees will interact with many individuals; therefore, engineers will need to make decisions independently. They must develop skills beyond mere technical ability. Prinsley and Baranyai (2015) advocated for work-integrated learning methods

and strategies to facilitate new engineers' transition from engineering theory to engineering practice. They state that exposure and experience is the best way to acquire transversal skills.

In other research, Colman and Wilmot (2016) surveyed engineering students, educators, and employers on the importance of transversal skills in engineering practice. Over 90% of the surveyed population considered transversal skills an essential engineering aspect. However, 71% thought technical skills were more critical than transversal skills. Colman and Wilmot suggested that participants believed transversal skills supported technical skills. However, 82% of participants agreed that while technical skills provided the necessary employment qualifications, transversal skills benefitted career success. Colman and Wilmot conducted interviews with employers after analyzing their survey results. Employers reported that the demand for transversal skills would increase as automation and integration socialize engineering practice. Colman and Wilmot stated that engineers do not work in isolation. Thus, more evidence supports that engineers must work collaboratively and communicate effectively.

One of the biggest challenges concerning transversal skills is subjectivity (Vasconcelos et al., 2019). Transversal skills do not have a clear definition, as each industry values different analytical, interpersonal, adaptive, cultural, critical, and performative skills. Thus, studies exploring transversal skills have difficulty quantifying data empirically. Colman and Wilmot (2016) provided great insight into the perception of transversal skills. However, they framed the transversal skills for their study, and they included senior and novice perceptions of transversal skills together. Lutz (2017) and Petkau (2014) observed that novice engineers lacked the experience to evaluate their skills and abilities, and further, novice engineers overestimated their capability and underestimated the value of transversal skills.

Colman and Wilmot (2016) sought a deeper understanding of their interviews. They found that more experienced engineering practitioners placed a high value on transversal skills. The high value placed on technical skills from the survey results suggests that inexperienced engineers lacked the perspective to see the bigger picture, as Benner established in her adapted framework of novice to competence (1982). Colman and Wilmot's study did raise an intriguing question. Why do inexperienced engineers place a lower value on transversal skills than their more experienced counterparts?

The Gap in Literature and Need for Current Study

As educators endeavor to prepare future engineers for the workplace, employers attempt to hire engineering candidates that will allow them to maintain and grow their businesses, and new engineers strive to transition from school into the workplace. Current research must address some of the challenges facing engineering stakeholders as they prepare for the future of engineering practice. My literature review on the transition to practice included studies exploring challenges new engineers may encounter during this time of change in their lives. A dearth of research revealed opportunities for further investigation. This section provided insight into the literature gaps that helped me arrive at the questions that guided my research.

Korte et al. (2019) examined the socialization experiences of recently hired engineers. They found that “workers will seek job and career satisfaction inside and outside of their current organization or occupation” (p. 107), suggesting that new engineers' experiences are subjective and likely to be socially driven. Accordingly, the skills required during the transition to practice are defined subjectively. Thus, it is crucial to understand better how to enrich engineering students' educational experiences to become engineering practitioners and for employers to better support the transition experiences of recently hired engineers.

There has been a considerable history of criticism from employers and graduates regarding the inadequate preparation of engineers for the workplace (Korte et al., 2019; Cheville, 2014; Johari & Jha, 2020). Brunhaver et al. (2018) observed that criticism focused on educators being ill-equipped to prepare students with skills, such as social skills, because each hiring organization has its specific social contexts within their workplace. Participants in Warsame's (2017) study reported similar criticism regarding technical skills. New engineers encountered software and technical practices that they did not learn in school. Hawse and Wood (2019) claimed that it is unreasonable to expect engineering institutions to prepare students for the specialization they may confront upon their transition into the workplace. Boiarsky (2004) stated that engineering educators "cannot prepare our engineering graduates of today by instructing them only in content-specific areas. What we can and must do is teach them to learn to learn" (p. 259). The reality is that despite the criticism by employers and alumni of engineering programs, employers will continue to hire engineering graduates regardless of the perceived inadequacies of their education (Head, 2019). Thus, it is essential to understand how new engineers overcome a perceived deficit of technical and social skills to develop into competent and productive engineers.

Engineering practice is increasingly intersecting with other disciplines (Trevelyan, 2014). As a result, Hawse and Wood (2019) argue that engineering is moving "away from an exclusively technical domain, and towards developing technical solutions in a multidisciplinary, social, ethical, and political context" (pp. 25-26). This move supports the subjectivity of experience described by Korte et al. (2019) and the importance of learning how to learn, as advocated by Boiarsky (2004). Further, it highlights the need for understanding how new engineers perceive the real work of engineering. It is not educators or employers that will make

meaning of the experiences new engineers encounter in the workplace. They alone will access the knowledge and capability of coworkers, navigate projects, interpret expectations, and manage the development of their technical and social skills to achieve workplace success.

Regardless of an engineer's skill set upon graduation, employers will continue to facilitate the transition to practice irrespective of whether engineering education aligns with the needs and wants of engineering practice (Janhonen, 2017). While researchers (Trevelyan, 2019; Warsame, 2017; Mohlamme, 2015; Petkau, 2014) have demonstrated that new engineers face challenges as they enter the workplace, there is little understanding of new strategies and skills engineers find most beneficial as they integrate into the workplace. According to Lutz (2017), the transition to practice does not exist within a vacuum; new engineers experienced multiple transitions inside and outside the workplace that impacted their transition.

Summary

This chapter presented a literature review related to new engineers' transition to practice and described the literature research methodology used to detail the studies examining the complexity and ambiguity surrounding the school-to-work transition and the possible challenges new engineers may face during this time of change in their lives. I explained how Benner's (1984) Novice to Expert model of skills acquisition accompanies a new engineers' school-to-work transition experience. Existing literature supports the idea that new engineers experienced unanticipated events during the transition to practice (Trevelyan, 2019; Hawse & Wood, 2019; Blom & Saeki, 2012). Duchscher's (2008) transition shock theory described a possibility of how engineers might respond to unanticipated transition experiences. This chapter also focused on the types of technical and transversal skills that new engineers' employers expect them to develop during their transition from novice engineers to competent engineers. Reviewing these topics

identified gaps in the literature and established the significance of exploring new engineers' perceptions of their transition to the workplace. The next chapter explains theoretical and methodological approaches to this research, including the methods used to collect and analyze the data.

CHAPTER 3: RESEARCH METHODOLOGY

This study used the inductive interpretivist method to understand the perceptions of new engineers' school-to-work transition. The main goal was to discover and understand the perceptions of their situation, the strategies used to navigate their transition, the support systems they used, and how they viewed themselves through their process (Yanow & Schwartz-Shea, 2015). This inductive method helped understand participants' shared patterns of behavior, processes, and perceptions. The outcomes of this study helped to understand new engineers' perceptions of the transition to practice experience. It also built upon various bodies of literature and connected the identified elements necessary to support engineers entering the workplace after graduation. Therefore, this study answered the following research question:

MAJOR QUESTION: What are new engineers' perceptions of their transition to practice?

SUB-QUESTIONS:

- (a) What everyday situations do new engineers experience as they move into, move through, and move out of the transition to practice?
- (b) What resources and strategies do new engineers utilize as they navigate the transition to practice?
- (c) What types of support did new engineers use to navigate the transition to practice?
- (d) How do new engineers develop and manage their personal and professional self-perceptions through the transition to practice?

The research questions established the qualitative nature of new engineers' transition to practice because there were too many possibilities for a quantitative research strategy. This inquiry necessitated descriptive and interpretive analysis that emphasized a deep understanding

of new engineers' transition experiences. Subsequently, a broad and open-ended research question could not fulfill the requirements necessary for a deductive inquiry. Moreover, the indeterminate facets of this research question meant that this study was more exploratory than explicatory. Therefore, this question offered the opportunity to describe and understand new engineers' in-depth perceptions of their transition to practice. Thus, an inductive interpretivist research strategy was most appropriate for investigating this question.

Inductive Interpretivist Method

I used an inductive interpretivist method because it provided a systematic process for analyzing qualitative data. The main strength of an inductive interpretivist method is methodological flexibility (Yanow & Schwartz-Shea, 2015). Unbounded by traditional qualitative methodologies, the inductive interpretivist method draws strength from phenomenology, grounded theory, narrative research, and case study (Creswell, 2013). The inductive interpretivist approach allowed me to: (a) condense response data into a clear and concise, thematic summary format, (b) establish well-defined links between the research objectives and the summary findings of the response data, and (c) develop a thematic framework from the essential structures of experiences and perceptions that were evident in the response data. The inductive interpretivist method provided flexibility to analyze the participants' responses concisely, summarize their descriptions into narrative themes, and build connections between the research aims and data generated through analysis. This research method connected Trevelyan's (2019, 2010) observations that engineers established their understanding and meaning of engineering practice within their workplace with my efforts as a researcher to interpret participants' shared meaning (McClure, 2015; Yanow & Schwartz-Shea, 2015).

Inductive interpretivism was appropriate for transition research because of its subjective nature. The transition into engineering practice is a social process that involves learning as much about organizational practices and traditions of the job as it does about the job's more technical aspects (Trevelyan, 2010). Transitions to practice are multifaceted and complex. They included such characteristics as diversity, personal experience, and feelings. Therefore, I required descriptions of their answers to understand participants' perceptions of moving out of school and into professional practice. Consequently, Trevelyan (2019) maintained that an engineer's experienced point of view provided the best understanding of their transition to practice. Inductive interpretivism's subjective nature generated data and supplied explanations of participants' social understanding founded on their self-perceptions (Yanow & Schwartz-Shea, 2015).

This study's ontological assumption is that people constructed social realities dependent upon their perceptions and multifaceted experiences (Yanow & Schwartz-Shea, 2015; Jackson, 2002). I worked from the hypothesis that meaning is a social construction created within a community of understanding developed over time within a social context (Gergen, 1999; Hacking & Hacking, 1999). In this study, the social context existed within the workplace where the participants were employed. Since I was concerned with new engineers' perceptions of reality embedded within their transition experience, the social constructionist approach provided access to the meaning made by the participants. Because social interactions occur throughout their transition within an organization and the encounters with people, participants' perceived realities guide their understanding (Gergen & Gergen, 2012). The social constructionist approach democratizes meaning by co-constructing reality between the researcher and the participants' responses (Galbin, 2014).

This research has an epistemological foundation in social constructionism (Gergen, 1999; Hacking & Hacking, 1999). Social constructionism advocates that understanding the world and acquiring knowledge is a socially collaborative process rooted within the experiences of language, culture, norms, mores, and folkways (Else-Quest & Hyde, 2016). The epistemology posits that characteristics customarily considered incontrovertible and natural, such as gender, race, class, ability, and sexuality, are inventions and interpretations shaped and defined by cultural and historical contexts (Subramaniam, 2010). The social constructionism epistemology maintains that identifying a universal true or false, good or bad, and right or wrong cannot occur because the only access to true, false, good, bad, right, or wrong is through the perceptions we share. Social constructionism considers that almost all human life occurs through social and interpersonal relations (Gergen, 1985). Social construction holds that “what we take to be the truth about the world importantly depends on the social relationships of which we are a part” (Gergen, 2015, p. 3). Thus, unlike an absolute position where meaning, rationality, and reason are assumed to be quantifiable, social constructionism claims these qualities as manifestations of human interaction (McNamee, 2017).

Consequently, the focus of social constructionism is rooted in interaction and what these interactions generate. Therefore, I used social constructionism to interpret, define, and categorize the meaning of reality through the collected experiences and perceptions in socio-cultural contexts provided through participant responses. The inductive interpretivist method grounded knowledge generation through intersubjective interactions. These exchanges occurred via a collaborative process of knowledge creation and sensemaking. The understanding accessed through the interchange between the researcher and the participant allowed codes to emerge from the generated data (Yanow & Schwartz-Shea, 2015; Jackson, 2002). These codes constructed

meaning from the bottom up, allowing me to explore respondents' perceptions of their transition to practice to develop a potential framework (Schwartz-Shea & Yanow, 2012). I constructed meaning through participants' responses to social interactions negotiated within their workplace and influenced by cultural and historical factors (Hacking & Hacking, 1999).

The inductive interpretivist method guided the research through the social constructionist epistemology. This method was suitable for this study because it focused on how new engineers understood their transition to practice within their organization (Yanow & Schwartz-Shea, 2015). Moreover, this study explored how the new engineers saw their new situation, which strategies they used to navigate their transition, why they chose the selected support systems, and how they perceived their professional and personal self-perceptions during their transition. Additionally, the school-to-work transition occurred when new engineers interacted socially with many different people in new environments. Thus, providing support for social constructionism's epistemological position.

Researcher Bias

Inspired by observations of recently graduated engineers transitioning from school to their first professional job, this study increased my understanding of how new engineers navigated the challenges they perceived throughout their first 24 months (about two years) as an engineer. I currently work with engineers from all over the world with different educational backgrounds and life experiences. Some engineers appear to make the transition effortlessly, while others struggle. Some engineers overcome their challenges while others do not. I want to understand why.

My work experience influenced my interest in the research topic (e.g., Air Force, a non-profit that worked toward total liberation, a video production company). Each of these jobs was

different; however, one thing tied them together. That is the inherent belief that no objective reality exists within the boundaries of given work experiences. Instead, the perceived reality depended on the knowledge shared within each work setting. Influencing this study are four assumptions.

First, I believe that multiple realities exist within different communities in and out of the workplace. Second, I trust language is central to constructing meaning, as it enables a phenomenon through which day-to-day interactions and understanding are possible (Alvesson, 2011). Further, language is biased, as language facilitates and impedes expression and perceptions (Bryda, 2020). Third, I believe that knowledge is created and used within organizations through their socialization processes that convey the collected knowledge to newcomers, who, in turn, may reconstruct, change, expand, or update the given accumulated knowledge base of the organizational social system that they have entered. Fourth, I believe the comprehension of knowledge transpires through the lens of individual experience. As a result, individuals must negotiate multiple constructions through shared frames of reference.

Research Design

The inductive interpretivist method allowed me to understand new engineers' transition through their experiences, perceptions, and interpretations. This method was relevant because the study aimed to understand an individual's perceptions of the meanings and processes of the phenomenon of transitioning from school to the workplace (Soss, 2015). The interpretive method did not rank one methodology over another because it incorporates multiple disciplines (Denzin & Lincoln, 2018). This method attempts to understand human experiences and perceptions through their interpretations (Denzin & Lincoln, 2018).

Setting

Participants in this study worked for companies across the Midwestern and Northeastern United States. The companies they worked for required engineers' expertise in multiple disciplines, such as industrial, mechanical, civil, electrical, computer, architectural, and manufacturing engineering. The new engineers worked on location or from their homes; however, all participants worked on virtual teams. In this study, Information and Communication Technology (ICT) tools connected virtual teams across distances, cultures, and time zones. This study occurred during a worldwide pandemic that changed how the workforce interacted and engaged. Members of virtual and traditional teams depended on ICT tools to facilitate collaboration and interactions within the workplace.

Data Collection

I used a purposive-snowball sampling method to recruit 10 participants. This method identified individuals based on their knowledge of the phenomenon researched (Creswell & Creswell, 2021; Creswell & Plano Clark, 2018). In addition to experience, I accounted for the availability to participate in this study, which helped determine participants' capacity to communicate perceptions, experiences, and sentiments in a coherent, meaningful, and reflective manner. The goal was to focus on participants with specific characteristics who could better contribute to the researched phenomenon and expose the dynamic processual experience of the transition (Fujii, 2011).

Participant Selection

I selected participants that met the following criteria:

- They had graduated from college with a bachelor's or master's degree in engineering.
- They worked as a professional engineer for less than 24 months at the present job.

- They were experiencing their first transition to professional practice transition post-graduation from college.
- They were willing to be interviewed for approximately 45-90 minutes about their perceptions of the strategies and supports used to cope with change and self-perceptions as a new engineer experiencing a transition to practice.

Excluded will be engineers who have worked in a professional capacity in another career field, military veterans, and engineers employed with the company for over 24 months.

Recruitment Process

Purposeful-snowball sampling allowed me to connect with people who knew participants that met the conditions for selection in this study (Polit & Beck, 2018). Further, this method allowed participants to recruit other participants. I sent a recruitment email to pre-screened engineers identifying the study's nature, requested participation in my research, and verified participant eligibility (see Appendix A).

Interview

I conducted semi-structured guided conversations to uncover thick and rich descriptions of participants' perceptions of their transition experiences based on the inductive interpretivist method (Soss, 2015). This less formal interview process allowed participants to construct responses in ways they considered meaningful (Riessman, 2008).

The interview process used Zoom®, a Voice over Internet Protocol (VoIP) program with an embedded plug-in to record the audio and video of the conversation. I use an iPad as a secure backup to record the interview. The recording ensured that the transcriptions of the interviews were verbatim. I explained to the participants the need for recording the interview (Patton, 2015) and assured them that they could stop the recording at any time.

During the interviews, I listened for the tone of voice, looked at expressions, and watched gestures as non-verbal communication to reveal unspoken information (Brinkmann & Kvale, 2018). I used probing questions to gain deeper access to the participants' insights and generate more data throughout the interview. The questions connected the new engineer to their situations, strategies, supports, and how their self-perceptions reflected their reality. This process was essential for constructing meaning vital to an interpretive study (Schwartz-Shea & Yanow, 2012).

I used an interview guide (see Table 3.1) to facilitate responsive interview prompts built around my research questions (Rubin & Rubin, 2012). My interview guide helped focus and organize my line of inquiry and kept the conversations flowing freely (see Appendix B). I used an opening question to establish a rapport with the participants and make them comfortable talking about themselves. The second question focused on participants' expectations of their transition. These questions prepared participants to answer the research sub-questions, which focused on the study's conceptual framework (situation, support, strategy, and self-perception). The last question elicited the participants' overall assessment of the phenomena.

Table 3.1*Interview Guide*

Subject	Main Questions	Probing Questions
Background	Why did you become an engineer?	Can you describe your preparation to become an engineer?
Expectations	Tell me how you think your education prepared you for the workplace.	Provide an example of what you expected and what you did not expect.
Situation	Tell me about situations you have experienced moving into, moving through, and moving out of your 24 months on the job.	Provide examples of a situation(s) that have impacted your transition.
Strategy	Tell me about the resources and strategies you have used to navigate your journey from school to work.	Provide examples of where and how you employed different tactics to manage a challenge.
Support	Tell me about the types of support you have received from inside and outside the workplace.	Provide examples of where and how you employed different tactics to manage a challenge.
Self-Perception	Tell me how you have developed your personal and professional self-perception throughout your 24 months in the workplace.	Tell me about the changes from when you first arrived in the workplace to where you find yourself now

Subject	Main Questions	Probing Questions
Phenomenon	What is your overall perception of your transition from school to the workplace?	How has your perspective changed from school to the workplace? How have your skills developed from school to the workplace?

Role of the Researcher

My role was to gain the participants' trust and explain the purpose of the research, their role, and why their participation was essential. I established an environment of tolerance, trustworthiness, understanding, and respect for the participants. I collected data using the following techniques:

- (a) I actively listened to participants to understand their responses.
- (b) I employed silence to allow participants to gather thoughts and consider their answers.
- (c) I asked for and provided clarification when needed.

The guided conversation provided better access to the complexities of participants' differences in their perceptions and helped form a more comprehensive understanding of these perceptions. I structured and directed the interview to answer my research question. Guided questions allowed participants to respond to contextual differences through similar questioning lines. I listened to what participants said, how they said it, how they used words, and watched the non-verbal communication when answering questions. The context was crucial to understanding their meaning (Schaffer, 2015). I considered that different cultures speak differently; thus, what some people consider ordinary language may be an unordinary language for others (Schaffer,

2015). It was essential that I, as the researcher, distinguished the proper context of participants' responses.

Each participant was provided an electronic copy of the Institutional Review Board (IRB) consent form before the scheduled interview for their review. A password-protected computer and email maximized confidentiality for all correspondence. I informed participants in writing that participation was voluntary. They could drop out of the study without penalty and be encouraged to ask questions at any time via phone, email, or Zoom©.

I conducted one in-depth interview with each participant, approximately 45-90 minutes. The open-ended questions allowed for follow-up questions while remaining on topic. Follow-up questions allow participants to share more subjective experiences, thus providing the opportunity to generate a deeper level of understanding (Schwartz-Shea & Yanow, 2012; 2015). The open-ended questions exposed and provided additional data to answer the research questions (Soss, 2012). The participants shared unique perceptions about their transition experiences, negotiating their support system throughout their transition, which helped them manage their transition and self-perceptions in and out of the workplace.

As the interviewer, I actively generated knowledge and meaning through the guided conversations (Brinkmann & Kvale, 2018). The participants actively engaged in the co-construction of understanding to reveal their social reality (Jackson, 2002; Hacking & Hacking, 1999). The interview was a reflexive process, where meaning and ambiguity provided multiple interpretations and generated numerous perspectives (Alvesson, 2011). As such, I spent time reflecting on the process of questioning and the meaning of the results. The collection of views supported the research's social constructionist epistemology (Yanow- Schwartz-Shea, 2015; Jackson, 2002; Hacking & Hacking, 1999).

As the researcher, I listened, observed, and engaged in the interview without conveying my own opinions or leading participants (Soss, 2015; Brinkmann & Kvale, 2018). I established significance during the interview process and explored the responses in detail (Rubin & Rubin, 2012). I needed to understand my inherent biases; thus, I created opportunities to check participants' interpretations throughout the research process so that my interpreted descriptions reflected the participants' intended meanings.

Field Notes

I documented my observations of the conversations to remind me of the participants' behaviors, actions, and other facets of their responses (Mouton, 2012). I jotted down a few words or short notes to help remember something observed, said, or happened. Field notes served this study's personal, observational, methodological, and theoretical purposes. Notetaking included personal feelings, reactions, and assessments of the data collection process. Observational notes explain what happened during a guided conversation and were essential for understanding the transition to practice. Methodological notes reminded me to maintain my objectivity. Theoretical notes included my interpretations of Schlossberg, Benner, and Duchscher's transition concepts and the themes and categories that surfaced during guided conversations.

Data Transcription

I used Descript dictation-speech software, a secure offline auto transcription app, to provide an initial outline for transcription. I noted the verbal and non-verbal interview responses during the transcription process, including asking the questions. Following each interview, I listened to and took notes of how the respondents answered the questions. I annotated my notes in a research journal and prepared the audio recording for the Descript software.

I removed all information identifying people, places, and the company to protect privacy. I changed all private information to a pseudonym to ensure confidentiality. I also manually transcribed each interview using the outline from the Descript software to ensure accuracy and provide a timecode for non-text data. I destroyed digitally recorded interviews after checking the accuracy of the transcriptions.

Data Analysis

The interview questions received consideration to determine that they adequately addressed the study's research goals and ensured that the appropriate data generated the dimensions of the transition to practice. I transcribed the interviews verbatim, coded, and interpreted each one thematically.

An inductive form of thematic analysis, called latent thematic analysis, addressed the study's investigative aims (Braun & Clarke, 2006, 2017). The thematic analysis provided an understanding of the patterns and meanings of the respondents' answers (Braun & Clarke, 2012). The inductive thematic analysis allowed me to discover unforeseen insights (Nowell et al., 2017).

I used Attride-Stirling's (2001) thematic networks for coding, and the six-phased thematic analysis method Braun and Clarke (2006) recommended to discover, analyze, and interpret the themes generated from the interviews. This method developed richness and uncovered the depth of the gathered data. Additionally, it helped me access the data and reveal themes (Schwartz-Shea, 2015; Soss, 2015). I familiarized myself with the data by using the following steps: transcribing the data, reading and re-reading the data, watching and re-watching digital recordings looking for non-verbal data, and logging initial ideas. Next, I followed Attride-Stirling's (2001) coding process (See Table 3.2). After completing the coding process, I defined

and named the themes, identified the story revealed through the data, and generated clear and concise definitions and designations for each theme (Braun & Clarke, 2006). Upon completing this process, I placed the themes into groups.

Table 3.2

Coding Process for Thematic Networks

Interpretive Stages	Steps	Processes
A: Data Reduction	1: Coding Data	Devise the coding framework and segment the data using the framework.
	2: Identify Themes	Consider and refine themes theoretically or separately from coded segments.
	3: Construct Thematic Networks	Arrange, illustrate, and refine themes into networks.
B: Data Exploration	4: Describe and Explore Networks	First, describe each network created. Secondly, explore the underlying patterns within the thematic networks.
	5: Summarize Network	Summarize the thematic networks into emergent themes and patterns.
C: Pattern Integration	6: Interpret Patterns	Combine and connect the interpretations concerning the research questions and associated theory.

After transcribing the data generated from the interviews, I double-checked the transcriptions for errors, read them repeatedly, and cross-checked the transcriptions with the recorded interviews for non-verbal data. This step enabled me to gain familiarity with the generated data, obtain an initial impression of the more evident components, identify the more significant findings, and foster familiarity to reveal the more discrete results. I continued cross-checking the transcriptions until further interpretations were no longer reducible (Fusch & Ness,

2015). This analysis process ended when no extra information was accessible to form new insight (Yanow & Schwartz-Shea, 2015).

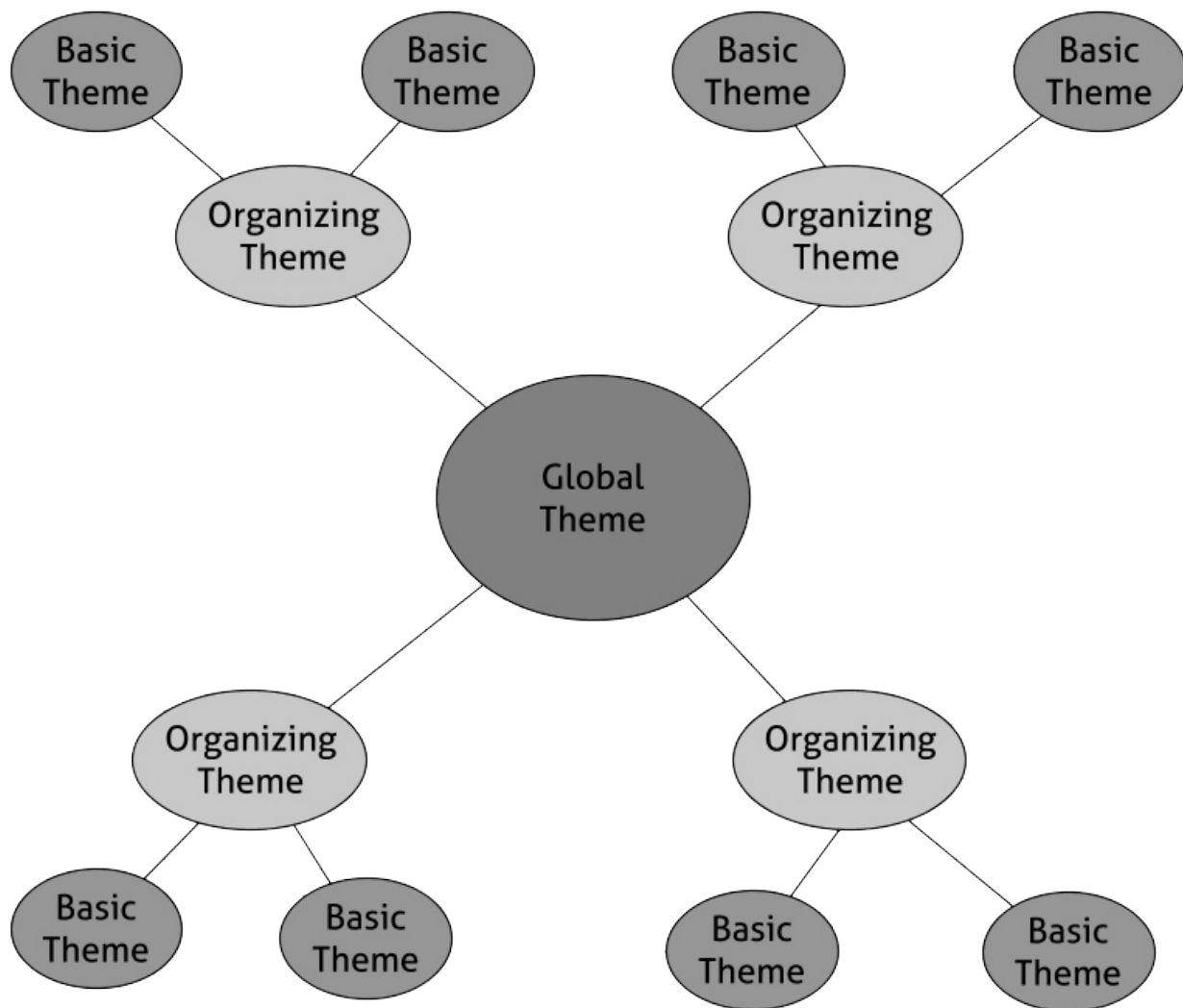
The latent thematic analysis does not attempt to use an established theory to create a coding framework and analyze the data. Instead, the themes emerge from the data itself, and the coding framework develops while examining the data (Braun & Clarke, 2006). This approach is appropriate to the inductive interpretivist method as the perceptions of participants' transitions are the focus (Yanow & Schwartz-Shea, 2015). I used memos to document my thoughts and observations that connected the research questions' themes during the analysis. Memoing was beneficial as it acknowledged those thoughts and interpretations without directly influencing the data coding and analysis (Saldaña, 2016). Thematic analysis dovetails with a social constructionist epistemology (Braun & Clarke, 2006). Social constructionism can reveal numerous themes through respondents' knowledge and beliefs (constructions). Constructions can reveal patterns of social interactions within the engineers' workplaces, thus providing access to the meaning of a transition (Braun & Clarke, 2013; Yanow & Schwartz-Shea, 2015). Thus a thematic analysis uncovers a reality exclusive to the respondent but still dependent on, exists simultaneously with other respondents' constructed realities (Braun & Clarke, 2013).

Attride-Stirling's (2001) analytic tool allowed me to create codes within thematic networks constructed from three themes accessed from the data: basic, organizing, and global themes. First, I established familiarity with the data by repeatedly reading what the respondents shared. I then reduced the data to codes into significant units of meaning. I looked for emergent codes from topics that frequently occurred in the data. I continued reducing the data until no further new codes emerged, thus achieving conceptual saturation (Saunders et al., 2018). Following this, I identified salient themes from the coded data. I then consolidated the themes

into a non-hierarchical thematic network (see Figure 3.1). I merged groups to form overarching organizing themes into a more abstract global theme using basic themes categorized from the coded data.

Figure 3.1

Attride-Stirling's Thematic Network



Basic themes are the building blocks of context. On its own, a basic theme provided little information. However, when placed with other basic themes, a pattern emerged into a higher-ordered theme (Attride-Stirling 2001). The organizing themes put basic themes into groups that

generated significance and provided access to a thematic network. The global themes coalesced the organizing themes into a data structure. Each global theme contained a thematic network of organizing and basic themes. The web-like format in Figure 3.1 illustrates how I eliminated hierarchy among the themes.

Table 3.3

Attride-Stirling's Thematic Network: Basic, Organizing, and Global Themes

Global Themes	Organizing Themes	Basic Themes
Awareness of the Need for Help	Lack of Confidence in Their Ability to do the Job	
	Humility to Ask for Help	
	Recognition for the Need for Support	Institutional Social
On-the-Job Skills Development Defined Their Transition to Practice	Technical Skills	Coding Analytics Spreadsheets
	Transversal Skills	Communication Collaboration
Acknowledgment and Practice Built Competence	Identified as a Resource	
	Given More Responsibility	
	Recognition from Coworkers for Their Expertise	

Attride-Stirling (2001) split the analytic process into three broad stages of thematic coding (see Table 3.3). Each stage reveals a deeper, more abstract level of interpretation that

aligns with Yanow and Schwartz-Shea's (2015) inductive interpretivist method. Stage A of Attride-Stirling's (2001) analytic process reduced the text data into three steps: (1) coding the material, (2) identifying the themes, and (3) constructing the thematic networks. The significant themes in the data guided the coding framework (2001). Stage B of the analytic process helped explore the data beyond simple description. During this stage in the coding, I looked to generate patterns of the thematic networks. I interpreted the meanings behind the generated themes. I summarized the thematic networks and described the data's patterns. Stage C of the analytic process allowed me to interpret the patterns and networks as something more significant than the sum of their parts. At this stage, I connected the research questions to the literature review. From there, I constructed an argument about the insights generated.

Quality Control

Qualitative research poses several questions regarding rigor when representing participants' perceptions, experiences, and meanings in an investigation's findings: How would I conduct the research? Would I accurately represent the participants studied? Moreover, would my biases simply present confirmatory evidence? Miles and Huberman (1994) and Lincoln and Guba (1985) advocated for quality controls, including credibility, transparency, authenticity, and trustworthiness. I safeguarded the quality and credibility of my research procedures, processes, and data using an inductive interpretivist criterion. Schwartz-Shea (2015) classified two orders of terms for interpretive and evaluative criteria for judging the inductive interpretive method's quality. First-order terms are conventional processes in interpretive research. Terminologies used to evaluate the quality included trustworthiness, thick description, reflexivity, and triangulation. Second-order terms are less conventional than first-order terms. However, these are also practical techniques for achieving trustworthy research: (1) informant feedback or member checks, (2)

audits, and (3) negative case analysis. I wrote rich and descriptive interpretations of the interviews, and my field notes included details on body language, facial expressions, interactions, and exchanges as contributed by the participants. The concept of trustworthiness meant that I would ensure systematic, transparent, and ethical processes to safeguard research quality. During fieldwork, I conducted myself ethically, following the IRB practices, and ensured my research goals were evident to the engineers participating in my study (trustworthiness).

I wrote highly descriptive, thorough presentations of the settings and the findings generated within this study (Merriam & Tisdell, 2016), allowing readers to better interpret and apply my discoveries to their particular situations (thick description). My field notes, written during the interview or immediately after, included a daily reflective journal to discuss interviews, other significant communication, and how the study progressed (reflexivity).

I cross-checked my data using different analytical tools to understand the data generated from the interviews, the thematic networks, member checks, and allowing participants to provide written feedback (triangulation). The member checking process enabled others to authenticate the descriptions constructed and confirm the transcribed interviews' credibility. I kept a journal to record dates, times, locations, and the collection of artifacts for all accessed data (audit). I continuously re-evaluated my evidence, checked for alternative understandings, and performed iterative data readings to interrogate my inductive interpretations (negative case study analysis).

Negative case analysis examines hypotheses to determine if refined data accounted for all known cases. Through progressive interpretations of participant interviews, negative case analysis strives to produce a socially constructed consensus between all interviews without exception (Kidder, 1981). Upon completing my initial analysis, I reexamined the data to identify concepts and incidents that did not fit the thematic framework. In brief, these steps helped ensure

that my study followed transparent and ethical guidelines and appropriate protocols for performing reliable research practices and met academic rigor standards.

Ethical Considerations

This study followed the Institutional Review Board (IRB) ethical standards of the University of Wisconsin-Milwaukee and used an informed consent form to communicate the study's pertinent information (Appendix C). I treated participants with respect, honesty, integrity, and transparency. All identifiable information, including digital documents, communications, and recorded media, was on a password-protected computer to which I had exclusive access. I am using Zoom© because it uses the Advanced Encryption Standard, which employs 256-bit encryption and public keys certified by a secure server using the RSA 1536 or 2048-bit public-key cryptosystem. I conducted each VoIP interview in a secure, confidential location and started each discussion with a verbal review of the informed consent form.

Consistent with IRB standards, the interview did not occur until the participants verbally reaffirmed their signing of the informed consent statement. The information sheet contained my contact information if the participants had any questions before agreeing to participate in the study. Despite this study being considered low-risk for participants, ethical considerations were still necessary. Informed consent is fundamental for ethical research practice (Merriam & Tisdell, 2016). Brinkmann and Kvale (2018) stated that acquiring informed consent is essential for respecting participants' autonomy. Further, participants needed to understand why and how I conducted this research study and the potential risks involved before making an informed decision (Brinkmann & Kvale, 2018). I explained to participants how and why I researched new engineers' transition to the workplace before asking them to sign an informed consent statement.

Risks to the Participants

This study had minimal risk of harm to research participants. I assured participants verbally and in writing that they did not have to answer any questions that made them uncomfortable. Furthermore, participants had the right to refuse to answer questions or quit the study.

The Anticipated Benefits to the Participants and Others

The benefits to the participants related to the opportunities they would have to reflect on their growth as engineers and how their transition experiences, supports, strategies, and self-perceptions have influenced their engineering practices. This research study aimed to fill existing gaps in the literature concerning new engineers' perceptions of their school-to-work transition. Advances to others would be in the form of knowledge that future engineers, employers, and educators could use to support new engineers as they leave the school setting and transition to their first engineering role. An additional benefit would be to provide information that participants could share with new engineers on transitioning into the workplace.

Assumptions, Delimitations, and Limitations

Assumptions

The social constructionist approach is the philosophical assumption rooted in this study. From this perspective, I did not look for objective realities. I assumed that individuals co-constructed realities based on the experiences, perceptions, and contexts they encountered throughout their lives and the lives of those they socialized with at work and away from work. In addition to the social constructionist approach, Schlossberg's transition model and Benner's Novice to Expert model served as valuable lenses to interpret the data. I assumed my methodology addressed my research questions and asked the right questions. Finally, I assumed

that I interpreted the participants' experiences with trustworthiness and were honest and insightful.

Delimitations

This study's delimitations included: New engineers completed an engineering degree from a college bachelor's or master's program within one year of being hired by their host companies. Due to the worldwide COVID-19 pandemic, I conducted interviews over Zoom©.

Limitations

A qualitative study's inherent limitation is that results cannot be generalized (Creswell, 2016). The small number of new engineers that participated in this study limited the range of perceptions and the capacity to generalize this study's findings to other new engineers. Another limitation was that most study participants worked from home due to COVID-19 restrictions. Further, in this qualitative study, as the researcher, I was the instrument accessing the meaning of the data (Yanow & Schwartz-Shea, 2015). For this reason, my assumptions and perceptions affect the findings this study has constructed. Lastly, other data collection modes, including participant observation and other qualitative research designs, could have produced different results.

Summary

This chapter presented the research questions posed in this study, followed by an explanation of the inductive interpretivist research methodology, my bias as a researcher, the research design, the description of the research setting, and the selection and collection of data. Also described were the organization of the interviews, an explanation of notetaking, and the transcription methods. Further, I explained how I generated codes, analyzed data using thematic networks, and processed my interpretations. Following this section, I discussed the steps that

ensured quality and included descriptions of trustworthiness, thick description, reflexivity, triangulation, member checking, audits, and negative case analysis. The chapter concluded with a description of the ethical considerations, the risks to participants, and the anticipated benefits for participants and others.

CHAPTER 4: FINDINGS

This chapter presents the perceptions of engineers' transition as they entered practice in their respective engineering environments using an inductive interpretivist approach through the responses of 10 engineers with less than two years of professional engineering employment. This study aimed to answer the following research question: What are new engineers' perceptions of their transition to practice experiences? Through interviews based on participants' experiences, three themes emerged: (1) awareness of the need for help; (2) on-the-job skills development defined their transition to practice; and (3) acknowledgment and practice built competence.

New Engineers' Perceptions of Their Transition to Practice

The findings of this study revealed how awareness, development, and acknowledgment impacted how new engineers experienced the transition to practice.

Awareness of the Need for Help

Study participants described the move into the role of the professional engineer as the "biggest," "most challenging," or "craziest" transition they had yet experienced. Lack of confidence in their ability to do the job, humility to ask for help, and recognition for support described participants' meaning and essence of transitioning into their professional practice as engineers.

Lack of Confidence in Their Ability to do the Job

All 10 participants shared their perceptions concerning their confidence during the first three to five months of their employment. Meredith expressed her lack of confidence as "not an ounce of confidence at all," and Tessa stressed, "my confidence was dropping" during those first three to five months. Archer found the first few months daunting, and he even questioned, "Am I really cut out for this? Should I look to find a different job?" The other participants echoed

similar perceptions. Hank and Declan agreed that they were “nervous” to share their thoughts with others early in their respective transitions. Patrick and Benjamin expected that a lack of confidence was typical, with Benjamin summing up the early transition with this observation, “everyone has been where I was.” New engineers expressed feeling lost within their new role because they were unfamiliar with work-specific knowledge possessed by their peers. Norman thought that “catching up on the things that we need to know is a challenge.” Participants’ perceptions contributed to their diminished confidence.

During the first three to five months, the lack of confidence left Patrick feeling pressed for time, “I didn’t have that much time to develop anything other than knowing my people.” As participants became more familiar with their teams, they learned that their teammates’ knowledge was an asset. Norman, still in his first 2.5 months at the time he participated in the study, stated, “I haven’t gotten to know a lot of different people, but people from different teams have better knowledge or insights about problems.” This lack of familiarity to access insights and knowledge disappears with time. Elena shared Norman’s frustrations during the early part of her transition, “When I first started, I didn’t fully understand everything going on or the correct people to talk to about unique solutions to problems.” Hank identified networking with his coworkers as the turning point in his quest to regain the confidence he lacked, “I had this epiphany. You need to step up. You need to be the one who goes out and asks these questions because no one else will.” Study participants realized that asking questions helped them build their confidence.

Humility to Ask for Help

Patrick and Louis stated that recently graduated engineers are often overconfident or have an inflated ego. They said that jokes about business and the liberal arts majors were not

uncommon because they felt their coursework was more rigorous than theirs. However, Patrick and Louis pointed out that such jokes were unfair. Because upon entering the workplace, they discovered that they did not know as much as they thought. Patrick offered the following advice, “I say it all comes down to one word – humility. Everything centers around humility and that ability to be inquisitive and ask questions, never be afraid to ask a question.”

All 10 participants shared their perceptions of humility and how they overcame their hesitancy to ask for help. In this study, humility is a participant’s ability to authentically understand their strengths and weaknesses. Participants became aware of their need to ask for help early in their transition to practice. Elena, Hank, Archer, Benjamin, and Patrick reported that they realized they needed help during their first three to five months of employment. Tessa and Norman recognized this in their first two months. Louis has family members that work as engineers, and one of them works for the same company as he does but in a different department. While Louis could ask family members for help, a few months was necessary before he was comfortable asking coworkers for help. After five months as a professional engineer, Declan stated that he still struggles to ask for help. Still early in her transition, Meredith was still adjusting to her role as an engineer.

Meredith reported that her coworkers shared information as if she understood the jargon they discussed, which impacted her confidence. Meredith emphasized, “I never asked because I was afraid to.” Meredith explained that she even hesitated to ask her manager questions because it “might be something really stupid that I should know.” Meredith recognized that she was struggling, but she saw a former classmate’s name in an email chain who worked for the same company but in a different department. Her classmate had started with the company months before her hire date. While Meredith was afraid to ask her manager and coworkers for help, she

was not afraid to ask her former classmate. She said of her classmate, “She’s already come across all of these issues that I have, and it’s the easiest answer ever. It’s not overwhelming.” This encounter helped Meredith to overcome her hesitation in asking for help. However, she added, “It’s still too early because, at this point, I don’t know what I’m doing or why I’m doing it.”

Other participants shared Meredith’s frustration about not knowing what they felt they should know. In his first four to five months, Patrick explained he was “trying to figure out what I’m supposed to be doing, what they want me to do.” Elena described feeling frustrated at this same time during the early part of her transition to practice because she did not think that she was using the full extent of her abilities. Hank, Archer, and Declan attested they did not know anything when they started. Benjamin expected his lack of knowledge about his role and responsibilities, but he perceived that every engineer began where he was. This perception did not mean that Benjamin started asking questions right away; like other participants, he took three to five months to figure things out.

Louis had a family member who worked for the same company he relied upon to answer his questions and help him to figure things out. However, as he gained familiarity with his role, he recognized questions only his coworkers could answer. Louis needed to become familiar with his coworkers to make himself comfortable asking questions. He did not mean socially or just casually asking someone a question; he needed to know the appropriate person to talk to and how to find them. Louis recognized that developing his ability to navigate the personnel directory helped him ask the right people. Louis came into the workplace knowing that he would have to ask questions. Instilled from an early age was the idea that there would be someone better. He declared, “I know I’m not the best. I can reach out to the available resources and say—Hey, you

know this a lot better than I do, then I can ask my question.” Louis stated that asking questions is more manageable in his fifth month now that he knows whom to ask.

Tessa and Norman started asking their coworkers and managers questions sooner than other participants. Tessa had two internships and participated in a cooperative learning program before being hired as an engineer. Norman had multiple internships and cooperative learning experiences across the country and in diverse fields throughout his undergraduate and graduate education. These experiences taught him to “Ask questions, stupid ones as well, and try to talk to different people to get different perspectives.” He came into the workplace assuming, “People are happy that you ask questions because that means you’re engaged, you’re interested, and you’re paying attention.” Tessa started with a company that she was already familiar with as she had spent three years working for as part of her education. While she began her career as a professional engineer in a new role and within a new department, she established a network of people she could ask questions. She said of her coworkers and managers, “Whenever I have questions, no matter how dumb, they are always willing to answer. If they don’t know the answer, they help me reach out to somebody who knows.” Tessa and Norman stated that it takes time to know who has the answers you are looking for and who can provide different perspectives.

One of the challenges Tessa, Hank, Louis, Benjamin, Patrick, Declan, Norman, Elena, and Archer found was knowing whom to ask their question. The participants figured out that their teams were there to help them. After two years on the job, Patrick emphasized that asking questions showed him that he had the “ability to be humble and know that [he did not] know everything and [he was] going to learn something new every single day.” Declan also felt the same as Patrick, “You’re not always going to know everything. You can’t solve everything by

yourself.” However, Declan admitted that he tried to solve problems independently, saying, “I try to solve it myself without any help. And that could help, and it could hurt. It could hurt because it might take longer to do it myself rather than asking for help.” Compared to the other participants, Declan was the only one who stated that he did not ask for help until he exhausted his knowledge and ability to solve a problem.

Archer, Benjamin, and Patrick shared that learning to ask for help was a humbling and empowering experience. Benjamin reflected on his early days:

I shouldn’t feel dumb for asking questions or not knowing something ... In the beginning, I tried my hardest to figure things out before I reached out to somebody.

Today, I’m not afraid to reach out if I don’t know and [ask for] help.

Archer described his experience when he first asked a question that his manager could not answer. He explained that his manager took this as an opportunity to show the new engineer how to find the answer. He elaborated, “This reassured me. If they don’t know, maybe it’s okay that I don’t know either. We were all working through this together.” Patrick thought that remaining humble and understanding that you do not know everything was the key to learning something new every single day. Patrick, having been a professional engineer for two years, concluded, “The faster a person [knows] they’re not the expert in the room ... but [knows] they could be the stupidest.... Asking questions is a cure for ignorance.”

Engineers with more experience identified that knowing their limitations is a strength. Tessa, Norman, Louis, Elena, and Hank shared Patrick, Archer, and Benjamin’s perspective that they were a part of a team and figured that their coworkers knew the answer, the process, or the solutions to their questions. Meredith, who had the least on-the-job experience among the participants, recognized the importance of asking questions but still found it intimidating to

connect with her coworkers. Whereas Declan acknowledges that his team is there to help, he still tries to solve problems independently.

Participants in this study shared a common perception about the importance of asking questions, recognizing that asking questions connected them to their coworkers and that it was okay not to know the answer. Asking questions brought participants closer to their respective teams. Participants overcame a self-imposed obstacle by conceding their lack of knowledge and embracing their limitations. Asking questions was among the first hurdles in seeking support.

Recognition for the Need for Support

When asked about their perceptions of the support critical throughout their transition to practice, study participants acknowledged they needed help to do the job and deal with the stress and pressures of being a new professional. Participants in this study viewed their sources of support as coworkers and managers (institutional) and family and friends (social).

Institutional Support. All participants in this study offered anecdotes or statements about their perceptions of the support they received in their workplaces. They described institutional support with variations of the following phrases “my team gives me great support” and “everyone is helpful.” All the participants in the study recognized and shared institutional support from coworkers and their managers.

Tessa felt surprised about the support she received as a new employee even though she had worked the previous three years with the same company as an intern and in a student cooperative education program. Based on that experience, she expected to receive support for her roles and responsibilities. However, Tessa explained, “I tend to scare myself—a hard, harsh, strict boss and then hard to deal with colleagues. Then just [tedious] and boring work.” However, that is not what happened; instead, she found an incredibly supportive workplace. Her coworkers

made themselves available to help her, and her managers considered her prior experience with the company when assigning her roles and responsibilities. She expressed surprise when her managers supported her immigration status. A foreign-born employee, she did not expect that her managers would choose to involve themselves with the challenges of working with a visa. This level of support impressed Tessa, who stated, “I’m not willing to leave because the teammates are so nice.”

Declan described a mistake he made transposing a code number for a report he ran. He did not realize the error until he sent the report to stakeholders. He reached out to a coworker, informing her of the error. He was nervous that he had ruined the data for this report. However, his coworker mitigated his fear and anxiety by telling him, “You’re not the first person. You’re not the last person that’s going to do this. Here’s this person, this person, and this person to reach out to get it fixed. We’ll send an update later today.” Declan stated that when he needs help, he has a support system upon which he can rely. This support taught Declan to remain calm when things go wrong. He can better assess situations, and he now knows how to gather the resources within his support system and find a solution.

Elena and Meredith also described the support they received from coworkers. Elena shared feelings of frustration with another female engineer. “I had someone on my team who had a similar experience to me where at first she just kind of felt like her voice wasn’t really heard,” she said. She found having a coworker to share her frustrations with helpful. Meredith revealed a similar interaction with a female coworker and discussed the difficulties of communicating across age and gender with a member of her burgeoning support system. The support provided by the coworker helped Meredith deal with the anxiety she felt in her new work environment.

Louis found his institutional support in his manager and from a family member. Although he described his team as helpful, he placed the most value on the help of his manager. Part of Louis's roles and responsibilities is writing computer code. Louis explained how his manager supports him when answering his coding questions, "He'll always attach a page saying what each [line] does, how it does it, why it does it, and why it was done that way." Louis' family member is versed in several coding languages. When his manager cannot provide the insight needed, he has someone else—his family member—who offers possible solutions.

Archer, Benjamin, Hank, Norman, and Patrick offered broader perceptions of institutional support. Archer found himself in a situation where everyone he worked with was asking questions and relying on each other for support, solving problems, and meeting the challenges of the workday. His coworkers' demonstration of support and camaraderie convinced Louis that he was an integral member of a support system. Benjamin found support in his team through his friendships during the 23 months (about two years) of his transition. Hank shares a similar perception of an institutional support network, "over time, I will have more friends and [fewer] coworkers." For Hank, building a network of friends across the company will help him have a myriad of options to find support. While new to his roles and responsibilities, Norman perceives support from the members of his team and his manager. Patrick maintained that he had built a network of people across his organizational enterprise to answer questions regarding his work. However, the conversations with his manager made him the most valuable institutional support. "I talk with my manager about growth development."

Social Support. Participants reported that their social support network outside of the workplace included friends and family. This social support network helped participants deal with

the stresses of their new roles and responsibilities inside and outside the workplace. Participants found that having an outlet to express themselves was of great comfort.

Only Hank and Norman did not include their parents in this support network. Hank relied upon his partner, and Norman relied upon his friends. Elena, Patrick, and Benjamin turned to family and friends for their support. Benjamin found comfort within the memories of his mother because he still wants “to make her proud.” Archer, Declan, Louis, Meredith, and Tessa found it helpful to have their parents and family members there.

Archer’s entire family was there for him to discuss his workdays, bad or good. He was able to talk with them about his uncertainty when he first started. Declan took comfort knowing that his family was there to support him if he failed at anything. Louis knew his parents would be at his side if needed. However, he was content knowing they would listen should he have a difficult day. Meredith values the emotional support and encouragement her family provides. When her plans for taking a position overseas ended due to the pandemic, she moved back in with her parents, which helped her transition from student to professional.

Elena and Patrick imparted the most comprehensive descriptions of their support networks. Elena described the difficulties of moving away from her established support system during the pandemic’s beginning. She found it challenging to meet new people, “That led to some feelings of not having a support system. Everyone I knew was over a thousand miles away.” Elena made friends with coworkers with whom she spends time outside of the workplace with time. “I usually go to them for support, especially if something’s bothering me and I’m upset. I will vent to them.” She likes having a support system that understands her experiences, “It is kind of nice to get things off my chest if it’s a particularly stressful day.” Elena also has the support of her parents. She explained that her new job was not the only transition experience in

her life. Her transition to practice was also the first time she was on her own. She also sought her parent's help to create a budget to pay her bills, "My parents helped me keep a trackable budget."

Patrick had the most extensive support network: family, friends, a wife, and church. Patrick separates professional and emotional support, "I keep a [rigorous] work-life balance. So, the stress is at work and does not leave work." He has friends at work whom he can speak to about the stresses and challenges of work. For everything that is not work-related, he has his wife. Unlike the other participants in this study, faith is a large part of Patrick's support system. He leverages his faith against the stresses of work, "I don't need to bring that [stress] home. Creating that mental divide really makes a huge difference." Patrick described how daily prayer helps alleviate stress, allowing him to put the day's priorities into perspective. He can come to work the next day refreshed and ready for a new day of challenges. This way, Patrick can focus on his life with his partner and not bring that stress into their marriage. He is thankful for the support that contributed to his career and life successes. "It makes me feel great to know that people care enough about me and about my success to take time out of their jobs to help me. I love it when people go out of their way to help. [Be]cause that, that says something to me, 99.9% of the time, they're not doing it for a favor."

Tessa was the only participant in this study who requested a mentor. She wanted someone to help her solve problems, discuss her career opportunities, and answer coding and data analysis questions. Tessa's education provided her with engineering fundamentals, but it did not train her directly for the roles, responsibilities, programming languages, and requirements specific to her employer. She recognized that a mentor could help her develop the abilities and skills required to do her job. This mentor supplies her with the guidance she needs to develop her

analysis skills because “he [helps] with solving problems, any problems. Mainly issues like programming and data problems because he has the expertise.” Tessa has developed her ability to analyze data with time. “I see a clear path. Like there’s no other way. It’s just a clear straight path of what I should do.”

Participants valued the support from friends and family members, which was instrumental in alleviating stress, having a safety net, and receiving encouragement. Participants found it essential to separate work and their personal lives and reported that their social support network helped them deal with the challenges they experienced at work.

On-the-Job Skills Development Defined Their Transition to Practice

When asked about their perceptions of the skills essential to their transition to practice, study participants recognized the need to develop two skillsets critical to their development as engineers: (1) technical and (2) interpersonal. Study participants shared how they developed their skills and learned to use available resources.

Technical Skills

Most participants were concerned about their technical skills. Some had preconceived perceptions of inadequacy early in their transition. Participants talked about developing work-specific skills required to achieve the technical aspects of their roles and responsibilities and applying their knowledge to practice. These skills included learning new coding languages, analyzing data, and working with spreadsheets.

Coding. Coding refers to the practice of how engineers use programming languages to command computers with detailed instructions but in words that are easier to understand. There are hundreds of coding languages used to meet the need of different data. The languages students learn in college are not necessarily the languages they will use in their workplaces. Furthermore,

coding languages evolve, and some companies use older languages that engineering programs no longer teach.

Moreover, the diversity and complexity of how users interface with a programming language may vary from organization to organization. Suffice to say. It is not uncommon for new engineers to have little or no experience with the programming languages they encounter in their first role as a professional.

Some engineers in this study transform data into easy-to-read sets to be used by end-users using coding languages. Tessa, Elena, Benjamin, Hank, Louis, and Archer reported learning new coding languages. Elena did not have experience coding languages in college. “Picking up new skills and quick learning has been huge. This [quick learning] is because we use a few different coding [languages] in the department. I didn’t learn any of those three prior to [company name],” she explained. Learning new skills in a short amount of time was a common theme among participants’ responses. Benjamin was unfamiliar with the coding language required for his job. He learned coding by studying his coworkers’ code line by line. When Benjamin came across something he did not understand, he educated himself by gaining insights from reading his coworkers’ reports and learning how they work. He pointed out, “you get so many different ideas I never thought of, but you need to know how to work with others because if you don’t, you’re just making problems.”

Tessa learned two popular and robust coding languages in college. She used these languages throughout her internships and cooperative learning program with her current employer. The expectation was to work with the coding languages learned in college. However, her employers required coding languages she did not have experience using. Tessa wondered if she would be able to meet the demands of her employer. “I have this very short amount of time

to learn a new language,” she said. Tessa described this development process as frustrating because she also had to understand the internal data infrastructure connecting her code to her desired output.

Hank also did not learn the coding languages he uses at his company. However, he went into the job expecting to learn new coding languages. Hank said that being exposed to multiple coding languages in college “would be super helpful” because it would have cut his time learning a new coding language.

Louis did not realize that coding would be a large part of his responsibilities. He shared his surprise, “This job is focused on programming and code writing, which was not a strong suit of mine. I’ve spent 60% of this work just learning the code [and] learning the software.” Louis explained that he approached learning to code based on the lessons in problem-solving he received as an engineering student. Louis asserted that knowing how to get the information needed to do his job was imperative. He reflected on a class where he learned how to use search engines, saying, “Learning how to Google is weird, but it’s very useful knowing how to use keywords,” which he used to learn the “basics of writing code.”

When Archer came to his workplace, he knew how to create macros to automate tasks and add functionality to forms, reports, and controls. This skill made him an asset at his workplace. His ability to code and create macros was not a skill he expected to benefit him in the workplace. Through coding, Archer said that he realized that working together with everyone’s “separate expertise can bring a quality solution together.”

Tessa, Elena, Hank, Louis, and Archer agreed that understanding the fundamentals and syntax of a coding language helped them learn new coding languages. The participants learned how to code in a short amount of time to meet the demands of their jobs. The participants relied

on their ability to research, asking their coworkers for help, and trial and error. Tessa provided a concise description of learning to code, “I just have to do it.”

Analytics. Most of the study’s participants analyze large data sets as part of their job, and all of the participants reported learning the fundamentals of data analysis as engineering students. They expected that their responsibilities would include some form of data analytics. Participants gave the following descriptions of their roles as analysts: “at first it was overwhelming;” “if I make the same mistake, I’m not learning;” and “I find insights for the [company].” Tessa, Elena, Hank, Benjamin, Declan, Louis, and Norman are the participants that analyze data as a part of their roles and responsibilities.

When Tessa started her career as an engineer, she expected to work on fundamental analysis using spreadsheets. However, one of her managers asked her to lead a project. Tessa explained that she was intimidated because the task had been a problem for years, and all the information was in multiple databases. Tessa found difficulty in knowing which data were valid. These facets of analysis caused a drop in her confidence and increased her frustration because she was “learning everything from scratch.” She worried that she would fail, but her manager encouraged her to take her time, and Tessa did. She devoted much of her time learning to navigate multiple databases and familiarizing herself with the contents. She reached out to her team for help isolating and categorizing data redundancies.

When Elena started, she admitted, “at first, nothing was exciting. I found the job extremely mundane.” She was learning coding languages and was not presenting analysis to her perceived abilities. Over time and with considerable practice, Elena developed her ability to analyze and present data. When she first started, Elena was easily intimidated by criticism. As her ability to analyze data improved, her confidence to defend her analysis improved. Early in

her transition, she would accept her manager's opinion without question. With almost a year of experience conducting, presenting, and defending her analysis, Tessa can speak to her manager openly and without equivocation about her decisions. Moreover, her manager trusts her analyses.

Hank, Benjamin, Declan, Louis, and Norman described analytics as a process, and every day holds something new to learn. As these participants became more familiar with the processes and better understood how their respective companies operated, they reported that their analysis improved. Declan stated, "If there is a question, there is always a correct answer. Alternatively, as an engineer, there might be two or three correct answers, and you're going to have to analyze that." The participants spoke about how working with real-world data, and real-world experiences expanded their perspectives on analyzing data. When they gained experience and became more familiar with their roles and responsibilities, they gained confidence in their analyses.

Participants found that time and experience improved their data analysis ability. Real-world experiences broadened their perspectives to become better analysts. Some participants expressed appreciation for the time to learn how to navigate databases. Others spoke of improving their analytical competence over time. Participants required support from more experienced coworkers to improve their skills.

Spreadsheets. Most participants used spreadsheets as a fundamental technology to shape, model, present, and analyze data. Their responsibilities included working with spreadsheets in their jobs. However, spreadsheets were a surprise for Meredith. She stated, "I would have been better at this job when I was 18 years old and just out of high school." Meredith explained that she expected to work with more complex software with which she is familiar. However, after four years of college and technical internships, her skills with spreadsheets have diminished,

“I’m not good at [spreadsheets]. I’m bad at my job. It’s not what I expected.” This self-doubt presented Meredith with a challenge because her job involved working with spreadsheets.

While all participants indicated using spreadsheets to fulfill their roles and responsibilities, Elena, Hank, Archer, Benjamin, and Norman used spreadsheets as an integral part of their responsibilities as engineers. Elena’s education did not prepare her to work with spreadsheets, so working with spreadsheets was among her early challenges. However, she would use search engines to find answers to her difficulties and reach out to her institutional support network to teach her to use the software more effectively when she could not find answers online.

Benjamin, Hank, Declan, and Louis also used online search engines and their support networks to develop their ability to use spreadsheets. Benjamin would ask his coworkers to take him through the steps until he was able to show his capabilities to whoever was helping him. Hank, Declan, and Louis learned to use online search engines to find the answers they needed to do their jobs. As for Norman, he was already a proficient spreadsheet user when he started.

Participants’ use of spreadsheets was ubiquitous. Online search engines and coworkers aided participants’ development using the software. As with coding and analytics, the reliance on coworkers provided participants with another set of skills to develop as engineers. Patrick provided this insight into developing technical skills, “As long as you know how to use a computer ... It’s having that network. That ability to be humble and know that you don’t know everything. You’re going to learn something new every single day.”

Transversal Skills

All participants reported the need to communicate and collaborate with managers, coworkers, subject matter experts, vendors, and customers as part of their jobs. While these were

not the only skills described by participants, these were the only two mentioned by every participant. Participants attributed the ability to communicate and collaborate as the best tools aiding their development.

Communication. Participants communicated with a wide range of audiences and described the need to adapt their messages appropriately to communicate effectively with diverse personalities. They explained the importance of listening and understanding how other people express themselves verbally and non-verbally. Participants conveyed the significance of communication to their development as engineers.

Benjamin gave voice to a common observation shared by the participants. He said that one of the challenges of transitioning to practice is that many “individuals don’t know how to talk and interact with others, and that’s one of the main things that individuals need to learn.” According to the participants, it took about three months to “figure out how to communicate” with their coworkers. Hank explained, “it just clicked in my head one day—I need to put myself out there. I need to ask these questions because others won’t ask them for me.” Tessa found that “the more contacts [she] had with different people,” provided a more complete understanding of her roles, responsibilities, and organization.

Meredith and Norman had not yet reached their third month of employment. Meredith did not share an anecdote regarding the importance of communicating with coworkers, as did the other participants. She expected her coworkers to supply context to work-specific terms during discussions and tell her how to do her job without asking them. She also indicated that she felt intimidated to speak with some coworkers. Norman did not share Meredith’s challenges. He thought it was essential to talk with many “different people to get their perspectives and get to

know them,” even if it was challenging. Norman noted that diverse opinions, perspectives, and personalities provided him with more complete and unbiased answers.

Participants reported tailoring how they communicated with different audiences depending on their awareness or understanding of the subject matter and their personalities. Patrick described “face-to-face skills” as essential, “I learned fast that taking [the time] to show up to shake somebody’s hand was worth a million phone calls.” He found that reaching out to coworkers and subject matter experts not domiciled at his location helped establish bonds of trust and respect. Further, “That’s how I figured out who [I have in my] group and how to leverage their skills properly. I learned how to lead somebody to an idea or help keep them on track.” Tessa perceived communication skills the same as Patrick. However, Patrick has been a professional engineer for 13 months longer than Tessa. She recognized that the diversity of personalities and backgrounds comes with different communication styles, “I realized that the more I have contacts with different people, the more I need to work on [my communication skills].”

Participants that recognized the need for communication skills agreed that they had room for improvement. Louis described an area of communication he needed to improve. He was “very proper” and “too formal” when he first started.” From his emails to how he presented himself to his coworkers, he said, “I created a disconnect between who I am and how I work.” He recognized that he needed to “mellow out” to “build trust” to make more authentic connections with his coworkers.

Participants described building familiarity with others through social and work-related conversations. Elena made friends with her coworkers by asking about their interests outside of work. Building these friendships helped her establish a support system inside and outside the

workplace. According to Hank, “If you’re not friends with the people that you’re working with, it’s hard to have accountability in that group.” Patrick maintained, “everything centers around humility and that ability to be inquisitive and ask questions. Never be afraid to ask a question because if you’re good with people, they won’t be afraid to give you an answer.” Participants agreed that making authentic connections with their coworkers was essential to effective communication, building trust, and making friends in the workplace. Benjamin shared his observation, “We interact with people every day. If you don’t know how to talk to people, that’s a big [problem].” Louis stressed, “You have to be able to communicate your ideas, why they’re beneficial, why they should buy into it, why they should be implemented at all.”

Participants found communication was crucial to learning, finding information, making themselves understood, and getting to know their coworkers. Most participants described an epiphany or a sudden realization that if they were going to develop their skills, they would have to learn how to communicate with their coworkers. Further, communication established trust and friendships. This aspect of friendship and learning how to talk with coworkers introduced the second interpersonal skill named by the participants—collaboration.

Collaboration. Collaboration skills enabled participants to work toward a common goal with others successfully. Participants said that to collaborate effectively, they had to communicate clearly, actively listen, take responsibility for mistakes, and respect the diversity of their coworkers. Participants’ collaboration skills included working well with others, having a cooperative disposition, and having mutual respect for team members.

Norman’s role requires him to work with over 100 individuals on numerous projects. He named collaboration one of the most important aspects of his job. He mentioned that everyone he works with uses different systems, works at contrasting times, and has distinctive personalities.

Therefore, he recognized his need to be available to those he collaborates with at work. He found that he needed to respect others' preferences to achieve project goals.

Elena found that collaborating with others improved her insights and problem-solving ability. Tessa discovered that collaboration helped her “blend with [her] company and with [her] department.” For Benjamin, collaboration promotes helping others and creating a sense of community. Louis said, “collaboration builds trust between everyone involved” and allows you to lose that fear of managers by working together because everyone has the same goal. Patrick thought that an engineer's most critical skill is being good with people. “Most of my job is networking and talking and listening to people,” he said. He views collaboration as a means to gain perspectives to solve problems.

Communication and collaboration are inextricably linked. Participants reported using their communication skills to collaborate with their coworkers, and they perceived their collaboration ability among their strengths, whether gaining insights, building trust, or developing their knowledge base. Further, participants relayed feelings of empowerment because they demonstrated their knowledge and ability to their peers and managers while working together toward a common goal.

Acknowledgment and Practice Built Competence

Acknowledgment describes how participants received recognition as engineering practitioners, and practice describes how participants engaged with their roles and responsibilities as they transitioned to practice. Together these formed participants' understanding of the general knowledge they have gained. Their coworkers and managers influenced this recognition. Participants described becoming a resource by their peers, being

given more responsibility by their managers, and receiving recognition for their ability as building their competence.

Identified as a Resource

Participants with more time as engineers had more opportunities to become resources. Tessa, Elena, Hank, Archer, Benjamin, and Patrick shared anecdotes about coworkers and managers relying on their abilities. Benjamin said, “now that I know some things, I’m helping out my team.” He described how his coworkers now come to him. “I never thought I’d ever [get] the confidence, all these people know stuff, and now people are running into me for help—and I’m able to help,” he said. Benjamin stated that he was proud of how far he has come, “but there’s more room for growth.”

Archer first became a resource when his coworkers recognized his code writing skills. He was writing code for all his coworkers when he received another opportunity to become a resource. A merger with another company expanded his roles and responsibilities. He said, “In becoming owned by this [new] company, we went straight into a facility layout project because they [brought] in all this material. I had experience because I took a facility design and layout course in college.” No one else had experience with facility layouts; thus, Archer became the resource for his team even though he felt like he was “thrown into the fire.” However, the experience helped him develop his communication and collaboration skills because the role required him to facilitate the entire inventory organization and work with everyone on the shop floor.

Elena saved her company a substantial annual amount of money through her analysis. News of her analysis went to the executive managers of her company. She said that she was proud of her work on that project. She can see how her work has improved since she first started.

She spoke of work, “I think it’s getting better, as there are more details covered that praise has been [a] kind of driving force.” She added that her manager is placing more confidence in her analysis. “He sees a lot more potential for new projects to come my way,” she said. Elena indicated that the confidence from her manager inspired her to seek more responsibility.

Participants shared similar accounts of how their peers named them as a resource, including helping write code, familiarizing a coworker with a database, or presenting analysis on a subject they know better than anyone in the company. Empowered by the recognition from their managers and coworkers, participants described feeling “good,” “appreciated,” and “valued.” Participants also agreed that receiving acknowledgment made them feel more loyal to their respective companies. Some participants noted that becoming a resource was empowering and intimidating for participants. Tessa, Elena, Hank, Archer, Benjamin, and Patrick reported receiving more responsibilities when their managers and coworkers recognized their knowledge and abilities.

Another aspect participants mentioned that was most critical to their transition was “fitting in” with their coworkers. Most wondered if they would ever fit in. Archer described his worries and doubts that his coworkers would see him as anything more than a trainee. However, once he demonstrated his value, he received “affirmation” for his work. He did this by coding automations into coworkers and then facilitating and overseeing a facility layout project. He said, “the feeling of knowing you belong—once I got that, that was the most important and influential part to me.” Other participants shared Archer’s sense of belonging. They described fitting in as a sign that they mattered to their coworkers.

Being recognized as a resource elicited a sense of pride in some participants. Participants described gaining more confidence when their managers or coworkers acknowledged or

complemented their work. Participants described feeling good, appreciated, and valued upon recognition for their work. Receiving recognition also helped them feel like they mattered and fit in with others, which was essential to fit into the workplace. The feeling of mattering and fitting in was among the most critical and influential milestones in their transition to practice. In some cases, receiving recognition motivated some participants to seek more responsibility.

Given More Responsibility

The study found that new engineers viewed their professional responsibility as integral to engineering practice. According to the participants, “you have a responsibility to know your data,” “you are responsible for helping your team,” and “you have to learn continuously.” Tessa, Elena, Hank, Archer, Benjamin, Declan, and Patrick received projects and promotions because they demonstrated their engineering skills, such as analysis, organization, leadership, technical acumen, time and project management, communication, collaboration, and continuous improvement learning.

Tessa’s manager made her a project lead. This responsibility came as a surprise as she was new to the company. However, since she interned and took part in a cooperative program for her company as an engineering student, her manager trusted that she could handle the responsibility. She said of this opportunity:

I was expecting Excel sheets, and he gave me a project that’s been a headache for decades. My first project, and it’s huge. I am impressed by the trust a manager can put into a fresh engineer, which makes me want to work harder to prove that he’s not wrong.

Well, not proving he’s not wrong, but prove I’m worth it.

After the excitement wore off and she had time to think, she began to doubt herself. “What if I fail? I don’t want to fail my boss. He has put so much faith in me. I don’t want to walk away, to

be honest,” she said. She overcame her initial doubts with the support of her manager and the help of her coworkers, “This is something that struck me. I was amazed. This [responsibility] makes me more loyal to the company, the brand, and this department.”

Archer received a promotion to a position in management after seven or eight months on the job. He still held the title of an engineer but now had a team of coworkers that reported directly to him. Although he felt strange being in charge of people older than him, he understood his responsibility:

That taught me the leadership role. It got to a point where my boss would defer to me to make decisions. That was comforting, knowing [upper management] trusted me enough to make an informed decision. Whether right or wrong, [upper management] could live with the consequences.

He indicated that he could not have met his responsibilities without his manager’s guidance and training. Additionally, he considered his ability to organize as a contributing factor to his promotion, “whether it’s emails or just papers on your desk—organization was good accountability, reaching deadlines, and not procrastinating.”

Patrick was the first engineering specialist at his company’s location. His transition into management happened because his managers were trying to figure out how to leverage his talents. He started with large systems installs and became a project manager, which led to a surprise promotion because of his experience overseeing systems installations. He stressed, “It was hectic and stressful because nobody knew how to use me.” In the beginning, he found that the information and support he received from upper management did not fit with his assigned roles and responsibilities. He feared that he “wasn’t going to be good enough and that [he] was never going to figure out what they wanted [him] to do.” As a result, he started asking questions

and reaching out for help; thus, he added institutional and social support networks as a manager. This support network was crucial to his success. He still has room for improvement. As he admits, “I’m working on my ability to manage people. I am still not totally confident managing people. I can walk into a [jobsite] and talk the talk. I can wheel and deal with [facility managers]. That’s not a problem anymore.”

Participants welcomed responsibility, even if they were scared. They reported that the support received from their managers and coworkers was beneficial to their development. Participants expressed that added responsibility, although stressful, was rewarding. The trust and recognition for their abilities provided participants with a more profound sense of loyalty to their respective organizations. Benjamin shared this insight about being given more responsibility: “It feels good to know that others look to you for answers.”

Participants described their responsibility as integral to their jobs. Further, participants acknowledged that they were not alone in managing their responsibilities. They received help from managers and coworkers. Although they felt stressed and afraid of making mistakes, the added responsibility built confidence and trust. Overall, they viewed the extra work as a reward for their efforts, which increased participants’ sense of loyalty to their respective companies.

The Participants' Stages and Phases in Their Transitions to Practice

Table 4.1

Participants' Stages and Phases of Transition

The table shows perceptions of New Engineers Transition to Practice (NETP).

Participant	Degree	Schlossberg/ NETP	Benner	NETP Phase	Months
Meredith	Industrial – Bachelors	Moving In	Novice	Awareness	0.75
Norman	Data – Masters	Moving In	Advanced Beginner	Ask for Help	2.5
Louis	Industrial – Bachelors	Moving In	Novice	Ask for Help	5.0
Tessa	Industrial – Bachelors	Moving Through	Advanced Beginner	Assimilate	11.0
Elena	Medical – Bachelors	Moving Through	Advanced Beginner	Assimilate	11.0
Declan	Industrial – Bachelors	Moving Through	Advanced Beginner	Acquire	11.0
Hank	Industrial – Bachelors	Moving Through	Advanced Beginner	Assimilate	12.0
Archer	Industrial – Bachelors	Moving On	Competent	Autonomy	18.0
Benjamin	Industrial – Bachelors	Moving Out	Competent	Apply	23.0
Patrick	Mechanical – Bachelors	Moving On	Competent	Autonomy	24.0

The Schlossberg/NETP (New Engineers' Transition to Practice) shows the adjustment to Schlossberg's (Anderson et al., 2012) stages of transition.

The participants are at different phases in their journey to practice. I used Attride-Stirling's (2001) analytic tool for creating thematic networks (Table 4.1) to guide and categorize the participants into three sets of transition themes: (1) Global—Schlossberg's Process Model of

Transition, (2) Organizing—Benner’s Novice to Expert Model, and (3) Basic—my observation based on the participant responses after analyzing the interviews. I also added a fourth organizing theme for time to account for the number of months each participant worked on the job. The themes revealed a complete picture of where each participant was during their transition to practice and helped access a deeper understanding of the new engineers’ path as they transitioned to practice.

Anderson et al. (2012) defined the transition process as navigation across four stages: moving in, moving through, moving out, and moving back in again. These four categories focus on understanding the transition and integrating and interpreting individuals’ experiences navigating their transition. Schlossberg’s model served as an excellent tool for organizing the participants into global themes. Participants moving into a transition reported familiarizing themselves with their new situation (Schlossberg, 1995; 2010; Anderson et al., 2012). Conversely, participants categorized as moving through their transition described how they relied on their managers’ guidance and support in meeting expectations and achieving roles and responsibilities. Lastly, participants identified as moving out of their transition were either in a managerial role or worked with a degree of autonomy with little guidance in their daily work.

Benner’s Novice to Expert model is significant because it outlines the skills individuals can measure themselves against as their careers develop. Although Benner’s (1982; 1984) research focused on nurses, the intent of her transition phenomenon applies to other fields. I organized the participants into three categories based on Benner’s model. The first stage was novice. These engineers had limited workplace experience, lacked confidence, and faced new situations daily. The second stage was advanced beginner. These engineers had increased confidence and had developed their skills and work-specific knowledge, but they still required

managerial support. In Benner's model's third stage, competent (proficient and expert did not factor into the findings), engineers worked independently with a specific area of specialization.

To round out Attride-Stirling's (2001) thematic tool, I used six of eight basic themes to place the participants. The global themes of awareness of transition, acknowledging agency, and asking for help are indicators that an engineer is still moving into a transition. Participants moving into their transition to practice were mindful of the changes disrupting the existing roles, routines, and relationships in their lives but had not yet figured out that they had to take action to initiate their transition to practice. They were still trying to understand their new situation but were unfamiliar with their work environment.

The themes of acclimating to the workplace, acquiring resources, and assimilating to work culture signify that an engineer is moving through their transition. Participants at this stage were still acquiring resources like building an institutional support network of coworkers or were in the process of assimilating into their work culture. At this stage, participants were spending time honing their skills with their managers' guidance. The next set of basic themes indicates that engineers are ready to move out of their current transition and move on to the next career transition. At this stage, engineers finish their transition, apply skills and learning, and advance their careers. Here, participants applied skills they had developed to projects or their area of specialization with some autonomy or received promotions into management. I will discuss these basic themes in detail in the next chapter.

Summary

This chapter presented the findings from interviews with 10 new engineers regarding their transition to practice experiences. Three themes emerged: (1) awareness of the need for help, (2) on-the-job skill development defined their transition to practice, and (3)

acknowledgment and practice bolstered competence. Further, I organized the participants into phases and stages of transition to practice constructed from their responses and based on Schlossberg's (Anderson et al., 2012) transition and Benner's (1984) competency models. In the next chapter, I will discuss the findings concerning the literature and present study limitations, implications, and recommendations for future research.

Chapter 5: DISCUSSION, IMPLICATIONS, AND CONCLUSIONS

The engineering field is moving through two shifting paradigms. The first, Industry 4.0, is identified by the emergence of disruptive technological changes in both software and hardware (Gürdür Broo et al., 2022). The second, Industry 5.0, balances the former by driving research and innovation towards being sustainable, human-centric, and adaptable (Gürdür Broo et al., 2022).

Industry 4.0 is technology-driven, whereas Industry 5.0 is value-driven. The coexistence of these two Industrial Revolutions requires individuals who can solve problems using technical and transversal skills to make “industries more future-proof, resilient, sustainable and human-centric” (Xu et al., 2021; p. 533). Rachmawati et al. (2021) stressed that the balance of Industries 4.0 and 5.0 requires the development of a workforce capable of adaptability, versatility, and resilience to “deal with changing situations or extreme circumstances in their environment, one of which is academic” (p. 676). Thus, engineers will need to develop competencies to meet the demands of the future of work (OECD, 2017; Siegfried et al., 2020). As the requirements for engineering competency change to meet the needs of Industries 4.0 and 5.0, the educational requirements for the engineering profession also need to change. According to Mitchell and Guile (2021), engineers will “require new, rather than additional, engineering skills” (p. 1). This study investigated how new engineers perceived the real work of engineering as they transitioned into practice as professional engineers, learning and developing their technical and social skills throughout their first two years.

Ten interviews were conducted based on the following research questions:

Primary Question: What were new engineers’ perceptions of their transition to practice?

Sub-questions:

- SQ1) What everyday situations did new engineers experience as they moved into, moved through, and moved out of the transition to practice?
- SQ2) What resources and strategies did new engineers use or employ as they navigated the transition to practice?
- SQ3) What types of support did new engineers use to navigate the transition to practice?
- SQ4) How did new engineers develop and manage their personal and professional self-perceptions through the transition to practice?

I discuss the study findings concerning relevant literature, the significant conclusions relating to the study's aim, and the study's limitations. This chapter concludes with implications for practice concerning engineering education, engineering managers, and new engineers and recommendations for future research.

Discussion

The focus of this inductive interpretivist qualitative study aimed to gain insight and understanding of new engineers' perceptions as they transitioned to professional practice. Schlossberg's Transition Process model and Benner's Novice to Expert model guided the theoretical understanding of engineers' transition to practice. Duchscher

Researchers can use Schlossberg's model to investigate various transition experiences (Anderson et al., 2012). Anderson et al. observed that transitions are not so much a matter of a change but an individual's perception of the changes experienced through four key stages moving in, moving through, moving out, and moving in again, which corresponds with the following actions at each stage: (1) approaching transitions, (2) taking stock of coping resources within the 4 S system (situation, self, support, and strategies), (3) taking charge by strengthening

the coping resources, and (4) approaching the next transition. The study participants did not follow the order of Schlossberg's systematic model. Study participants realized they had to take charge of their potential resources as they moved into their transition to practice. Moreover, moving out of a new engineers' transition to practice does not include separation from familiar roles, relationships, routines, or expectations. Comparatively, the experiential competency basis of Benner's (1982; 1984) novice to expert model showed consistency with study participants' perceptions of their transition experience. This connection to Benner's novice to expert model added a fifth coping resource in which study participants showed concern—skills. Skill development was an essential facet of their transition to practice. Through the perceptions of 10 new engineers, this study illustrated different phases of a new engineers' transition to professional practice (Figure 5.1). The transition process was constructed based on their responses.

The literature review in Chapter 2 focused on the factors influencing the engineers' transition to practice and the skills required to achieve engineering competence. Although an engineer's transition to practice is not a new phenomenon, there is a scarcity in the literature that documents their perceptions. There is a gap in the literature in understanding how new engineers overcome a perceived deficit of technical and transversal skills to develop into competent and productive engineers. Some findings supported the existing literature, while others explained transition misconceptions and filled gaps in the literature. In the following paragraphs, I will discuss the themes revealed by my research, highlighting key points related to Schlossberg's Transition Theory and Benner's (1982; 1984) novice to expert model.

The Process of a New Engineer's Transition to Practice

The literature reviewed for this study highlighted the phenomenon that affects the new graduate transitioning to practice. Anderson et al. (2012) used the term “situation” to define the transition experience. The study participants’ perceptions of their “situation” or transition to practice varied. As Schlossberg (1995) says, every transition is unique, and “every individual’s situation varies” (p. 53). The Schlossberg transition theory (Anderson et al., 2012) demonstrated how individuals balance their situation, strategies, and support and view themselves throughout the transition to practice (McKitterick et al., 2021; Pleshkan & Hussey, 2020; Eldred, 2018). However, Schlossberg (Anderson et al., 2012) does not cover how individuals develop skills through a transition. According to Benner (1984; 2004), since everyone experiences transitions differently, the transition from novice to expert is not necessarily linear as skill acquisition and development are experiential. Benner (1984) also postulated that confidence and self-efficacy evolve over time and with experience. The following section presents the phases of the process new engineers navigate as they transition to engineering practice.

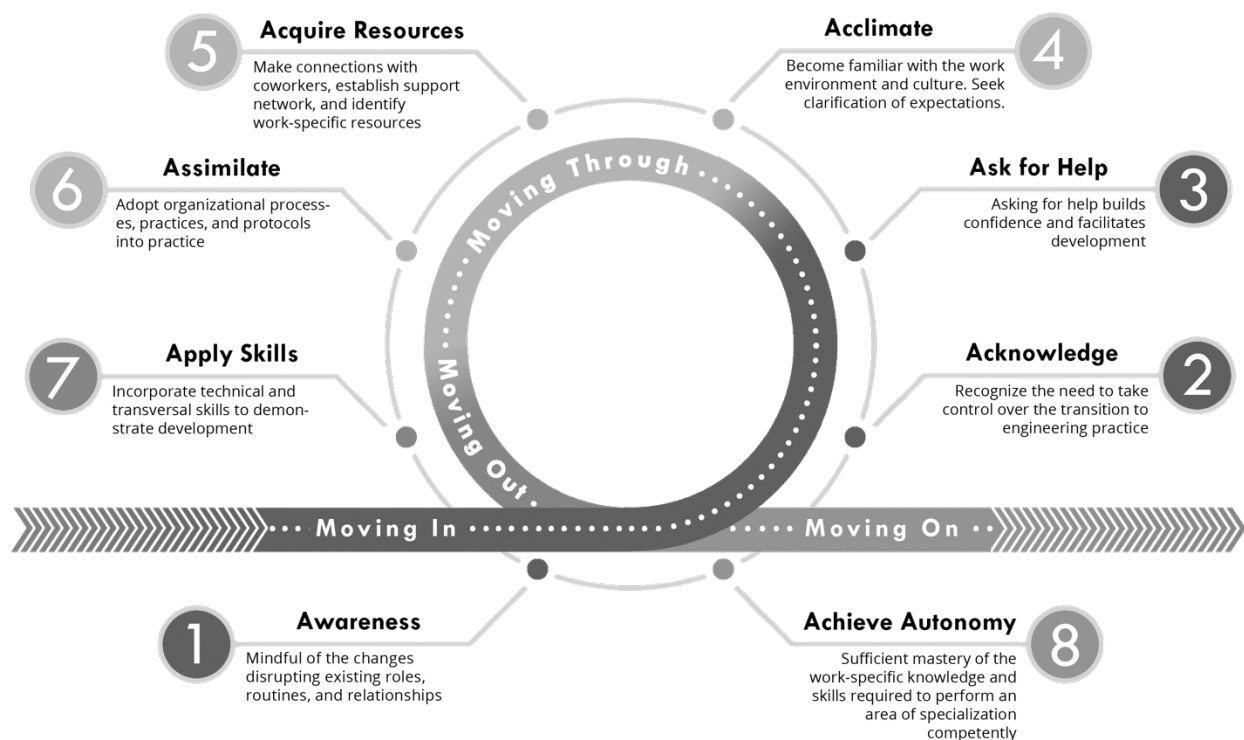
The New Engineers’ Transition to Practice Process

The study participants’ perceptions revealed that aspects of transition they had experienced were not present in Schlossberg’s model (Anderson et al., 2012). Schlossberg (2004) advocated that her transition model “can be used as a framework for conducting research on any group or person in transition” as well as a “guideline for developing interventions with individuals” (p. 7). However, Schlossberg’s (Anderson et al., 2012) event-based transition theory is more effective in describing the meanings of the experiences new engineers have during their transition to practice than providing objectives.

Schlossberg's (Anderson et al., 2012) transition process is not a transition model but a counseling model to help individuals interpret the meaning of their transition (Hare, 2019). As such, the counseling model encourages a guided assessment of the transition situation, available supports, and strategies to manage the experienced transitions, focusing on identifying available resources to increase personal agency (Anderson et al., 2012). On the other hand, transition models include defined outcomes, learning objectives geared toward work-specific competencies necessary for a smooth transition into practice, and skill development to meet the demands of professional practice (Chant & Westendorf, 2019).

Figure 5.1

New Engineers' Transition to Practice Process (TPP)



The TPP shows the phases and stages that study participants engaged in developing the skills and competence to achieve engineering competence.

While Schlossberg (Anderson et al., 2012) provided insight into how engineers make meaning of transition to practice, Benner's (1982; 1984) novice to expert model established a foundation for how engineers engage and make meaning of the skills they develop throughout their transition to practice. The process in Figure 5.1 uses Schlossberg's (Anderson et al., 2012) and Benner's (1982; 1984) transition models and my analysis of the study participants' perceptions of their transition to practice.

I will provide a brief overview of the process with an explanation for each phase in the following sections. Starting in the lower left-hand corner of the process is the Moving In or preliminary stage of an engineer's transition to practice. Moving In comprises three phases that serve to initiate the engineers' transition process: (1) Awareness of moving into a new situation; (2) Acknowledging of the need to take control of the transition; and (3) Asking for help. Study participants passed through these stages at different times; however, it was not until they took control of their transition did they recognize the need to ask questions. This aspect of control differs significantly from Schlossberg's (Anderson et al., 2012) model. The engineers took control of the only resource they knew, themselves.

The second stage of the process is where the new engineer Moves Through their transition: (4) Acclimating to their work environment, (5) Acquiring the resources needed to meet their employer's expectations, and (6) Assimilating into the company culture. This stage of the process is where engineers develop job-specific technical and transversal skills.

The third stage is where the engineers prepare to Move Out of the transition to practice by (7) Applying the skills they have learned throughout their transition. During this phase, new engineers demonstrate the skills they have developed by taking on a more significant role with more responsibility.

The fourth stage of the process is a significant finding. After engineers move out of their transition to practice, they Move On to engineering practice. The engineer has demonstrated mastery of the technical and transversal skills and has established trust in their abilities. Further, they have (8) Achieved Autonomy. This stage is a significant departure from Schlossberg's (Anderson et al., 2012) model, where moving out of a transition is the first step in moving into a new situation. Study participants did not move into new situations, nor did they prepare for a disruption of their established roles, relationships, and routines. On the contrary, they strengthened their resources because they had prepared for this situation through their transition to practice.

While Schlossberg's (Anderson et al., 2012) model provided insight into how engineers make meaning of transition to practice, Benner's (1982; 1984) novice to expert model established a foundation for how engineers engage and make meaning of the skills they develop throughout their transition to practice. The process in Figure 5.1 uses Schlossberg's (Anderson et al., 2012) and Benner's (1982; 1984) transition models and my analysis of participants' perceptions of their transition to practice. I will provide a brief overview of the process with an explanation for each stage and phase in the following sections.

Moving In (Stage 1)

Starting in the lower left side of the process (Figure 5.1) is the Moving In or preliminary stage of an engineer's transition to practice. This stage comprises three phases that serve to initiate the engineers' transition process: (1) Awareness of moving into a new situation, (2) Acknowledging of the need to take control of the transition, and (3) Asking for help. Study participants passed through these stages at different times. However, it was not until they took control of their transition did they recognize the need to ask questions. This stage differs from

Schlossberg's (Anderson et al., 2012) model. The engineers took control of the only resource they knew, themselves.

Awareness Generates Transition (Phase 1). The engineer has a rudimentary awareness they are moving into a transition when a company hires them for their first professional role as an engineer. Meleis (2010) stated that the awareness of a transition is the starting point for all transitions. Study participants recognized that they were in a transition to practice (Figure 5.1 – Awareness – 1). Anderson et al. (2012) described how transitions are disruptive, whether positive or negative, as a change occurs whether the individual is aware of the transition. Participants in this study expressed similar observations of their transition. Nine of ten participants expressed a positive view of their transition. However, one participant reported experiencing frustration and uselessness. Kaufmann (2021) found that nurses transitioning into organizational roles “experienced a full range of emotions, from frustration and anger to enlightenment, which heightened their awareness of the transition” (p. 92). Study participants declared a similar range of emotions and excitement for developing skills.

Schmitt and Schiffman (2019) noted that individuals experiencing a transition were more likely to manage the process if they were aware of the length of their transition. Study participants expected that their transition from Engineer Level I to Engineer Level II would take two to three years—less if they applied themselves. Schlossberg et al. (1995) emphasized that transitions alter the “roles, relationships, routines, and assumptions” (p. 26), and some participants expressed that change events disrupted their existing routines, roles, and relationships and required them to create new ones. Most study participants indicated that their expectations of the new situation matched their reality. However, some said they had no idea what to expect when starting their transition to practice, but they were ready. Schlossberg et al.

(1995) stated, “For an individual undergoing a transition, it is not the event or non-event that is most important but its impact the degree to which the transition alters one’s daily life” (p. 33). Herein lies the most significant difference between the combined model and Schlossberg’s Transition Process (Anderson et al., 2012). Schlossberg’s transition process does not offer actionable goals. Just a means for individuals to make sense of any transition with the guidance of a counselor (Anderson et al., 2012). In contrast, Benner (1982; 1984) offers a specific goal-oriented means for evaluating skill development (Chant & Westendorf, 2019).

Study participants were aware of a transition to engineering practice occurring but did not express their concern over the meaning of the transition. Instead, they focused their attention on skills development. Moreover, awareness of a transition did not initiate the transition to practice. Instead, participants described a realization or figured out that they would have to take action if they were to advance in their transition to practice.

Acknowledge the Need for Action (Phase 2). Acknowledging the need for action is the second phase of a new engineers’ transition to practice. It may last for only a moment, but this acknowledgment initiates the transition to practice. Nine out of ten study participants pointed to recognizing the need to take control of their development as instrumental in developing their skills and establishing relationships with their coworkers. The one participant that did not acknowledge the need for action had less than a month on the job. The frustration she reported came from expecting someone to provide her with answers to questions she was afraid to ask.

During the second phase of the transition process (Figure 5.1 – Acknowledge – 2), study participants recognized the need to take control of their transition before taking stock of their resources, as suggested by Schlossberg’s (Anderson et al., 2012) 4 S model (situation, support, strategies, and self). This action by participants demonstrated self-efficacy and agency as they

initiated their transition to practice with a single realization. The times varied when participants understood that no one would hold their hand through the transition. No participant took longer than three months to make this decision. This finding is contrary to Anderson et al. (2012), who stated that “taking charge” was essential to establishing control over a career transition (p. 38). However, Anderson et al. (2014) stressed that the act of taking charge occurs after the individual in transition has taken stock of their selves, situations, supports, and strategies. Schlossberg’s (1981; 2007) transition process model states that individuals who are moving into a transition lack control. Study participants acknowledged that they needed to take control of their transition to practice to initiate their skill development and, ultimately, the transition to practice. The study participants took control by taking action. They did not take an inventory of their available resources, as Anderson et al. (2012) suggested. Instead, they took agency and expressed their developmental needs despite inventorying the available resources. New engineers recognized that their future was theirs to control, and the first step was to ask for help.

Ask for Help Without Feeling Burdensome (Phase 3). The third phase of new engineers’ transition to practice was asking for help. Benner’s (1984; 2005) novice to expert model expects those early in their careers to ask for help. Participants in Reimche’s (2017) study of newly graduated nurses’ transition to practice found that asking questions helped build confidence and develop career skills. Study participants reported similar boosts of confidence and skill development. Eight out of ten participants reported that asking for help provided answers and helped them establish trust with coworkers. One participant said he still would try to exhaust “every possible solution” himself before asking for help. This struggle for independence was in direct contrast to other participants that reached this phase of their transition. Participants

realized that asking questions was a strength and a more effective and efficient means to engage in engineering practice (Figure 5.1 – Ask for Help – 3).

Study participants gained the confidence to ask questions when they realized three things: (1) no one was going to ask questions for them, (2) asking questions was preferable to making mistakes, and (3) their coworkers enjoyed answering questions. Two participants stated that they felt empowered to ask questions when they saw their managers asking questions.

Early in their transition, study participants' questions were often related to work-specific terms, processes, and their roles and responsibilities. As study participants gained confidence, they asked more complex questions. The increased question complexity signaled the transition moving from asking to adapting. Participants with more challenging internships, more education, or cooperative education experiences started asking questions earlier. The participant with the most education recognized the need to ask for help from their date of hire. The participant whose family member worked for the same company also asked questions soon after they started working. Duchscher (2001; 2007) observed that once nurses gained the confidence to ask questions, they could move into the next transition phase.

Moving Through (Stage 2)

The second stage of the process is where the new engineer Moves Through their transition (Figure 5.1—top side of the loop): (4) Acclimating to their work environment, (5) Acquiring the resources needed to meet their employer's expectations, and (6) Assimilating into the company culture. This process stage is where engineers develop job-specific technical and transversal skills.

Acclimate to the New Situation (Phase 4). The fourth phase of the new engineers' transition to practice occurred when they began to adapt to their transition to practice. Anderson

et al. (2012) found that individuals in transition took stock of coping resources, specifically through Schlossberg's 4 S System (situation, self, support, and strategies), to identify the potential coping resources individuals' possessed to manage a transition. Anderson et al. argued that no matter where an individual was in a transition process or the kind of transition, their ability to cope depended on the resources available. Study participants at this phase (Figure 5.1 – Acclimate – 4) began to take stock of their available resources.

Schmitt and Schiffman (2019) identified two main themes based on Schlossberg's (Anderson et al., 2012) coping resources: (1) Institutional Support (human connection, process approach, and resources) and (2) Sense of Self (self-awareness and fear). Study participants reported taking stock of the same resources. Every participant emphasized the importance of making human connections during their transition to practice, no matter where they were, from the least experienced to the most experienced—each shared anecdotes about a connection with a coworker that helped them overcome emotional or functional challenges. Another coping resource used by participants was the process approach, which involved coding, analysis, and working with spreadsheets, a step-by-step approach in some cases. Participants relied on senior engineers to provide guidance, with one participant stating that he would ask to be shown each step in a process and then ask if he could show them to make sure he understood. The third coping resource within institutional support was job-specific resources. For example, coding and analysis involve data, and participants had to learn where to find the data and connect to the people who understood the data. The self-awareness coping resource helped participants recognize the need for continuous learning, inter and intrapersonal skills, and the job-specific skills required to do their jobs. Self-confidence increased as participants received more responsibility and decreased as they learned how to manage their increased responsibilities.

Tessa, Elena, Hank, and Declan described this as their first transition as an adult and their first time working in real life. They recognized that they were leaving the relative safety of a structured school environment and into a place where they no longer had the protection of family and the teachers. Participants recognized that they had to get to work on time. Those that worked on-site had to wake up early and get to work on time. They also reported that adapting to their workplaces included learning to communicate with a wide range of personalities. During this stage of a new engineer's transition to practice, they expressed a need to familiarize themselves with their roles and responsibilities, learn how their companies operated, and become acquainted with the company culture.

During this stage, new engineers' most sought and used resources were more functional and tactical than emotional or introspective ones. They expressed a need to make sense of their workplace, acclimate to their surroundings, and fit in with their coworkers. Acclimation included identifying where to find work-specific information, whom to talk with for help achieving their work-specific goals, and whom to rely upon when they required help or support. During this phase, study participants took inventory of their potential resources and familiarized themselves with how to engage and use them (Anderson et al., 2012).

Acquire Resources to Meet Expectations (Phase 5). Acquiring necessary tools, the fifth phase of a new engineers' transition to practice, occurs after taking stock of their potential resources and starting to strengthen them. Anderson et al. (2012) call strengthening resources "taking charge" (p. 38). However, participants had already taken control of their transitions in this study. They had strengthened their resources by building trust in themselves and developing their technical and transversal skills, building trust in their coworkers, and increasing their proficiency with their work-specific resources. Participants called this a time of learning (Figure

5.1 – Acquire Resources – 5). Participants spent most of their time developing and acquiring necessary skills, writing code, navigating databases, or improving their communication and collaboration skills.

Schmitt and Schiffman (2019) found the most significant coping resources for nurses transitioning to practice were institutional support and an ability to “identify needs, fears, and uncertainties that lie within the self and serve to undermine a successful transition” (p. 6). Engineers that were transitioning to practice agreed on the importance of institutional support. They found support by establishing a workplace support network. Participants got to know their coworkers in the adaption stage (Figure 5.1 – Phase 5). As new engineers became more comfortable with their roles and responsibilities expanded, they required more complex answers to their questions. As du Toit’s (2016) study of nurses transitioning to practice found, new engineers also required a colleague they could trust. New nurses in Schmitt and Schiffman’s (2019) study stated that having a coworker they could rely upon for support was crucial during the transition to practice. Study participants recognized the value of their workplace relationships. Not only because these relationships provide answers, but they also provide friendships. Oneal et al. (2019) cited camaraderie, communication, and collegiality with coworkers as a way for new nurses to protect themselves from the stress of their roles and responsibilities. However, study participants wanted to make friends just for the sake of making friends.

During the acquisition phase, study participants gained experience. New engineers had the opportunity to focus their attention on building their transversal and technical skills because their workplaces provided them with the time and the resources to develop their skills. Similarly,

Benner's (1984) model provided a framework for new nurses to develop skills and for organizations to provide the resources necessary to develop nurses at all skill levels.

Assimilate Processes, Practices, and Protocols into Engineering Practice (Phase 6).

The sixth phase (Figure 5.1 – Assimilate) of a new engineers' transition to practice is assimilating what they have learned and putting it into practice. Benner (1984) observed that nurses advanced through the stages of competence with more exposure to workplace situations. The participants in this study with more experience and education received greater responsibilities from their managers. For example, Tessa spent her internships and educational cooperative with the company that hired her. This educational-work experience was a determining factor in her manager's decision to assign her a significant project. This project came as a surprise, and it was intimidating. However, her manager assured her that she would have time to develop her skills and the project. The participant with a master's degree received a comparable responsibility and time to fit into his role. The six participants who reached or moved through the assimilation phase felt that they had ample time to develop and make mistakes. The assimilation stage was a time for learning and developing, and participants stated that their managers provided guidance and resources to help them develop their skills and work-specific duties.

Participants indicated that things started to make sense during the assimilation phase of their transition experience. Their confidence increased, and they knew whom to speak with and where to find answers. One participant stated that having that time to find their way gave them the confidence to explore different approaches and opportunities. Participants who were in the process of assimilating into the workplace reported increased confidence in their abilities and wanted more opportunities to demonstrate these abilities. Success gave participants the drive to

reach for greater responsibilities. During this phase (assimilate), participants received the guidance they needed from their managers, senior engineers, or team. They also received opportunities to take the lead on projects and presentations.

Moving Out (Stage 3)

The third stage (Figure 5. 1 – left side of the loop) of the process is where the engineers prepare to Move Out of the transition to practice. By (7) Applying the skills they have learned throughout their transition, engineers demonstrated their development by taking on a more significant role with more responsibility.

Apply Skills Developed Throughout Transition (Phase 7). In the seventh phase (Figure 5.1 – Apply Skills) of transition, participants received increased responsibility and demonstrated proficiency in an area of specialization. There was only one participant at this phase, and two had already moved through this phase. One had proven that he was an excellent project manager. The second was “thrown into the fire,” yet proved his ability to apply his education into practice with versatility and innovation. The third, still in the applied skills phase, was a process owner. He described how good it felt having people come to him for answers. There was no comparable nursing stage, the nature of their responsibilities is different—nurses work with patients, and engineers work with processes. Research on new nurses’ transitions to practice supplied ample evidence that fear and anxiety to make and report mistakes are commonplace (Mellor, 2021; Murray et al., 2019a; Liang et al., 2018). However, the engineers in this study did not express fear or anxiety about making mistakes. Because the nature of their mistakes would be resolved by the next day at the latest, mistakes could easily be solved, and participants said that their managers gave them the latitude to make mistakes because mistakes

presented learning opportunities. As participants demonstrated their ability to manage responsibilities, they could move on to fulfilling their roles and responsibilities independently.

Moving On (Stage 4)

The process's fourth stage (Figure 5.1 – right side of the loop) is a significant finding. After engineers move out of their transition to practice, they Move On to engineering practice. The engineer has demonstrated mastery of technical and transversal skills. They have established trust within their workplace and have (8) Achieved Autonomy. This stage is a significant departure from Schlossberg's (Anderson et al., 2012) model, where moving out of a transition is the first step in moving into a new situation. Study participants did not move into new situations or prepare for disrupting their established roles, relationships, and routines. On the contrary, they strengthened their resources because they had prepared for this situation through their transition to practice. This process was the culmination of experience, the demonstration of technical and transversal skills, and the trust they established throughout their transition to practice.

Achieve Autonomy in Engineering Practice (Phase 8). The last phase of an engineer's transition to practice is being able to work with autonomy. Benner (1982) made a distinction between practical knowledge ("knowing how") and theoretical knowledge ("knowing that"). Early in the transition to practice, Benner's (1982; 1984) competency model provides a foundation for nursing practice. Nurses apply their education to the situations they encounter early in their transition, exposing them to new knowledge. Benner posited that theoretical knowledge could extend practical knowledge and obtain it through practice. Participants in this study reported that developing their skills through practical knowledge helped them incorporate their education into practice.

The engineers with the most experience thought their education helped them make important decisions when they were in positions of authority. They asserted that the practical experiences prior to making that decision helped them make the right decision. Archer explained that he applied theoretical learning to practical solutions when facilitating the organizational layout of the shop floor. He applied Benner's (2015) ways of knowing throughout his transition into engineering practice. A class on facility design and layout that he used with the knowledge he acquired throughout his transition allowed him to apply theoretical knowledge toward a practical solution. Archer was the only participant asked to take on more responsibilities due to the changes in his work environment. The other participants had time and stability to develop within the controlled on-the-job or institutional supports described by Schmitt and Schiffman (2019) and Benner (1984). Archer started his career with a company undergoing organizational change. Due to a shrinking workforce, his manager presented him with opportunities to advance and a safety net should he stumble. He accepted and met the challenges presented.

Benner (2015) stated that effective integration occurs when nurses combine “knowing that, and about, with knowing how, and when” in real-world situations (p. 1). Patrick said that he thought engineering jobs were interchangeable during his transition to practice. However, as he assimilated into his company's culture and developed his job-specific skills, his opinion changed. He recognized that his education prepared him to “think like an engineer.” The foundations of technical and transversal skills he learned in engineering school helped him integrate Benner's (2015) ways of knowing into his engineering practice. He developed and demonstrated the skills, abilities, and decision-making needed to receive a promotion into a managerial position.

Patrick and Archer are the only two study participants to achieve autonomy as engineers. However, Benjamin, Tessa, Elena, and Hank looked forward to having more confidence in their

ability to achieve goals on their own. Study participants that achieved autonomy revealed perspectives on moving out of a transition not represented in Schlossberg's model.

Moving On From Moving Out of the Transition to Practice

Anderson et al. (2012) proposed that transitions do not have an endpoint. They described transition for adults as a continuous change influenced by ambiguous environmental, cultural, and professional situations. Through a transition, individuals cope with change through predictable, structured processes by moving into a new role, moving through that role, moving out of the role, and moving into a new role again. According to Anderson et al. (2012), moving out refers to the stage of transition where there is a separation from familiar roles, relationships, routines, and expectations of one situation and moving into a new situation with new roles, relationships, routines, and expectations. However, study participants are not moving into an unfamiliar situation. They are not in the process of separating from familiar roles, relationships, routines, and expectations. When new engineers move out of their transition to practice, they move on to roles, relationships, routines, and expectations they cultivated throughout their transition to engineering practice. The findings revealed that study participants moved onto, or were preparing to move onto, a situation they had prepared for since they started their transition to practice. The entire point of an engineers' transition to practice is to prepare them to work autonomously and with an expected level of mastery on a work-specific task, project, or product (Saunders-Smiths et al., 2021). New engineers must move out of their transition to practice and onto the practice of engineering.

Skills Provide a Fifth S When Transitioning to Practice

Schlossberg's 4 S system captures the transition process for numerous individuals experiencing change. The very essence involves interactions with the following resources:

situations, supports, strategies, and how individuals view themselves throughout a transition (Schlossberg, 2011). According to Anderson et al. (2012), the 4 S system categorizes these resources as follows: (1) situation (environmental resources); (2) support (family and non-family); (3) strategies (coping resources to deal with life problems); and (4) self (psychological and spiritual resources). Missing from this 4 S system is how study participants engaged with their transition to practice—precisely the skills they used to develop their engineering competence.

Study participants perceived the acquisition of technical and transversal skills as the critical factors in their transition. Schlossberg's 4 Ss provided a means to reveal participants' perceptions of the transition experience, but the skills they developed provided the meaning. Participants identified three primary technical skills required for engineering practice (e.g., coding, analytics, and spreadsheets). However, they also identified the transversal skills that helped them facilitate their technical skills (e.g., communication and collaboration skills, inter and interpersonal skills, problem-solving and continuous learning, and building trust). Further, the transversal skills aided participants' engagement with the 4 Ss. Patrick, Benjamin, Elena, and Archer used communication and collaboration to establish support networks. Tessa used continuous learning to familiarize herself with the coding languages required to access the data she worked with within her capacity as a project leader. Louis built trust with his team by actively trying to be a helpful team member. All but the engineer with the least experience recognized the importance of inter and intrapersonal skills such as presenting their ideas and persevering when they doubted themselves. Skills provide an additional S during a new engineers' transition to practice because skills are the metric an engineer gauges their development.

Study's Contribution to the Literature

The discussion in this chapter focused on creating a process to illustrate how new engineers transition into professional practice. It included what initiated the process into action; the phases engineers navigated as they cultivated work-specific skills and learned and fostered transversal and technical skills; and how they developed as engineers throughout their transition to practice. Although each of the phases discussed informs on engineers' perceptions and experiences, four parts of the discussion stand out as significant contributions this study has made to transition research literature.

First, the creation of an integrated process (Figure 5.1) is a significant contribution, as its construction occurred through the new engineers' perceptions as they transitioned into professional practice rather than educators' and employers' perceptions. Illustrating and defining the phases engineers moved through established a foundation for the following:

- (1) Providing managers and engineering onboarding programs a map of the competency process to support new engineers throughout their transition,
- (2) Recommending topics of instruction that engineering programs can use to help student engineers prepare for engineering practice, and
- (3) The research offered insights for new engineers on what to expect when they enter the world of professional engineering and the significance of integrating technical and transversal skills to aid the transition process.

The new engineers' transition to practice process (Figure 5.1) contributes to the existing research literature because it illustrates an engineer's transition phases. The process outlines new engineers' development throughout their transition to engineering practice, from when an

engineer first becomes aware of their transition until they achieve autonomy in their engineering practice.

The second key contribution is new engineers' acknowledgment of the need to take action and agency over their transition. Acknowledgment differs from being aware of an impending or existing change. Acknowledgment follows awareness. Study participants did not acknowledge their need for action until time on the job had passed. They recognized they were in the midst of a transition, but they did not recognize their agency to take control of their transition. The control required to take action differed from Schlossberg's transition theory (Anderson et al., 2012; Schlossberg, 2008), where control is a means for individuals to alleviate the stress of the transition. When study participants acknowledged the need for action, they initiated control over their transition to practice. They acknowledged that they had to control the situation by establishing a support network among their peers and seeking strategies to learn and develop themselves. Acknowledgment served as the impetus for the participants to ask for help.

The third contribution is the opportunity for new engineers to develop their skills in the workplace to achieve autonomy. While study participants moved out of the transition to practice, they did not move into a new situation. Nor did they separate themselves from their roles, relations, or responsibilities. By moving out, participants are in effect moving onto the engineering practice. Shapiro (2020) referred to companies training new engineers as "skilling up" to fill future roles (p. 3). Study participants also indicated that having support from their managers, coworkers, and company, as Schmitt and Schiffman (2019) described, benefitted their development and helped them achieve independence as an engineer. Patrick stated that the transition to practice helped him to become an engineer.

The fourth contribution is the perception of skill development throughout the study participants' transition to practice. Skill development was integral to the study participants. Like Schlossberg's 4 Ss (e.g., situation, support, strategy, and self), the skills helped study participants manage their assets and liabilities through technical and transversal skills. The skills coping resource may be unique to the transition to practice because the study participants did not have previous transition experience to help inform their transition to practice.

Overall, the findings support and augment the existing literature. Schlossberg (Anderson et al., 2012) and Benner (1982; 1984; 2005) helped to illustrate an integrated transition process that reflected the study participants' experiences as they transitioned to practice. Study participants' recognized that they needed to take control over their transition as their success was ultimately their responsibility. The application of the skills phase demonstrated how providing time to skill up employees aided their technical and transversal skills and helped them develop Benner's (2015) ways of knowing.

Study Limitations

The limitations of this qualitative interpretive study include the obtainability of new engineers to participate in the research and share their perceptions of their experiences. This study changed its sample recruitment after the host company reneged on its agreement to allow recruitment through company emails. To obtain participants, I used purposeful snowball sampling. Sending out recruitment emails using LinkedIn, I connected with professional engineers who put me in contact with participants who met the study requirements. One of the limitations of purposeful snowball sampling is that participants may have similar traits that can cause potential sampling bias.

Another limitation of this study is the small sample size of 10 new engineers and the lack of gender diversity, as seven participants were male and three were female. However, although small, the sample represented four companies and spanned across the midwestern and northeastern United States. The third limitation identified was the possibility of only one interview with each participant. The nature of the study sought to explore the perceptions of a transition to practice. One interview only provided a snapshot of the transition. I have no way to know if the participants' motivations on the interview day or a follow-up interview would provide deeper insights into their transition.

The fourth limitation was that all semi-structured interviews occurred online due to state, local, and company COVID-19 restrictions. As a result, there were no opportunities to recruit study participants on location. Online communications may have prevented some engineers from participating as they did not want to use work computers to ensure their answers were confidential. Another challenge in using online communications is that technical difficulties due to poor internet connection could have limited participation.

Implications for Practice

Transitioning to engineering practice is a critical phase for new engineers. This study's results lead to implications for three areas: higher education institutions, managers, and new engineers.

Higher Education Institutions

The professional engineer's foundation for the transition to practice begins with engineering education at the higher education level. Research studies support the idea that engineering is a collaborative field based on a community of technical knowledge dispersed across a diverse group of practitioners, accessed transversely throughout a web of trusting

relationships, and constructed by workplace communities (Trevelyan, 2019; Lutz, 2017). To be clear, engineers solve technical problems through communication and collaboration. Trevelyan (2019), Korte (2019), and Hawse and Wood (2019) have advocated for engineering education to include critical and innovative thinking skills, inter and intrapersonal skills, information literacy, global responsibility, and global citizenship (collectively called transversal skills) for over a decade.

In this study, participants failed to identify transversal skills. When asked which skills were most important, they answered technical skills. However, they identified core transversal skills, such as critical thinking, problem-solving, obtaining and analyzing information, and lifelong learning, as beneficial to their transition. Further, study participants stated that more opportunities for communication and collaboration would have helped them connect with coworkers sooner. Defining and showing how transversal skills benefit the field of engineering would help engineers with their transition to practice.

Second, study participants agreed that college courses or more opportunities to develop communication and collaboration skills would have helped them acknowledge the need to take action. Participants expressed frustration at taking so long to take control of their transition because it was something they could have done sooner. Teaching engineering students to take agency and communicate effectively would help them take greater control of their transition. Engineering schools could better prepare student engineers for the social aspects of engineering practice by exposing them to the social aspects of engineering: communication, collaboration, building trust, presenting their work, and being good coworkers. However, at the same, it is essential to emphasize that engineering practice is diverse, and there is no uniformity. Each company has its way of engaging the practice of engineering.

Further, people possessing diverse personalities, backgrounds, and abilities fill workplaces. Engineers will be collaborating with engineers and non-engineers alike. Exposing them to different situations can help them experience challenges they may face in the workplace. Therefore, teaching versatile engineering skills and managing expectations more effectively for the world of work could help engineers transition more effectively (Trevelyan, 2019; Vinck, 2019). Moreover, higher education could provide instruction on the most needed transversal skills for the workplace by employing role-playing, simulation, or gamification to teach analysis and problem-solving, communication and collaboration, adaptation and flexibility, and planning and organization (Zheng, 2022; Cortés-Rodríguez et al., 2022; Abrantes et al., 2022).

Managers

Engineers are good at acquiring new skills, but it depends on their support networks. As new engineers transition to practice in their chosen disciplines, they will need continuously learn on the job. Participants in this study worked for companies that took time to develop the new engineers' skills throughout their transition to practice. This practice of skilling up or upskilling is crucial to the transition to practice. The foundational engineering knowledge participants learned in college did not prepare them for their respective employers' job-specific coding languages, software applications, and processes. Managers must realize that their organization is unique. Engineering schools do not tailor a curriculum to support the specific needs of one company. New engineers require time to learn how to meet the needs of the organizations that hire them. Therefore, managers will require versatile engineers that are good at acquiring at upskilling and acquiring new skills quickly.

Study participants complained about not understanding work-specific terms, processes, and topics. While one participant asked for a mentor, other participants thought of their manager

as their mentor. Managers can support engineers by encouraging them to ask questions, ask for help, and ask for clarity sooner and more often. Having a clearly defined mentor could aid new engineers' transition to practice. Mentors can provide new engineers with support and guidance throughout the transition to practice. One engineer explained that they took copious notes but did not understand everything they had written down. A mentor could provide insight into the minutiae of the everyday work culture. They can also provide context and insight regarding the engineering practices and the engineer's role, which would prove invaluable to newer engineers as they continue to learn and develop their skills.

Six study participants started their transitions to practice during a worldwide lockdown, and one went into lockdown about a month after her first day in the office. Those six did not receive an introduction to coworkers outside of their immediate team. Managers should have scheduled virtual meets and greets for new engineers. Another challenge with starting a transition and working from home is that virtual work can be very isolating. Participants expressed a need to connect, similar to walking across a physical aisle. Participants that started in the office or were able to work on-site during the lockdown did not report a comparable feeling of isolation. Managers need to help new engineers feel included regardless of their work environments. Managers play an essential role in new engineers' careers. Establishing a clear understanding of roles and responsibilities and effectively managing expectations can reduce new engineers' stress navigating their first transition to practice.

Benner (1984) emphasized that novice nurses required institutional support in the form of education and a workplace mentor; Schmitt and Schiffman (2019) confirmed Benner's (1984) suggestion. The two study participants with a mentor figure emphasized this person's benefits upon their transition. Managers should follow Benner's (1984) suggestions for supporting the

transition to competency and assign a senior engineer to mentor new engineers. A mentor will aid the transition process. Should the mentor not be a good fit, another can be assigned. Another implication for practice is training senior engineers to be mentors.

New Engineers

An engineer's transition to practice is their initiation into engineering. They may be aware of an anticipated job, but they may not anticipate that their expectations and reality differ. New engineers must expect challenges throughout their transition to practice. Their education may not have prepared them for the roles and responsibilities of their new position. New engineers need to establish a professional network outside of their workplace to mitigate the stress of these early challenges. Joining a professional engineering network or recruiting a group of mentors can help manage various facets of transitioning to practice. Such a group can help a new engineer understand the early challenges of starting their first professional role.

Another essential support system to establish is a network of family and friends. Participants in this study reported feeling stressed when they did not feel comfortable sharing within the workplace. Having sounding boards outside of the workplace can help alleviate workplace stress. One of the participants in this study made a clear separation between work and life. He stated that keeping work out of his personal life helped compartmentalize work and made for a happier home.

Engineers must recognize that their employer wants them to succeed. The new engineer did not receive their job for what they could do but for what they will do in the future. Therefore, new engineers must communicate their needs. They need to recognize where and when they need help. More importantly, new engineers must inform their managers and coworkers how they can provide them with the help they need to transition to practice successfully.

It is also essential for new engineers to realize that they need to take control of their transition. Study participants reported that their development did not start until they took control of their development and realized that they alone were responsible for their transition to practice. Before they took action over their transition, participants said they struggled to develop because they did not know where to find resources, manage their roles and responsibilities, or simply fit into the workplace. They realized that asking questions helped them develop work-specific knowledge and connect with their coworkers, which also helped them establish a workplace support system.

Recommendations for Future Research

This study gave voice to the perceptions of new engineers who are transitioning to practice. In the face of a shifting landscape of engineering, employers and educators must understand how to prepare new engineers better to meet the demands of an ever-changing workplace. The results of this study steer future research efforts in onboarding and skills development and the transition to practice in other professions.

I recommend five areas for further research on understanding new engineers' transitions to practice. First, researchers should consider conducting longitudinal studies on the experiences and perceptions of the transition to engineering practice. In the current study, I interviewed the participants only once. It is advisable to interview new engineers when they first enter practice. Following them until their promotion to Engineer II would provide a rich and in-depth understanding of new engineers' transition to practice. Any organization that hires and develops engineers as a part of its onboarding program could participate in such a study. Researchers need to keep in mind that new engineers may experience multiple transitions outside of the workplace that can affect their transition to practice.

Second, research studies should focus on new engineers who have quit their job or have left engineering to pursue another career path before achieving Engineer II. Historically, individuals that leave a targeted research population are difficult to study. Understanding why new engineers leave practice would be essential to improve the transition to engineering practice. The third area of research could include examining the impact of skills development. Researchers could inquire about new engineers' readiness and adaptability concerning the practice of engineers in their workplace. These studies could identify ways to improve engineers' transition to practice.

Fourth, I recommend a qualitative study investigating employers' perceptions and how they understand their role in new engineers' transition to practice. In the current study, I informally asked engineering managers and educators to supply context and understanding for the study. However, throughout these inquiries, I realized the importance of employers' expectations for new engineers and how different employers manage those expectations. Though outside of the scope of the current study, these findings warrant further consideration. Finally, I recommend that researchers explore if the transition to practice process revealed through study participants' perceptions can apply to other professions. The perceptions of the transition to engineering practice informed the creation of this model. It would be informative to understand if the model is unique to the engineers in this study or if this model can be applied to other professions' transitions to practice.

Conclusion

This dissertation has supplied an in-depth qualitative study of the perceptions of new engineers' transition to practice. An abundance of research attempted to confirm that new engineers are consistently unprepared for the transition to practice. However, few researchers

explored the transition perceptions and experiences of new engineers transitioning to practice. As an educator, it baffled me that the focus of research on the transition to engineering practice was not on the individuals in transition. Engineering schools have tailored curricula to meet industry demands yet are still seen as not preparing students for practice. My goal was to explore how new engineers perceived their transition to practice through their experiences.

I set out to create a study that constructed meaning based on the interpretations of new engineers' perceptions of transition to practice. The literature implied that the new engineers would be ill-prepared. However, that was not the case. The new engineers applied their education to learn applications and coding languages. They were able to build upon their education to meet work-specific demands. As I analyzed the collected data, I was impressed to see the study participants' success throughout their transition. The participants' resilience inspired reflection on my transition experiences.

This dissertation represents multiple transitions. On the surface, I developed research and analysis skills, improved my academic writing, and learned to manage a long-scale project while exploring engineers' transition to practice. In the depths, a more significant transformation occurred. Not revealed in these pages are the unanticipated situations that affected and influenced this dissertation. The struggle of fostering and building a life with my partner, the pain and challenges that come with losing a parent, and how my attention deficit disorder diagnosis changed my research direction. Were it not for the academic and familial support networks. I may not have found the focus and the perseverance required to contribute these findings to the transition literature. Nevertheless, thankfully, everything converged to help me complete my transition from Ph.D. student to scholar.

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APPENDIX A: Recruitment Email to Participants

My name is Todd Southern. I am a doctoral candidate in the Urban Education Program focusing on Adult, Continuing, and Higher Education Leadership at the University of Wisconsin-Milwaukee.

I am exploring the transition experiences of recent graduates into their full-time employment as engineers. I am emailing you to ask if you would like to contribute to this study. I am looking for participants who:

- Have graduated from college with a Bachelor's or Master's degree in Engineering.
- Have worked as a professional engineer for less than 24 months at the present job.
- Are experiencing their first school-to-work transition post-graduation from college.

Participation is entirely voluntary, and your answers will be de-identified. Additionally, I will code all names and identifying information. I will keep all the research information shared with me confidential. I will not discuss or share the research information with anyone other than the participant and the research supervisor. Nor will I share any personal information with the employer, including the decision of whether or not to participate. I will conduct all interviews on a non-company, non-networked computer. I will encrypt all electronic data.

If you have any questions or would like to participate in the study, please do not hesitate to contact me at souther5@uwm.edu.

Thank you for your time.

Sincerely,

Todd Southern
Doctoral Candidate
Department of Administrative Leadership

University of Wisconsin-Milwaukee School of Education
Phone: 352-256-4659
Email: Souther5@uwm.edu

Under the supervision of Dr. Simone C. O. Conceição, Ph.D.
Professor & Administrative Leadership Department Chair
University of Wisconsin-Milwaukee School of Education
Phone: 414-416-4248
Email: simonec@uwm.edu

IRB#: 21.204

APPENDIX B: Interview Guide

Pseudonym:

Date:

INTERVIEW GUIDE

Subject	Main Questions	Probing Questions
Background	Why did you become an engineer?	Can you describe your preparation to become an engineer?
Expectations	Tell me how you think your education prepared you for the workplace.	Provide an example of what you expected and what you did not expect.
Situation	Tell me about situations you have experienced moving into, moving through, and moving out of your 24 months on the job.	Provide examples of a situation(s) that have impacted your transition.
Strategy	Tell me about the resources and strategies you have used to navigate your journey from school to work.	Provide examples of where and how you employed different tactics to manage a challenge.
Support	Tell me about the types of support you have received from inside and outside of the workplace.	Provide examples of where and how you employed different tactics to manage a challenge.
Self-Perception	Tell me how you have developed your personal and professional self-perception throughout your 24 months in the workplace.	Tell me about the changes from when you first arrived in the workplace to where you find yourself now
Phenomenon	What is your overall perception of your transition from school to the workplace?	How has your perspective changed from school to the workplace? How have your skills developed from school to the workplace?

APPENDIX C: Informed Consent

Study title	New Engineers Perceptions of the School-to-Work Transition
Researcher	Todd Southern, Doctoral Candidate, Department of Administrative Leadership Under the supervision of Dr. Simone C. O. Conceição, Ph.D., Professor & Administrative Leadership Department Chair

I am inviting you to participate in a research study. Participation is completely voluntary. If you agree to participate now, you can always change your mind later. There are no negative consequences, whatever you decide.

What is the purpose of this study?

I want to understand new engineers' perceptions of their transition to practice.

What will you do?

If you agree to participate, I will ask you questions about your perceptions of the transition to practice. The interview will include questions about the support systems you used throughout your transition, the strategies you found beneficial or detrimental, your self-perceptions as you transition from school to professional, and your insights into your transition from school to the workplace.

Risks

Possible risks	How we are minimizing these risks
Breach of confidentiality (your data being seen by someone who should not have access to it)	• All identifying information is removed and replaced with a pseudonym. • I will remove all identifiers after the interview is completed. • I will store all electronic data on a password-protected, encrypted personal computer. • I will store all documentation data in a locked filing cabinet in a locked office. • I will keep your identifying information separate from your research data, but I will link it to you using a pseudonym. • I will destroy this link after we finish collecting and analyzing the data.

There may be risks we do not know about yet. Throughout the study, we will tell you if we learn anything that might affect your decision to participate.

Other Study Information

Possible benefits	The information you provide will increase the understanding of new engineers' school-to-work transition experiences.
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Estimated number of participants	I intend to interview between 14 and 17 participants.
How long will it take?	The Skype interview will take between 45-90 minutes.
Costs	None
Compensation	You will not receive any compensation, gifts, or extra credit for participating in the research study.
Future research	Your responses will not be used or shared for any future research studies.
Recordings	I will record the interview. The recording will be used to transcribe a written document of the interview. The recording is necessary for this research. If you do not want to be recorded, you should not be in this study.

Confidentiality and Data Security

I will collect the following identifying information for the research: name and email address.
This information is necessary to establish contact and to set up the interviews.

Where will data be stored?	All electronic information is stored on a password-protected personal computer. All paper data will be stored in a locked filing cabinet in my home office.
How long will it be kept?	All data will be kept for two years after the completion of the study.

Who can see my data?	Why?	Type of data
The researcher	To conduct the study and analyze the data	Identifiable (names and emails addresses included for contact) De-identified (names and any identifying information is removed) Coded (pseudonyms replace names)
The IRB (Institutional Review Board) at UWM The Office for Human Research Protections (OHRP) or other federal agencies	To ensure we are following laws and ethical guidelines	Identifiable (with your name included) De-identified (no names, birthdate, address, etc. attached to the data)
Anyone (public)	If we share our findings in publications or presentations	• Aggregate (grouped) data • De-identified (names and any identifying information is removed) • If we quote you, we will use a pseudonym (fake name)

Contact information:

For questions about the research	Todd Southern Dr. Simone C. O. Conceição, Ph.D.	souther5@uwm.edu /262.796.7161 simonec@uwm.edu /414.251.7553
For questions about your rights as a research participant	IRB (Institutional Review Board; provides ethics oversight)	414-662-3544 / irbinfo@uwm.edu
For complaints or problems	Todd Southern Dr. Simone C. O. Conceição, Ph.D.	souther5@uwm.edu simonec@uwm.edu
	IRB	414-662-3544 / irbinfo@uwm.edu

Signatures

If you have had all your questions answered and would like to participate in this study, sign on the lines below. Remember, your participation is completely voluntary, and you are free to withdraw from the study at any time.

Name of Participant (print)

Signature of Participant
Date

Name of Researcher obtaining consent (print)

Signature of Researcher obtaining consent
Date

APPENDIX D: IRB Manager Protocol Form

NOTE: If you are unsure if your study requires IRB approval, please review the UWM IRB Determination Form.

Instructions: Each Section must be completed unless directed otherwise. Incomplete forms will delay the IRB review process and may be returned to you. Enter your information in the **colored boxes** or place an **X** in front of the appropriate response(s). If the question does not apply, write **N/A**.

SECTION A: Title

New Engineers Perceptions of the School-to-Work Transition

A1. Full Study Title:

SECTION B: Study Duration

B1. What is the expected start date? *Data collection, screening, recruitment, enrollment, or consenting activities may not begin until IRB approval has been granted. Format: 07/31/2011*

12/10/2020

B2. What is the expected end date? *Expected end date should take into account data analysis, queries, and paper write-up. Format: 07/05/2014*

08/30/2021

SECTION C: Summary

C1. Write a brief descriptive summary of this study in Layman Terms (non-technical language):

The study will examine new engineers' perceptions of their transition from school to the workplace.

C2. Describe the purpose/objective and the significance of the research:

The purpose of this study is to gain a deeper understanding of new engineers' perceptions of the school-to-work transition. This study will explore their new situation, their strategies to navigate their transition, the support systems they use, and how they perceive their professional and personal self-perceptions throughout their school-to-work transition.

C3. Cite the most relevant literature pertaining to the proposed research:

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SECTION D: Subject Population

Section Notes...

D1. If this study involves analysis of de-identified data only (i.e., no human subject interaction), IRB submission/review may not be necessary. **Please review the UWM IRB Determination Form for more details.**

D1. Identify any population(s) that you will be specifically targeting for the study. Check all that apply: (Place an "X" in the column next to the name of the special population.)

Existing Dataset(s)	Institutionalized/ Nursing home residents recruited in the nursing home
UWM Students of PI or study staff	Diagnosable Psychological Disorder/Psychiatrically impaired
UWM Students (but not of PI or study staff)	Decisionally/Cognitively Impaired
Non-UWM students to be recruited in their educational setting, i.e., in class or at school	Economically/Educationally Disadvantaged
UWM Staff or Faculty	Prisoners
Pregnant Women/Neonates	International Subjects (residing outside of the US)
Minors under 18 and ARE NOT wards of the State	Non-English Speaking
Minors under 18 and ARE wards of the State	Terminally ill
X Other (Please identify):	

D2. Describe the subject group and enter the total number to be enrolled for each group. For example: teachers-50, students-200, parents-25, student control-30, student experimental-30, medical charts-500, dataset of 1 500, etc. Then enter the total number of subjects below. Be sure to account for expected drop outs. For example, if you need 100 subjects to complete the entire study, but you expect 5 people will enroll but 5 drop out of the study, please enter 105 (not 100).

Describe subject group:	Number:
Engineers	20
TOTAL # OF SUBJECTS:	20

TOTAL # OF SUBJECTS

(If UWM is a collaborating site for a multi institutional project):

D3. For each subject group, list any major inclusion and exclusion criteria (e.g., age, gender, health status/condition, ethnicity, location, English speaking, etc.) and state the justification for the inclusion and exclusion criteria:
Engineers who have graduated with a Bachelor's or Master's degree and are working in their first professional role as engineers have less than 24 months of experience.

SECTION E: Study Activities: Recruitment, Informed Consent, and Data Collection

Section Notes...

- Reminder, all recruitment materials, consent forms, data collection instruments, etc. should be attached for IRB review.

The IRB welcomes the use of flowcharts and tables in the consent form for complex/ multiple study activities.

In the table below, chronologically describe all study activities where human subjects are involved.

- In column A, give the activity a short name. Please note that Recruitment, Screening, and consenting will be activities for almost all studies. Other activities may include: Obtaining Dataset, Records Review, Interview, Online Survey, Lab Visit 1, 4 Week Follow-Up, Debriefing, etc.
- In column B, describe who will be conducting the study activity and his/her training and/or qualifications to complete the activity. You may use a title (i.e., Research Assistant) rather than a specific name, but training/qualifications must still be described.
- In column C, describe in greater detail the activities (recruitment, screening, consent, surveys, audiotaped interviews, tasks, etc.) research participants will be engaged in. Address **where, how long, and when** each activity takes place.

In column D, describe any possible risks (e.g., physical, psychological, social, economic, legal, etc.) the subject may *reasonably* encounter. Describe the **safeguards** that will be put into place to minimize possible risks (e.g., interviews are in a private location, data is anonymous, assigning pseudonyms, where data is stored, coded data, etc.) and what happens if the participant gets hurt or upset (e.g., referred to Norris Health Center, PI will stop the interview and assess, given referral, etc.).

SECTION E: Study Activities: Recruitment, Informed Consent, and Data Collection (continued)

A. Activity Name: **B. Person(s) Conducting Activity:** **C. Activity Description:** **D. Activity Risks and Safeguards:**

Recruitment Student Researcher Eligible participants receive a recruitment email. (An email describing the study with a request for volunteers). Minimal

Screening Student Researcher By filtering a list of employees with less than 24 months of active employment, they will create a list of participants. Minimal

Obtaining Consent Student Researcher A consent form made from a template created by the UWM IRB office will be sent to the study participants before the interview begins. Minimal

List all other study activities in the following rows

Interviewing Student Researcher Interviews will follow an interview protocol with questions, suggested probes, and
protectional guides to ask follow-up questions. Minimal (Interviews use Voice over

Internet Protocol. (e.g., Skype or Zoom), data will use Pseudonyms, a password-protected computer securely stores data,
transcriptions will be de-identified, and the interview will end should the participant become upset).

E2. Explain how the data will be analyzed or studied (i.e., quantitatively or qualitatively) and how the data will be reported (i.e., aggregated, anonymously, pseudonyms for participants, etc.):

This qualitative study will use the inductive interpretivist method to understand new engineers' school-to-work transition perceptions.

An inductive form of thematic analysis, called latent thematic analysis, will address the study's investigative aims. I will use a combination of Attride-Stirling's (2001) thematic networks for coding and the six-phased thematic analysis method recommended by Braun and Clarke (2006) to discover, analyze, and interpret the themes generated from the interviews.

To protect privacy, I will remove all information identifying people, places, and the company. All private information will be changed to a pseudonym to ensure confidentiality.

SECTION F: Data Security and Confidentiality

Section Notes...

Please read the **IRB Guidance Document on Data Confidentiality** for more details and recommendations about data security and confidentiality.

F1. Explain how study data/responses will be stored in relation to any identifying information (name, birthdate, address, IP address, etc.)? Check all that apply.

☐ Identifiable - Identifiers are collected and stored with study data.

☐ Coded - Identifiers are collected and stored separately from study data, but a key exists to link data to identifiable information.

☐ De-identified - Identifiers are collected and stored separately from study data without the possibility of linking to data.

☒ Anonymous - No identifying information is collected.

F2. Will any recordings (audio/video/photos) be done as part of the study?

☒ X ☐ Yes

☐ No **[SKIP THIS SECTION]**

If yes, explain what activities will be recorded and what recording method(s) will be used. Will the recordings be used in publications or presentations?

The interviews will use a Voice Over Internet Protocol program called Skype and recorded using a plug-in called Voice Recorder of Skype.

Future publications and presentations will not use the recordings.

F3. In the table below, describe the data storage and security measures in place to prevent a breach of confidentiality.

- In **column A**, clarify the type of data. Examples may include screening data, paper questionnaires, online survey responses, EMG data, audio recordings, interview transcripts, subject contact information, key linking Study ID to subject identifiers, etc.
- In **column B**, describe the storage location. Examples may include an office in Enderis 750, file cabinet in ENG 270, a laptop computer, desktop computer in GAR 420, Qualtrics servers, etc.
- In **column C**, describe the security measures in place for each storage location to protect against a breach of confidentiality. Examples may include a locked office, encrypted devices, coded data, non-networked computer with password protection, etc.
- In **column D**, clarify who will have access to the data.

In **column E**, explain when or if data will be discarded.

A. Type of Data	B. Storage Location	C. Security Measures	D. Who will have access	E. Estimated date of disposal
Interview transcripts	Desktop Computer	Password-protected personal computer	Student researcher	08/15/2023

Should there be any questions about the legitimacy of my transcripts.

F4. Will data be retained for uses beyond this study? If so, please explain and notify participants in the consent form.

No

SECTION G: Benefits and Risk/Benefit Analysis

Section Notes...

Do not include Incentives/ Compensations in this section.

G1. Describe any benefits to the individual participants. If there are no anticipated benefits to the subject directly, state so. Describe potential benefits to society (i.e., further knowledge to the area of study) or a specific group of individuals (i.e., teachers, foster children).

N / A

G2. Risks to research participants should be justified by the anticipated benefits to the participants or society. Provide your assessment of how the anticipated risks to participants and steps taken to minimize these risks (as described in Section E), balance against anticipated benefits to the individual or to society.

N / A

SECTION H: Subject Incentives/ Compensations

Section Notes...

- H2 & H3. The IRB recognizes the potential for undue influence and coercion when extra credit is offered. The UWM IRB, as also recommended by OHRP and APA Code of Ethics, agrees when extra credit is offered or required, prospective subjects must be given the choice of an equitable, non-research alternative. The extra credit value and the non-research alternative must be described in the recruitment material and the consent form.

H4. If you intend to submit to Accounts Payable for reimbursement purposes make sure you understand the UWM : Payments to Research Subjects: Procedure 2.4.6 and what each level of payment confidentiality means ([click here for additional information](#)).

H1. Does this study involve incentives or compensation to the subjects? For example, cash, class extra credit, gift cards, or items.

☐ Yes

☒ No [SKIP THIS SECTION]

H2. Explain what (a) the item is, (b) the amount or approximate value of the item, and (c) when it will be given. For extra credit, state the number of credit hours and/or points. (e.g., \$5 after completing each survey, subject will receive [item] even if they do not complete the procedure, extra credit will be award at the end of the semester):

H3. If extra credit is offered as compensation/incentive, please describe the specific alternative activity which will be offered. The alternative activity should be similar in the amount of time involved to complete and worth the same number of extra credit points/hours. Other research studies can be offered as additional alternatives, but **a non-research alternative is required.**

H4. If cash or gift cards, select the appropriate confidentiality level for payments (see section notes):

☐ **Level 1** indicates that confidentiality of the subjects is not a serious issue, e.g., providing a social security number or other identifying information for payment would not pose a serious risk to subjects.

- For payments over \$50, choosing Level 1 requires the researcher to collect and maintain a record of the following: The payee's name, address, and social security number, the amount paid, and signature indicating receipt of payment (for cash or gift cards).
- When Level 1 is selected, a formal notice is not issued by the IRB and the Account Payable assumes Level 1.
- Level 1 payment information will be retained in the extramural account folder at UWM/Research Services and attached to the voucher in Accounts Payable. These are public documents, potentially open to public review.

☐ **Level 2** indicates that confidentiality is an issue, but is not paramount to the study, e.g., the participant will be involved in a study researching sensitive, yet not illegal issues.

- Choosing a Level 2 requires the researcher to maintain a record of the following: The payee's name, address, and social security number, the amount paid, and signature indicating receipt of payment (for cash or gift cards).
- When Level 2 is selected, a formal notice will be issued by the IRB.
- Level 2 payment information, including the names, are attached to the PIR and become part of the voucher in Accounts Payable. The records retained by Accounts Payable are not considered public record.

☐ **Level 3** indicates that confidentiality of the subjects must be guaranteed. In this category, identifying information such as a social security number would put a subject at increased risk.

- Choosing a Level 3 requires the researcher to maintain a record of the following: research subject's name and corresponding coded identification. This will be the only record of payee names, and it will stay in the control of the PI.
- Payments are made to the research subjects by either personal check or cash. Gift cards are considered cash.
- If a cash payment is made, the PI must obtain signed receipts.
- If the total payment to an individual subject is over \$600 per calendar year, Level 3 cannot be selected.

If Confidentiality Level 2 or 3 is selected, please provide justification.

SECTION I: Deception/ Incomplete Disclosure (INSERT : NA; IF NOT APPLICABLE)

Section Notes...

- If you cannot adequately state the true purpose of the study to the subject in the informed consent, deception/ incomplete disclosure is involved.

II. Describe (a) what information will be withheld from the subject (b) why such deception/ incomplete disclosure is necessary, and (c) when the subjects will be debriefed about the deception/ incomplete disclosure.

N / A

IMPORTANT – Make sure all sections are complete and attach this document to your IRBManager web submission in the Attachment Page (Y1).