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AN INTERPERSONAL BEHAVIORAL FRAMEWORK FOR EARLY-CAREER ENGINEERS DEMONSTRATING ENGINEERING LEADERSHIP CHARACTERISTICS ACROSS THREE ENGINEERING COMPANIES

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Meredith (Meg) Handley

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The dissertation of Meredith Handley was reviewed and approved* by the following:

William J. Rothwell
Professor of Education
Dissertation Advisor
Chair of Committee

Wesley Donahue
Associate Professor of Education

Edward Yoder
Professor of Extension Education

Al Vicere
Professor of Business Administration

Dena Lang
Associate Director for Engineering Leadership Research

Susan Land
Department Head, Learning and Performance Systems
Associate Professor of Education

*Signatures are on file in the Graduate School

ABSTRACT

National organizations such as the National Academy for Engineers and the accreditation bodies like ABET are increasingly stressing the importance of leadership in engineering education. Since 2000, with ABET's updated curriculum requirements, and NAE's Engineer of 2020 report, engineering educators have struggled to figure out a way to fit leadership into already packed curriculum (NAE, 2004). Engineering leadership programs and research on the subject emerged. Engineering leadership research has evolved from describing effective practices in the classroom for engineering leadership knowledge development to empirical studies attempting to define the concept of engineering leadership. Findings suggest that traditional notions of leadership do not sit well with engineers (Rottmann, Sacks, & Reeve, 2014). One aspect of traditional leadership theory and development includes the importance of interpersonal competencies. Interpersonal competencies have been identified in recent research focused on the construct of engineering leadership (Cox, Cekic, Ahn, & Zhu, 2012; Hartmann, Stephens, & Jahren, 2015; Rottmann et al., 2014). However, the interpersonal behaviors associated with engineering leadership have not been explored. This study explores the behaviors associated with interpersonal competencies of engineering leadership during the early-career stage. This qualitative study describes the interpersonal behaviors that are important for demonstrating engineering leadership during the early-career stage. A qualitative approach, utilizing in-depth interview techniques, was utilized due to the need for an exploratory analysis of interpersonal competencies within the context of engineering. Nine engineering leaders across three large engineering firms participated in in-depth interviews to produce four engineering leadership characteristics important for early-career engineers and six interpersonal behavioral themes. Findings also focus on the importance of technical knowledge and abilities and generational stereotypes that impact leadership and interpersonal competencies within the engineering context. The results from this study suggest a framework for interpersonal behaviors associated with engineering leadership and relate to Emotional Intelligence. Findings from this study help to inform Human resource professionals, engineering managers, and engineering educators as to the interpersonal behaviors that are important for engineering leadership at the early-career stage and can help to inform training programs, coaching techniques, and engineering leadership curriculum.

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This is dedicated to all those whose leadership is inside….waiting to emerge and change the world.

Chapter 1

INTRODUCTION

Background

The report by the National Academy of Engineering (NAE), *The Engineer of 2020: Visions of Engineering in the New Century*, states that future engineers must understand and apply leadership principles throughout their career, remembering the global and societal impacts of engineering (NAE, 2004). Accrediting bodies, like the Accreditation Board for Engineering and Technology (ABET), continue to stress the importance of both technical and non-technical components in engineering curriculum for the successful education and development of engineers (ABET, 2014). Employers and society expect that engineers will graduate with the competencies needed and ascertain that educators have a responsibility to society to develop the needed competencies required for engineering work (Male, 2005). The realities of the need for a leadership-oriented, globally-minded, technically-trained engineer requires educational institutions to assess learning outcomes for both the technical and non-technical aspects of their curriculum. No longer can an engineer succeed long-term without acknowledging and building both technical and non-technical competencies (Farr & Brazil, 2009).

Engineering educators, unable to increase credit hours to accommodate non-technical aspects of engineering, are working to meet this requirement by creating leadership development programs. Numerous programs have been recognized for their innovative curriculum and projects that work to build leadership in alignment with workforce needs (Athreya et al., 2010; Cox, Berry, & Smith, 2009; Riley, Horman, & Messner, 2008; Sankar, Kawulich, Clayton, & Raju, 2010; Schuhmann, 2010). To truly evaluate the effectiveness of these programs engineering educators must agree on the definition of engineering leadership and create a standardized survey designed to assess leadership (Cox, Cekic, & Adams, 2009). While there are only a few empirical studies to build an assessment, attempts to operationalize engineering leadership has resulted in three important themes for effective engineering leaders: (a) technical competence, (b) collaboration in global teams, and (c) innovation management (Cox, Cekic, Ahn, Zhu, 2012; Farr & Brazil, 2009; Hartmann, Stephens, & Jahren, 2015; Rottmann, Sacks, & Reeve, 2014).

Further synthesis of this research highlights that interpersonal competencies are critical for all three themes identified in the emerging research for effective engineering leaders. As an example, in a study analyzing the readiness of civil engineers upon transition to the workforce, a participant commented on his perspective of leadership:

> You get a lot of things done ... simply in the manner that you deal with people. Friends of mine who were much better in chemical engineering, I think they did not go as far as I have gone to date because of the interpersonal skills. I'm honest about this because there are guys that are just not cutting it in terms of coming across and moving up the echelons of the company because of the way you relate to people (Martin, Maytham, Case, & Fraser, 2005, p. 172).

The engineer in this quote demonstrates that the ability to relate to people (interpersonal) is foundational to moving up (leadership) in an engineering context.

This relational theme highlighted above can be identified in each of the three theme areas of engineering leadership synthesized from current research; (a) technical competence, (b) collaboration in global teams, and (c) innovation management. Rottmann et al. (2014), found that technical competency required coaching and mentoring skills. Competencies for both coaching and mentoring include an ability to build trust, active listening, and communication; all of which can also be found also in lists identifying interpersonal competencies (Carpenter & Wisecarver, 2004; Fleming et al., 2013; Hutchins et al., 2013; ICF, n.d.). Collaboration within engineering team environments requires consensus and relationship building, resolving conflicts, motivating others, and communication (Hartmann, et al., 2015; Rottmann et al., 2014). A 2013 summary report of interpersonal competencies published from 2000-2012 aligns interpersonal skills with engineering leadership's collaboration within engineering teams. The summary lists communication skills, relationship building skills, peer leadership skills, and social/behavioral agility as the overarching categories of interpersonal competencies (Hutchins et al., 2013). Within each of these categories, interpersonal competency consists of: team cooperation and coordination, conflict resolution, energizing others, social influences, and oral, written, & non-verbal communication.

Innovation management centers on a leader's ability to manage change within an organization. An organizational leadership study's finding suggested that "leaders who effectively implement change possess a multidimensional set of interpersonal competencies including the abilities to motivate, communicate, build teams, coach, involve others, and reward appropriately" (Fiedler, 1981, p. 7). Interpersonal themes cutting across technical competence, collaboration, and innovation management, include communication, conflict resolution, coaching and motivating- all of which indicate that interpersonal competencies foundationally support the successful development of engineering leaders.

Problem Statement

Based on some of the early work of Waldman and Spangler (1989), knowledge, skills, and abilities impact effective job performance. Competencies are defined as a person's underlying characteristics related to effective performance that result in behaviors needed to succeed in a situation (Kim, Min, Yune, Choi, & Gong, 2008; Spencer & Spencer, 1993). Competencies are partially built on sets of behaviors that can be observed, called behavioral indicators, important for desired performance outcomes (Bartram, 2005). Identifying behavioral indicators are one method of documenting specific actions that demonstrate competencies needed for effective job performance in a particular context. (Spencer & Spencer, 1993; Waldman & Spangler, 1989). Competencies are perceived when behaviors are judged as effective and appropriate within the context of a situation (Spitzberg & Cupach, 1989). Interpersonal competencies have been identified as important in relation to effective performance in the workplace (Boyatzis, 1982; Wayne, Liden, Graf, & Ferris, 1997), positively related to salary and career progression (Luthans, Hodgetts, & Rosengrantz, 1998; Wayne et al., 1997), leadership and management (Kilduff & Day, 1994; Zaccaro, Gilbert, Thor, & Mumford, 1991), and overall organizational effectiveness (Argyris, 1962). Interpersonal competencies are proven difficult to conceptualize due to the complexity and ambiguity of the concept, and the inconsistency in describing the phenomena within the huge and fragmented volume of interpersonal competence research (Kim et al., 2008; Spitzberg & Cupach, 1989). Lack of advances in determining consistent interpersonal competencies is attributed to the inadequate use of contextual factors affecting the judgment of competencies associated with interpersonal competencies (Schlundt & McFall, 1985; Spitzberg & Cupach, 1989). However, more recent research into interpersonal has been described as those who need to improve "people skills," dealing with relationships, and in more recent years the term emotional intelligence has become synonymous with the concept of interpersonal skill (Riggio & Lee, 2007).

Interpersonal competencies are listed as important within the context of engineering leadership. The literature describing engineering leadership lists interpersonal competencies as important to incorporate into leadership development curricula (Athreya & Kalkhoff, 2010; Bayless, 2013; Daniels, 2009; Sankar et al., 2010), or are included as a factor or theme in empirical studies attempting to operationalize engineering leadership (Cox et al., 2009; Hartmann et al., 2015). These studies demonstrate the need for development of interpersonal competencies for successful engineering leaders; however, the contextually specific behaviors associated with effective and appropriate interpersonal competencies have not been explored.

Purpose of Study

The aim of this study is to explore behaviors associated with interpersonal competencies through the unique context of the engineering profession. Limited research exists exploring the impacts of interpersonal competencies on the potential for engineering leadership. Engineering leadership educators, expected to develop leadership characteristics in early-career engineers, have little evidence as to the interpersonal behaviors associated with leadership potential within the context of the engineering profession. This qualitative study describes which interpersonal behaviors of early-career engineers are important for engineering leadership roles from the perspective of engineering leaders across three large engineering firms. The qualitative approach to this study is indicative of the need for exploratory analysis of interpersonal competencies within the context of engineering. Investigation of the research problem will occur through interviews with identified leaders in the engineering profession. The research questions listed below explore leadership potential through perceptions of interpersonal behaviors developed through interactions with early-career engineers. In this study, behaviors are defined as observable actions that are the result of a person's underlying characteristics (Spencer & Spencer, 1993). The research questions guiding this study include:

Research Question 1: What leadership characteristics are important for early-career engineers to exhibit as indicators of emerging engineering leaders?

Research Question 2: Which interpersonal behaviors of early-career engineers are associated with leadership characteristics identified for emerging engineering leaders?

Competencies are perceived through an actor's judgment of effective behaviors relative to context (Spitzburg & Cupach, 1989). Therefore, an important first step is to understand from the perspective of an expert (an engineering leader), what interpersonal behaviors are relative within an entry-level engineering context. It is expected that the interpersonal behaviors identified through the current research will align with emotional intelligence competencies. Daniel Goleman's competency model for emotional intelligence is built off research finding that strengths in emotional intelligence made a crucial difference in average leadership performance and top performers (Goleman, 1998). Central to Goleman's emotional intelligence competency model is the idea that "interpersonal ineptitude in leaders lowers everyone's performance" (Goleman, 1998, p.32). The anticipated alignment of interpersonal behaviors identified within the context of engineering leadership during the early-career stage and emotional intelligence competencies will provide a framework by which interpersonal behaviors can be observed. This information will be helpful in aligning learning goals and assessments in engineering leadership programs towards the behaviors and actions warranted by industry professionals. Second, the research community has called for a standardized assessment tool to better evaluate the impacts of engineering leadership programs on student development of competencies related to engineering leadership. (Ahn, Cox, London, Cekic, & Zhu, 2014; Besterfield-Sacre et al., 2000; Cox et al., 2012). This study's findings will assist these efforts by identifying behaviors associated with interpersonal competencies within the context of engineering leadership. This study's findings will also contribute to efforts in developing competency models for engineering leadership and subsequent evaluative tools needed for determining effectiveness of leadership education or training programs as well as performance evaluation tools.

Definitions

The following section provides definitions for key terms to help provide context in their use throughout this thesis.

- *Behaviors:* Observable actions that are the result of a person's underlying characteristics (Spencer & Spencer, 1993).
- *Behavioral Indicators*: Competency models can be built on sets of behaviors that can be observed called behavioral indicators, important for desired performance outcomes (Bartram, 2005). Behavioral indicators are specific actions that demonstrate competencies needed for effective job performance in a particular context. (Spencer & Spencer, 1993; Waldman & Spangler, 1989)
- *Competence*: "the proven ability to perform a job competently (i.e. to the standards required in employment)" (Moore, Cheng, & Dainty, 2002, pg. 314). Competence can be considered the individual's particular trade and can be regarded as their "area of competence" (Moore, Cheng, & Dainty, 2002, pg. 316).
- *Competencies*: the individual's underpinning attributes that reflect the "generic underlying characteristics" of the competency (Moore, Cheng, & Dainty, 2002, pg. 317). Individual competencies are built from underlying characteristics that enable a person to demonstrate the competency associated with a particular job (Boyatzis, 1982; Spencer & Spencer, 1993). These underlying characteristics provide more detail to the concept of competencies and are described by Spencer and Spencer (1993) as the following:

1. Motives: The things a person consistently thinks about or wants that cause action. Motives 'drive, direct, and select' [McClelland, 1971] behavior toward certain actions or goals and away from others.
2. Traits: Dispositional in nature and is a generalized response to events (Boyaztis, 1982).
3. Self-concept: A person's attitudes, values, and self-image.
4. Knowledge: Information a person has in specific content areas.
5. Skill: The ability to perform a certain physical or mental task.

   (pp. 9-11)

- *Competency*: "dimensions of behavior lying behind competent performance" (Moore, Cheng, & Dainty, 2002, pg. 314; Armstrong, 1998). Spencer and Spencer (1993) also describe competency as "underlying characteristics of an individual that are causally related to criterion-referenced effective and/or superior performance in a job or situation" (p. 9).
- *Competency Model:* The sets of competencies needed for effective job performance (Bartram, 2005)
- *Early-Career Engineer*: an individual who has recently entered the workforce from a post-secondary education and may have as little as six months to three years of engineering work experience.

Chapter 2

LITERATURE REVIEW

Identified in this study are the interpersonal behaviors of early-career engineers that affect potential for engineering leadership roles. Central to the current study's focus on behaviors, is the idea that competencies are a valid predictor of job performance. Effective job performance can be defined as the specific actions that lead to the specified results of a particular job (Boyatzis, 1982). Competencies are defined as a person's underlying characteristics related to effective job performance that result in behaviors needed to succeed in a situation (Kim et al., 2008; Spencer & Spencer, 1993). Competencies are perceived when behaviors are judged as effective and appropriate within the context of a situation (Spitzberg & Cupach, 1989). Therefore, specific behaviors are the manifestations of competencies within the context of a particular job (Boyatzis, 1982). Boyatzis (1982) provides a model for effective job performance where the individual's competencies, the job's demands, and the organizational environment impact an individual's behaviors and actions (see figure 2.1).

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(pp. 9-11)

To fully understand a person's competencies, it is important to distinguish between the underlying characteristics. Motives, traits, and self-concept characteristics are core personality competencies that are not easily observed (Spencer & Spencer, 1993). Knowledge and skill characteristics are surface competences that are more visible and more easily developed (Spencer & Spencer, 1993). Both Spencer & Spencer (1993) and Boyaztis (1982) describe models by which the underlying characteristics of a person lead to the behavior, which leads to job performance.

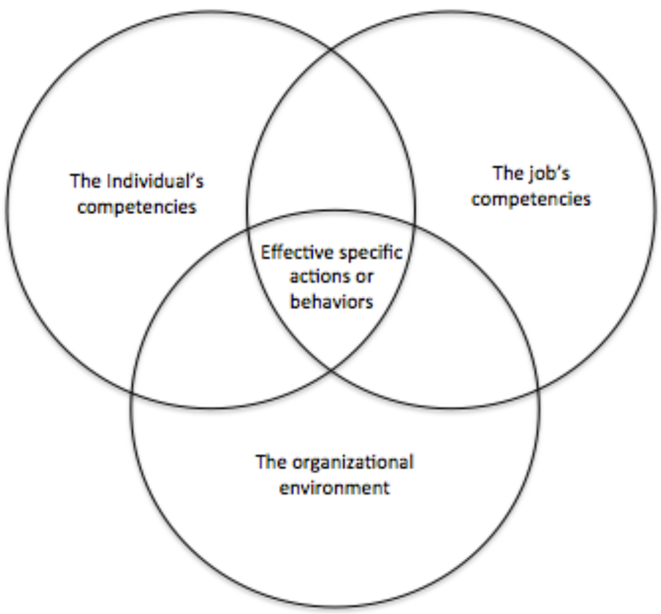


Figure 2.1. A model of effective job performance. Adapted from Boyatzis (1982). *The competent manager: A model for effective performance. New York, NY: J. Wiley.*

The job's demands and the organizational environment impact behaviors due to the context by which the person's underlying characteristics will manifest. Characteristics are not competencies unless it "predicts something meaningful in the real world" (Spencer & Spencer, 1993, p. 13). Job demands describe what a person will be doing in a particular role and the organizational environment contributes to "how a person is expected to respond to the job" (Boyatzis, 1992, p. 16). Bartram's 2005 study generated what he labels as "The Great Eight" clusters of competencies emerging from factor analysis of self and manager ratings of job performance providing for a framework of observable workplace behaviors that demonstrate competencies based on the criterion of the job (Bartram, Robertson, & Callinan, 2002; Kurz & Bartram, 2002). This distinction is important as it reflects the importance of determining job performance, not solely on an individual's underlying characteristics, but on the criterion related to the job. Bartram (2005) notes this importance by stating:

> Inconsistencies in predictors of overall performance between jobs might be explained by differences between jobs in the relative importance of different aspects of performance. Differentiation of the criterion space would allow better prediction of job performance for a particular role once the competency requirements for the role were understood (p. 1186).

Bartram's (2005) study is important to this work because it provides an example of the importance of understanding the contextual factors of a job (job demands and organizational environment) that impact the perception of competencies.

Spencer and Spencer (1993) and Boyatzis (1982) are central to this study because they provide the framework for understanding the importance of identifying behaviors within a particular context to determine competencies. Ultimately, Boyatzis's (1992) model aligns with a classical approach to behavioral theory: "behavior is a function of the person and the environment" (Boyatzis, 1992, p. 16). The idea that demonstrated behaviors are a result of the interaction between person and environment is central to this study (Boyatzis, 1992). The remaining portion of this literature review focuses on the literature relevant to interpersonal competencies developed within various workplace contexts, and the criterion related to engineering leadership in which interpersonal behaviors will be explored.

Interpersonal Competencies in the Workplace

Interpersonal competencies have proven to be difficult to conceptualize due to the complexity and ambiguity of the concept and the inconsistency in describing the phenomena within the huge and fragmented volume of interpersonal competence research (Kim et al., 2008; Spitzberg & Cupach, 1989). Attempts to define interpersonal competencies vary in both phrasing and underlying characteristics studied. Relational competencies describe trait characteristics of interpersonal competence (Cupach & Spitzberg, 1983; Hochwarter, Witt, Treadway, & Ferris, 2006; Huffcutt, Conway, Roth, & Stone, 2001). Emotional and social intelligence are terms used to define trait, self-concept, and skill characteristics of interpersonal competencies (Goleman, 1998; Hunt & Baruch, 2003; Riggio & Lee, 2007). Others used the term interpersonal skill to create taxonomies to define the underlying characteristics of motive, knowledge, and skill (Carpenter & Wisecarver, 2004; Hutchins et al., 2013; Spitzberg & Hecht, 1984).

The studies of interpersonal competencies are also dispersed between disciplines such as communication, psychology, and behavioral sciences (Riggio & Lee, 2007). Spitzberg and Hecht (1984) developed a theory of interpersonal communication, which define interpersonal competencies as the ability of communicators to accomplish tasks successfully or enhance success in particular communication situations. Spitzberg's later work describes interpersonal competencies as abilities in interaction management, composure, other orientation, and expressiveness (Spitzberg, Brookshire, & Brunner, 1990) . Riggio and Lee (2007) describe social skills as abilities, which express and control emotions and display sensitivity to others, aligning with psychology and behavioral science. Daniel Goleman's work in emotional intelligence considers competencies in social and relationship management as half of his popularized theory, which aligns with behavioral sciences. Klein, DeRouin, and Sala (2006) narrowed interpersonal competencies into communication and relationship-building skills, aligning with both communication theory and behavioral sciences.

Two recent attempts to conceptualize interpersonal competencies have identified behaviors associated with interpersonal and effective job performance within specific contexts. Carpenter and Wisecarver (2004) worked to develop descriptions of interpersonal competencies to provide a framework for effective job performance and goal attainment within the US Army. The first phase of the study identified interpersonal behaviors through meta-analysis of 54 studies, finding 167 unique interpersonal behaviors within the relevant literature. Five categories with 17 lower-level behaviors were identified through this literature review. The authors validated the interpersonal competencies through a critical incident card sort of worker behavior utilizing 175 officers with an average of 13 years of experience in the US Army. A total of 1,186 critical incidents were collected, 410 of which related to interpersonal performance. Experts sorted the critical incidents into five categories determined from the review of relevant literature. Through this analysis, 14 of the 17 original behavioral dimensions determined through the literature review were supported and placed into a list of interpersonal competencies.

The goal of the second phase of the study was to empirically evaluate the interpersonal competencies developed in phase one of the study. The researchers used the critical incident card sorts to create 128 items describing interpersonal behaviors. Respondents used a five-point Likert scale to indicate the importance of the item on successful job performance as well as the amount of time allocated towards this behavior in the job. A criticality index was calculated for each item with a higher weight given to importance to the job. Factor analysis was used to calculate the mean differences of interpersonal performance dimensions across military ranks. Significant correlations were calculated for criticality and for the model fit based on the factor analysis.

The findings from this study reveal that interpersonal performance factors are important within the context of the military and when compared across ranks show differences in level of importance within the organization (Carpenter & Wisecarver, 2004). The importance of Carpenter and Wisecarver's (2004) study for the current research is the identification of interpersonal competencies relative to a technical organization based on behaviors. Additionally, Carpenter and Wisecarver (2004) reveals the importance of interpersonal behaviors across rank. The current research effort is designed to explore the interpersonal behaviors relative to entry-level engineers' potential for leadership. The Carpenter and Wisecarver (2004) study is evidence that there is a difference in interpersonal behaviors across job levels and summarized that, "enlisted soldiers' dimensions such as influencing others, coordinating, and informing, increased in importance from entry-level to senior level soldiers" (p. vii).

In Kim et al., (2008), interpersonal competencies were placed into six clusters, derived by examining employees' perceptions of interpersonal behaviors within a Korean company. The study aimed to explore employees' perceptions of interpersonal competencies in a particular context "based on the norms of the particular peer group in which the social behavior occurs" (Kim, et al., 2008, p. 223). Phase one of the study asked 56 participants (with diversity in gender, career experience, and work group) to make a list of interpersonal competencies and further probed these responses by asking for statements detailing the behaviors of someone who may be good with interpersonal relationships at work. This strategy generated 273 statements, which were further analyzed for redundancies and narrowed to 79 qualitative statements. In the second phase, 44 participants were asked to sort the statements in piles according to similarities. Next, participants rated the importance of behaviors for career success and for importance in choosing a co-worker on a scale of one to seven with one being not important and seven being very important. A concept mapping approach was used to create six clusters describing interpersonal competencies within the workplace: ‘caring and considerate’, 'sociable and outgoing’, ‘kind and gentle’, ‘gregarious and friendly’, ‘reliable and leadership skill’, and ‘confident and responsible’. A *t*-test found a difference in means between the ratings of the behaviors being important for career success verses importance as a co-worker. ‘Reliable and leadership skill’ cluster and ‘confident and responsible’ were the most important competencies for success at work while ‘caring and considerate’ rated highly important as characteristics of a co-worker. The study also revealed that the cluster ‘sociable and outgoing’ was “consistently considered as least important for career success as well as for when stating preference as a co-worker” (Kim et al., 2008, p. 229).

Kim’s et al. (2008) study is important because it revealed employees’ perceptions of interpersonal competence within the context of the work environment. Specifically, the study reveals the interpersonal competencies relative to the social and work environment of a large technical company in Korea. The findings from this study are important to the current study in that they provide further evidence of the importance of understanding interpersonal competencies within a particular context. For example, Kim et al, (2008) found that the ‘sociable and out-going’ category was consistently rated as not important for career success. Bartrum (2005) cited studies where extroversion was positively related to job performance. Extroversion also had a high correlation with the Great Eight factor ‘leading and deciding’ in Bartrum’s 2005 analysis. The difference in the results of these studies indicates the need for contextual understanding of competencies to determine effective job performance. Lack of advances in determining interpersonal competencies is attributed to the inadequate use of contextual factors which affect the judgment of competencies (Schlundt & McFall, 1985; Spitzberg & Cupach, 1989).

Both of these studies noted the importance of interpersonal competencies for leadership. In Carpenter and Wisecarver, (2004), the criticality ratings increased with the increase in rank of the individual across nine of the 16 interpersonal performance dimensions. The nine dimensions increasing in criticality with rank fell into the clusters of energizing and directing behaviors. In the research by Carpenter and Wiscarver (2004), leadership literature was explored for findings of the impact of interpersonal competencies on achieving work goals. In the review, the authors found that both energizing behaviors and directing behaviors were critical for leaders based on the work of Bass (1990) and Yukl (1998). In the Kim et al. (2008) study, 'reliable and leadership skill' was rated as the most important cluster related to success at work. Both of these articles also show the importance of studying interpersonal behaviors within a particular context, such as a particular work environment or rank within an organization. The connection of interpersonal and leadership is explored more fully in the next section.

Interpersonal Competence and Leadership

Leadership research, appearing as early as the first part of the twentieth century, includes underlying characteristics of interpersonal competencies: motives, traits, behaviors, knowledge, and skills as part of theory generation (Avolio, Reichard, Hannah, Walumbwa, & Chan, 2009; Dinh et al., 2014; Hunt & Baruch, 2003; Riggio & Lee, 2007). As leadership research has evolved there has been an increasing emphasis on the importance of interpersonal competencies. A 2014 study to summarize the theoretical trends in leadership research over the past 20 years found that Social Exchange/Relational leadership theories were the third highest research publications behind Leadership and Information Processing theories and Neo-charismatic theories (Dinh et al., 2014). "Leadership is no longer simply described as an individual characteristic or difference, but rather is depicted in various models as dyadic, shared, relational, strategic, global and a complex social dynamic" (Avolio, Walumbwa, & Weber, 2009, p. 423).

Interpersonal skill development embedded within leadership training programs became popular for executive development across various industry sectors due to evolving leadership theory research (Cainer, 1970; Carpenter & Wisecarver, 2004; Gist & Stevens, 1998; Hunt & Baruch, 2003; Hunt & Sorenson, 2001; Riggio & Lee, 2007; Spitzberg & Hurt, 1987; Tews & Tracey, 2009). The Center for Creative Leadership (CLL) conducted studies over the course of 25 years to determine if factors causing derailment of top executives follow time and cultures (Van Velsor & Leslie, 1995). The top derailment theme across time and cultures included interpersonal relationships. The authors claim this is an issue of development due to the nature of different job requirements as individuals progress in leadership roles and deserves increasing organizational attention (Van Velsor & Leslie, 1995).

Despite an increase in quantity and need for leadership training programs with interpersonal skill development components, there is little evidence to show the effectiveness of these programs on improvements in interpersonal competencies related to leadership (Hunt & Baruch, 2003; Riggio & Lee, 2007). This difficulty in evaluating interpersonal competencies support Spencer and Spencer's (1993) conclusions that surface characteristics of competence are easier to develop than core personality competence. One study evaluated the impact of an interpersonal skills program on 252 executives. The program was delivered over a four-year period and included pre- and post-feedback from subordinates on the development of interpersonal competencies of their supervisors. The underlying characteristics of interpersonal competencies most enhanced from the program were those related to knowledge and skill characteristics of competencies (Hunt & Baruch, 2003).

Interpersonal skills, emotional intelligence, and leadership have also been shown to impact the success of leaders. Emotional intelligence as defined by Goleman (1995) is a competency model, which includes skills that impact effective leadership performance. Emotional intelligence competencies are defined as an ability based model where an individual demonstrates "an ability to recognize, understand, and use emotional information about oneself or others that leads to or causes effective or superior performance" (Boyatzis & Sala, 2004, p. 5). Goleman's claims resulted in the creation of assessment tools used in empirical research to analyze the relationship between emotional intelligence and leadership. Studies utilizing emotional intelligence assessments resulted in statistically significant relationships between emotional intelligence competencies and leadership effectiveness or potential (Anand, 2010; Barling, Slater, & Kelloway, 2000; Dries & Pepermans, 2007; Dulewicz & Higgs, 2004; George, 2000; M Higgs & Aitken, 2003; Lopes et al., 2004; Mandell & Pherwani, 2003; Prati, Douglas, Eerris, Ammeter, & Buckley, 2003; Rosete & Ciarrochi, 2005). In particular, Goleman argues that technical or cognitive ability alone does not explain the differences in star performers particularly related to leadership performance (Goleman, 2014; Malcolm Higgs, 2004; Judge, Colbert, & Llies, 2004). Jensen et al. (2007) describes this difference in performers by stating "It can then be argued that, if IQ is held constant, EI abilities will be helpful in distinguishing leaders that are more effective" (Jensen, Kohn, Rilea, Hannon, & Howells, 2007, p. 25). Emotional intelligence competencies are specifically defined with four competency clusters: self-awareness, self-management, social awareness and relationship management (Boyatzis, Goleman, & Rhee, 2000). Within these competency clusters, Goleman's (1995) theory centers on relationships, with interpersonal skills being essential for effective leadership performance. Research suggests strong relationships between emotional intelligence, interpersonal, and leadership abilities (Boyatzis et al., 2000; Saarni, 1999; Schutte et al., 2001; Sunindijo & Zou, 2013). Boyatzis, Goleman, and Rhee (2000) empirically analyzed the four competency cluster for emotional intelligence and argue that self-awareness and self-management are foundational to building personal skills and social awareness and relationship management are foundational to building social skills. Self-awareness specifically has been shown to be a prerequisite of the remaining emotional intelligence competencies and therefore initiates interpersonal relationships (Sunindijo & Zou, 2013). The emotional intelligence literature provides evidence of a strong connection between interpersonal and leadership.

Table 1. Emotional Intelligence Competency Clusters

Personal Skills- (how we manage ourselves)	**Social Skills (how we manage relationships)**
Self-Awareness	*Social Awareness*
- Emotional Self-Awareness	*- Empathy*
- Accurate Self-Awareness	*- Organizational Awareness*
- Self-Confidence	*- Service Orientation*
Self-Management	*Relationship Management*
- Self-Control	*- Leadership*
- Trustworthiness	*- Communication*
- Conscientiousness	*- Influence*
- Adaptability	*- Change Catalyst*
- Achievement Orientation	*- Conflict Management*
- Initiative	*- Building Bonds*
	- Teamwork & Collaboration
	- Developing others

Adapted from: Goleman, D. (1998). *Working with Emotional Intelligence.* New York, NY: Random House.

This portion of the literature review is important as it describes the evolution of interpersonal competencies within leadership theory and leadership development strategies. It reveals both the importance of interpersonal competencies for effective leaders and also the difficulty in identifying and measuring interpersonal competencies. The Hunt and Baruch (2003) article assert that trait- and ability-based characteristics with clear outcomes and objectives could be developed to improve performance. Bartrum's (2005) work highlights that trait- and ability-based approaches to development neglect the criterion-specifics of a job. Bartrum's (2005) work attempts to explain the difference in workers who meet job performance criteria, yet may have lower scores in trait and ability assessments. Emotional intelligence is important because it provides a framework by which interpersonal competencies particular to successful leadership may be explored within the context of engineering. The final section of this literature review attempts to summarize the literature related to engineering leadership and the extent to which interpersonal as a theme or skill is included as a factor within the context of engineering leadership.

Engineering Leadership and Interpersonal Competence

The report by the National Academy of Engineering (NAE), *The Engineer of 2020: Visions of Engineering in the New Century* states that future engineers must understand and apply leadership principles throughout their career, remembering the global and societal impacts of engineering (NAE, 2004). The recent call for leadership development in engineers are a result of a variety of economic, societal, and demographic forces. Globalization and "e-commerce" require organizations to use strategic thinking to re-think processes and products to meet diverse customer needs and emerging competition (Daniels, 2009; Novoselich & Knight, 2014). Societal implications driving change in the engineering profession include sustainability and ethical awareness in engineering decision-making (Novoselich & Knight, 2014; Rottmann et al., 2014). Demographic realities of a large, aging workforce followed by a smaller generation of workers require that recent graduates fill in leadership roles earlier in their career. A 2015 study highlighted that 62% of recent graduates employed full-time globally are in jobs where they manage the work of others (EY Global Diversity & Inclusiveness, 2015).

These realities support the call for reform in developing future successful engineers. Accrediting bodies, like ABET, adapted the current standards in 1998, supporting the need for non-technical competencies in engineering curriculum and implemented outcome-based accreditation models. To address these changes, engineering education saw a growth in engineering leadership development programs throughout the globe. Prior to ABET's 1998 changes to engineering competency requirements, literature in engineering education centered on the gap in engineering education and industry needs which helped to established the need for engineering leadership development. A review of literature on engineering leadership development since 2000 reveals approximately half of the publications describe best practices in addressing the gap in graduate engineers aligning with workforce demands. A common theme among these varying levels of peer-reviewed articles indicates the lack of uniformity in applying leadership theory and evaluating leadership development in relation to workforce needs. An often-cited article by Farr & Brazil (2009) uses the Center for Creative Leadership's model to describe an approach to developing leadership for engineers. Kumar and Hsiao (2007) assert that Problem-Based Learning, a method of instructional strategy which utilizes contextually specific problems for student knowledge development and problem-solving skills (Albanesse & Mitchell, 1993), is the best method to gain the industry demanded non-technical skills. These articles demonstrate that various forms of applied theory are being used to address leadership development for engineers in education.

Recognizing the need for uniformity, attempts to define engineering leadership have emerged over the past five years. Many studies have utilized qualitative methods for operationalizing engineering leadership (Cox et al., 2009; Hartmann et al., 2015; Rottmann et al., 2014) The researchers in these studies generated themes through interviews with peer identified engineering leaders (Rottman, et al., 2014), hiring managers (Hartmann, et al., 2015), and industry and faculty experts (Cox et al., 2012). Other studies utilized competency models already created through established leadership theories to survey recent engineers, industry experts, and faculty to determine the most important non-technical characteristics in engineers (Crumpton-Young et al., 2010; Donahue, 1996; LaTorre, 2014; Nair, Patil, & Mertova, 2009; Pitts, Klosterman, & McGonagle, 2013).

Two studies have extended their previous work in qualitative analysis to develop surveys associated with industry identified engineering leadership competencies. These studies add to the body of research seeking to define engineering leadership within the context of the profession. Both studies produce engineering leadership competencies that include interpersonal characteristics.

Ahn et al. (2014) conducted a mixed methods approach to develop a survey instrument to analyze student self-reported engineering leadership competencies, with the goal of producing an instrument to evaluate leadership development in undergraduate engineers. The authors interviewed 11 engineering professionals and 12 engineering academics with experience in industry to generate constructs related to engineering leadership, recognizing and managing change, and synthesizing engineering business and societal perspectives. Fifty-nine descriptive constructs were identified and narrowed down through a Q-sort methodology. Following the Q-sort, the constructs were placed into four dimensions for factor analysis: being an engineering leader, engineer's impact on society and economy, engineering leadership, and development of an adapter to change. Exploratory factor analysis was completed utilizing 753 undergraduates from a large Midwestern university. Exploratory factor analysis showed high internal consistency among items related to each of the four factors. However, 14 of the constructs did not align with any of the four factors indicating that revision of their descriptions may be necessary to ensure inclusion of the important items identified by industry professionals. The authors also caution that a large proportion of respondents were younger students who may have not yet realized higher order competencies in the engineering constructs identified by industry. All of the research participants reside in one institution, so application in another setting may not be generalizable. Ahn et al. (2014) focused on industry identified non-technical competencies with the goal of creating an assessment for undergraduate engineers.

Findings from Ahn et al. (2014) are important to the current study as their research produced a factor named "engineering leadership" which was defined with interpersonal competencies. The authors align this factor with leadership literature citing the importance of interpersonal exchanges aimed at building relationships for effective leadership (Ahn et al., 2014). Because Ahn et al. (2014) focused on developing an instrument to analyze leadership in engineering graduates, it supports the importance of a better understanding of the impact of interpersonal behaviors for early-career engineers on engineering leadership potential.

Hartmann et al. (2015) developed a survey instrument based on identified themes through interviews with personnel responsible for hiring entry-level engineers. The goal of the study was to develop an instrument to determine the importance of each of the themes within industry. Six recruiters were interviewed to determine five engineering leadership competencies engineering undergraduates should possess when applying for full-time jobs: initiative/confidence, communication, interpersonal interaction, teamwork, and engagement. The researcher developed 60 possible questions by analyzing the themes and language used in the qualitative interviews with recruiters and a literature review describing leadership competencies. Two experienced recruiters were utilized in a cognitive interview process to narrow down survey questions created based on the themes emerging from the qualitative analysis. The survey has been distributed to 800 recipients for further analysis. However, a possible limitation of the study is the small number of interviews conducted in the initial phase of the study and the lack of engineering professionals interviewed.

Different from Ahn et al. (2014), the instrument created informs engineering leadership programs on the importance of the five leadership characteristics from industry's perspective. Of the five characteristics determined from the qualitative analysis, three are interpersonal in nature: communication, interpersonal interaction, and teamwork. The authors defined these three leadership characteristics as:

- Communication: Possess excellent written, oral, non-verbal, and listening skills
- Interpersonal Interaction: Having people skills and the ability to build relationships and resolve conflicts
- Teamwork: Being a team player, collaborator, and a consensus builder

As with the Ahn et al. (2014) study, the initial phase of the Hartmann et al. (2015) study helps to inform the current work described in this thesis, as it provides further support of the importance for interpersonal competencies in engineering leaders. Hartmann et al. (2015) also demonstrates a need for a larger number of interviews specifically with engineering leaders to provide a stronger analysis of themes important to engineering leadership.

While all of these studies are important contributions to the study of engineering leadership, theses studies are characterized by program review and descriptions, limitations in the size of qualitative interview participants, and varying use of leadership competency models used to fit engineering leaders into pre-defined leadership characteristics. Further, each of these studies focus on how to best impact engineering leadership education within the context of a university setting. However, a common theme throughout each study is the call for the importance of defining engineering leadership. Findings, which attempt to operationalize engineering leadership, help to give context in which to explore interpersonal competencies.

Three studies within the last 10 years have worked to address this issue. Mallette's (2005) work utilizes observations from 30 years within the aerospace industry to assert that engineers are different and need to be led differently. The study focuses not on how engineers lead, but how they should be led. Mallette (2005) hypothesizes a leadership theory, Theory Pi, which provides plenty of autonomy for leading engineers. Theory Pi is compared against traditional leadership theory to describe the difference in approaches. Mallette’s (2005) analysis is important because it reviews traditional leadership theory and compares it to the leadership needs of a niche population of workers. Mallette (2005) pulls from psychometric testing showing that "all engineering personality types score moderate to very high on autonomy and none fall into either low or very low categories" (p. 5). Scoring high on autonomy implies that energy is obtained internally, which concludes that most engineers are more introverted (Mallette, 2005).

Robledo, Peterson, and Mumford (2009) argue that existing theories of leadership have not considered the unique needs of engineers, specifically in supporting creativity and problem solving. Robledo et al. (2009) developed a model for leading engineers based on previous research in psychometrics indicating that engineers are "open, autonomous, self-confident, and ambition/achievement oriented" (p. 141). Leaders influence through providing feedback, setting direction, planning, and defining the mission, which may prove difficult with the self-directed, autonomy of the engineer's personality (Robledo et al., 2009). The model asserts that successfully leading engineers requires strategies that appeal to engineering personalities.

In the Mallette and Robledo, et. al. studies, engineering personalities are described and theories introduced to best lead engineers. Most recently, Rottman et al. (2014) recognized that these studies only talked about how engineers should be led, not what makes an engineering leader. Rottman et al. (2014) used a grounded theory approach to understand, from identified leaders in the engineering field, how they conceptualize engineering leadership. The study identified seven junior and senior engineers and human resource professionals in four engineering-focused firms for interviews and conducted nine focus groups using a convenience sample in Toronto, Canada. A total of 721 pages of qualitative data were analyzed using the constant comparative method. Findings aligned with Mallette's (2005) and Robledo's et al. (2009) arguments that traditional views of leadership do not resonate with engineers. As data were analyzed, the researchers found "an element of cognitive dissonance between their professional identities as engineers and their views of leadership as antithetical to these strongly held identities" (Rottman, et al., 2014, p. 6). Resistance to leadership was based in an engineer's identity in being an "applied scientist, service professional, team player, technical problem solver, task oriented doer and process optimizer" with difficulty finding a place in traditional leadership competencies centered in charisma, hierarchy, "great man", subjective, and task master notions of leadership (Rottman, et al., 2014, p. 7). Despite this finding, Rottman et al. (2014) identified leadership characteristics across all participants: they were informal mentors to help others develop technical problem-solving skills, they leveraged their colleagues' strengths in teams, and they used entrepreneurial skills to develop ideas to address societal needs (Rottman, et al., 2014).

The authors identified three orientations of engineering leadership including: technical mastery, collaborative optimization, and organizational innovation (Rottman et al., 2014). Interpersonal competencies are evident in each of the categories. Technical mastery includes subject experts who mentor others and require coaching, listening, and communicating technical concepts to various audiences (Rottman et al., 2014). Collaborative optimization includes building high performing teams where collaborating, giving critical feedback, motivating, and handling conflict are characteristics of engineering leaders (Rottman et al., 2014). Organizational innovation includes creativity and problem-solving that drive company innovation and requires relationship building as a change agent (Rottman et al., 2014). Despite a resistance to traditional notions of leadership, this study found leadership characteristics important for engineers that included interpersonal competencies.

These three studies, Mallette (2005), Robledo et al. (2009), Rottman et al. (2014), are important to the current research in that each provide insight into the personality and work tendencies of an engineer. Engineers' personalities and perceptions of traditional notions of leadership reveal a need to understand which interpersonal behaviors are most impactful for effective engineering leadership. Based on Bartrum's (2005) Great Eight model, the variance in performance differences based on personality type can be mapped to the domain-specific criteria. Strengths of engineers favor Bartrum's 'analyzing and interpreting' competence cluster, aligning with Mallette's (2005), Robledo et al.'s (2009), and Rottman et al.'s (2014) analysis that engineering leaders exhibit technical competence. Introversion, while not mapping to Bartrum's (2004) 'leading and deciding' domain, aligns with Kim et al's (2008) analysis of the important interpersonal competencies within a technical organization, which found that the 'sociable and outgoing' cluster rated low in importance to work success. Findings within the engineering leadership literature support the importance of domain-specific criteria's impact on competencies and the behaviors associated with effective job performance.

Based upon this literature review, interpersonal competencies have a long history of studies related to motives, traits, self-concept, knowledge and skills and are found as a key component throughout the evolution of leadership theory. Engineering leadership is an emerging discipline within leadership research and these early studies reflect the importance of interpersonal competencies in engineering leadership. Engineers identify with autonomous and introverted personality indicators and reject traditional notions of leadership. There is a gap in the literature on the interpersonal behaviors most important within the context of engineering leadership to influence and impact the unique style of an engineer.

Chapter 3

METHOD

The aim of this study was to explore interpersonal competencies through the unique context of the engineering profession. This qualitative study explored which interpersonal behaviors of early-career engineers impact their potential for engineering leadership roles. The information addressing this study was collected from the perspective of current engineering leaders representing three large engineering firms. The qualitative approach to this study is indicative of the need for exploratory analysis of interpersonal competencies within the context of engineering leadership. The research questions guiding this study included:

Research Question 1: What leadership characteristics are important for early-career engineers to exhibit as indicators of emerging engineering leaders?

Research Question 2: Which interpersonal behaviors of early-career engineers are associated with leadership characteristics identified for emerging engineering leaders?

Findings from this study provide an empirical basis to identify behaviors associated with interpersonal competencies related to engineering leadership within the context of the engineering profession across multiple sites. This information provides a basis for aligning the learning goals and assessments used within engineering educational programs to more directly reflect the behaviors and actions identified by industry professionals. Second, the engineering research community has called for a standardized assessment approach to better and more formally evaluate the impacts of engineering leadership programs in student development of engineering leadership competencies (Ahn et al., 2014; Besterfield-Sacre et al., 2000; Cox et al., 2012). The current study's findings are especially useful in identifying the behavioral indicators of interpersonal competencies relative to the context of engineering leadership as a basis for the creation of standardized assessment tools.

Study Design

Qualitative methodologies represent an interpretive approach to a research problem that situates the researcher in the world in which the problem resides and uses both inductive and deductive analysis to determine patterns and themes (Creswell, 2013; Denzin & Lincoln, 2011). The qualitative approach to the current study is described as a multiple in-depth interview study within three engineering companies. In-depth interview studies are defined as intensive individual interviews with the purpose of interpreting meaning of a particular phenomena (Boyce & Neale, 2006; Kvale, 1994). Some literature refers to in-depth interviewing as qualitative surveys representing a descriptive research design, which seeks to find patterns of categories and provide explanation of diversity based on contextual factors (Jansen, 2010). Therefore, in-depth interview studies are appropriate for the current study because the purpose of the study was to understand from another's perspective the behaviors associated with leading within the engineering context. Figure 3.1 outlines the work-flow for this qualitative interview study.

According to the literature, in-depth interview studies are relevant means of qualitative inquiry because they provide a means by which to enter into another person's perspective (Patton, 1990). The central aim of this study was to explore the perspectives of current engineering leaders regarding behaviors previously observed in early-career engineers which provide evidence towards potential for engineering leadership. Qualitative interviewing is a rigorous and reliable process used when data cannot be observed directly by the researcher to socially construct meaning of a phenomenon (Kvale, 2007; Merriam, 2009; Patton, 1990). The qualitative interview was the sole method of data collection in this study due to the goal of understanding perspectives bounded by the engineering profession. Bounding the study with particular parameters helps to align the study directly to the research questions (Miles & Huberman, 1994). Additionally, the phenomenon being explored, interpersonal competencies within the context of engineering leadership, is an ill-defined topic where in-depth and unstructured data collection utilized in qualitative interview studies is imperative to derive meaning (Rose, Nigel, & Canhoto, 2015).

A multi-company approach was used in this study to address the need to understand interpersonal competencies within the engineering profession. The unit of analysis in the current study was the perspective of current individual engineering leaders. Obtaining perspectives from engineering leaders at multiple companies facilitated comparison of perspectives across settings, communities, or groups within the engineering profession (Khan & Vanwynsberghe, 2008).

Pilot Study

Two pilot studies were conducted to obtain information to refine the interview protocol, improve communications with interviewees, and develop interview skills. The first pilot study was conducted in the spring of 2015. This initial pilot study focused on evaluating the use of communication strategies for securing interview times and to practice asking questions aimed at soliciting responses on observable interpersonal behaviors of entry-level employees. Interviews targeted recruiters within large organizations that had at least five years of experience recruiting and evaluating graduating students.

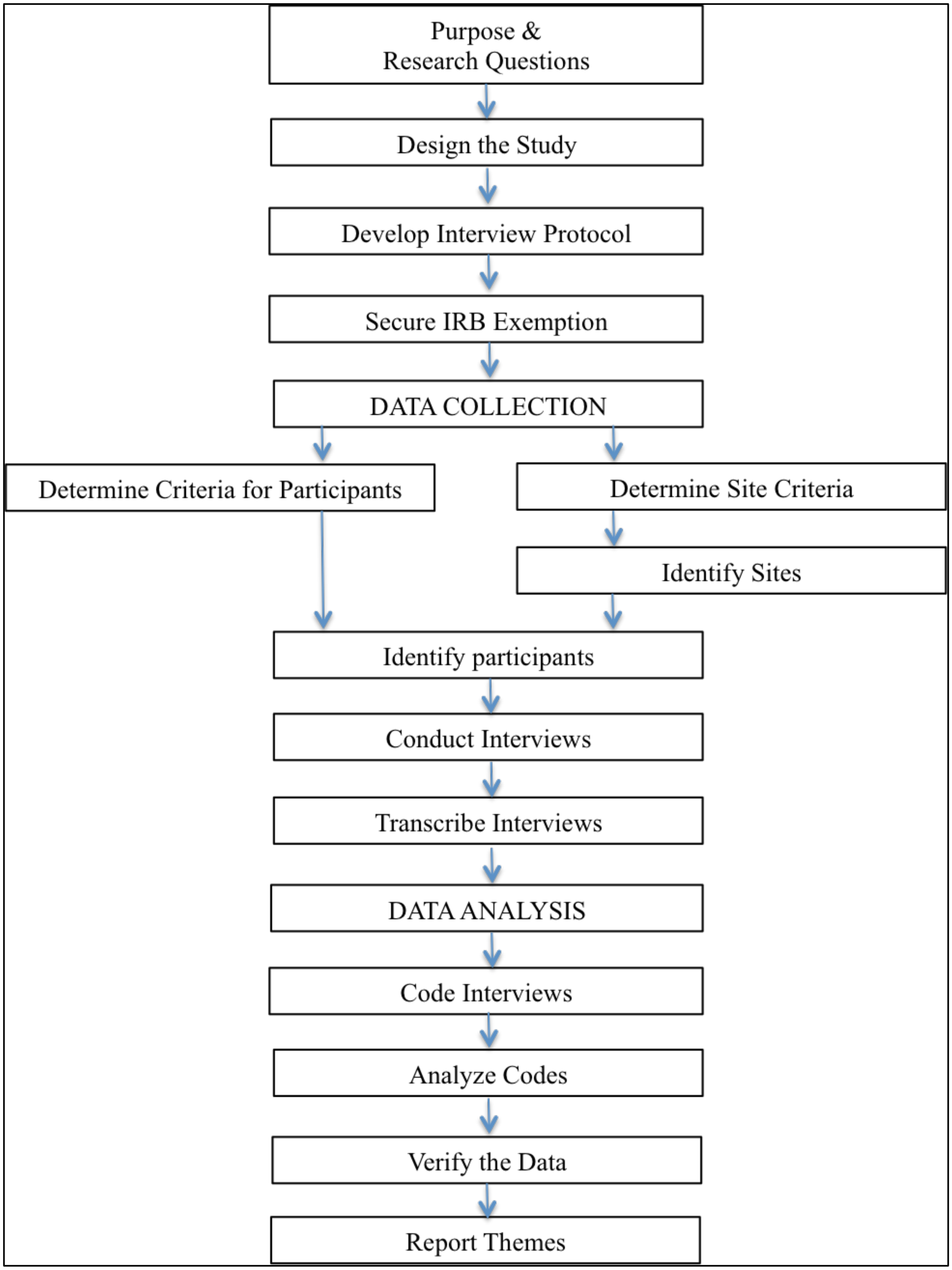


Figure 3.1. Interview study design map. Adapted from Kvale, S. (2007). *Doing Interviews*. London, England: SAGE Publications, Inc.

The pilot study participants were contacted via email with details regarding participation in the pilot study that included the interview protocol and consent information. Interviews were completed via phone or in person. Upon completion of the interviews, the researcher transcribed the hour-long interviews and submitted the transcribed interviews to the interviewees to provide any further opportunities for clarification. In addition, the researcher asked questions related to the interview experience including:

1. Were the interview questions easy to understand and did you feel they addressed the purpose of the study? How could these questions be improved to solicit behaviors associated with interpersonal competence of entry-level workers?
2. Did the research study letter describe the study in sufficient detail?
3. How could the interviewer improve questioning techniques to address the research study objectives?

Through the analysis of these questions, the interview protocol was adjusted to ensure the questions specifically stated "behaviors" in each question and notes were made for appropriate follow-up questions to re-word the question to ensure that the interviewee communicates behaviors associated with interpersonal competencies. Additionally, some of the interviews were conducted in-person. Feedback received indicated the need to restrain from confirming head nods and other non-verbal cues that indicate to the interviewee that they are "on the right track". This feedback was helpful to create an interview setting that solicits answers true to the context of the participant.

The second pilot study was an additional attempt to test interview questions related to identifying observable interpersonal behaviors, however, the study differed in that it explored the questions within an engineering context. This pilot study generated 96 responses to a set of five qualitative interview questions distributed via email to recruiters participating in an engineering career fair. This pilot study was designed to solicit information on how recruiters determine the leadership potential in students participating in the on-campus recruiting process. The questions focused on identifying specific behaviors associated with leadership potential communicated through the on-campus recruiting process. This pilot study provided information on the effectiveness of questions to solicit leadership behaviors within a specific context. This pilot study revealed similar needs to adjust strategies in interviewing to solicit behaviors as opposed to broad themes and skills. This pilot study also produced general themes associated with engineering leadership for entry-level employees, which included interpersonal competencies. This second pilot study is more fully discussed in the results and discussion sections of the current study.

Sampling Strategies

Purposeful sampling is a technique in which the sites and participants of a study are chosen due to information-rich potential that will illuminate and inform understanding of the central phenomenon of the study (Creswell, 2013; Patton, 1990). Specifically, purposive criterion sampling was used to identify both the sites and the participants in this study. Criterion sampling is a method for determining the sample based on a predetermined criterion of importance that is likely to be information rich to best inform the understanding of the study (Patton, 1990). With the goal of the current study being to develop a deep understanding of the appropriate interpersonal behaviors within the context of an engineering leader's perspective, this sampling approach was chosen to obtain information-rich data, which takes into consideration the context and cultural implications of the engineering profession.

Multi-Site Selection Criteria

The three companies utilized in this study were identified on application of two criteria: (a) appear within the top ten of companies hiring the most entry-level engineers based on a large northeastern university's job placement data, and (b) engineering organizations hiring across at least three different engineering disciplines. This information was obtained through review of a large northeastern university's annual placement report for undergraduate engineering students available from the college of engineering. The three companies considered were evaluated based on the numbers of entry-level engineering graduates hired over a three-year time period and the extent to which the hires were from diverse engineering disciplines. These criteria are appropriate to this study based on the need to explore interpersonal behaviors across engineering disciplines and to ensure the population being explored, early-career engineers through the perspectives of engineering leaders is dense. The companies selected for the study also have a long history of active recruitment at the large northeastern university. Contacts already established within the three companies selected were utilized for assistance in identifying the interview participants. The companies selected are multi-national engineering companies in diverse industries such as diversified industrials, defense, and project management. Three interview participants were selected from each site for a total of nine interview participants for this study.

Interview Participants

Interview participants were selected based on criteria gathered through an expert panel. The concept of engineering leadership is being explored within the literature; therefore, consensus on a definition of an engineering leader has not yet emerged. The participants in this study were identified as a current engineering leader so as to effectively determine the interpersonal competencies needed for potential engineering leaders. Without consensus on the definition of engineering leader, using criterion sampling for an engineering leader is difficult to apply. The current body of knowledge surrounding engineering leadership resides in educational institutions with engineering leadership development programs. The researchers and faculty within these programs have provided the bulk of the research to define engineering leadership. Studies conducted by Cox et al., (2009), Hartmann et al., (2015), and Rottmann et al., (2014) are examples of educators who have led efforts in exploring the engineering leadership phenomenon. These experts are members of the Leadership Division a group within the American Society for Engineering Education (ASEE). Experts and researchers were identified in this group to provide an expert panel of five members, in which agreed upon criteria are established to identify participants within the three sites. The specific criteria for determining the expert panel participants were as follows:

1. Member of the Leadership Division within ASEE
2. Involved in developing curriculum and teaching for an engineering leadership program at the undergraduate level

An email directed to members of the division was sent which included information regarding the study and a request to respond to questions regarding characteristics of an engineering leader. The researcher compiled the emails and spoke on the phone with some of the members to collect the expert panel criteria in which 15% of the division responded. The following criteria were identified by the expert panel:

1. At least 10 years of experience in the field of engineering, of which 10-20 should be in a management or leadership role
2. The participant should be a subject matter expert in his/her engineering discipline and be in a middle management position where he/she has supervised at least 20 engineers cumulatively over their career

3. Ideally participants may have one or more of the following characteristics:
   - Promoted at some point during their career
   - Worked at numerous companies across their career
   - Held a variety of positions
   - Acted as a mentor to young engineers
4. Ideal candidates may be described as being:
   - Highly self-aware
   - Good verbal communicator
   - Patient
   - Very reflective

Dr. Wes Donahue, a member of the researcher's committee who completed a study on the perceived importance of leadership competence to practicing electrical engineers (1996), reviewed these criteria on June 13, 2016. Dr. Donahue confirmed the criteria were appropriate for identifying current engineering leaders as the interview participants.

Data Collection

In-depth interview studies include open-ended questioning techniques with participants at sites that have been vetted to provide information-rich data. The nature of the data being collected can be described as abstract, i.e. 'having people skill', in which in-depth interviews would produce descriptive outcomes of behaviors that when observed would contribute to agreement that a performance goal was achieved (Mager, 1972). A semi-structured interview strategy was selected for this study to allow the respondents' perspectives to emerge. This approach allows the researcher to be guided by questions addressing the issues being explored but allows flexibility with the situation in which the respondent is the expert (Merriam, 2009).

Instrument Design

Prior to interviewing, the literature review and pilot studies provided insight into the design of the interview protocol. Developing quality open-ended questions that provide information-rich answers towards the phenomenon being studied is difficult, but such questions are essential for a reliable and rigorous in-depth interview study (Merriam, 2009). For this study, the goal was to identify the interpersonal behaviors associated with characteristics of engineering leadership during the early-career stage. Mager's (1972) goal analysis theory asserts that after identifying a goal, describing the performances that represent the goal is important. The semi-structured interview protocol is designed to describe and define abstract states, such as the "fuzziness" of interpersonal competence (Mager, 1972). The study did not aim to identify interpersonal competence of current engineering leaders, rather, the perceptions that are formed by observing behaviors of entry-level engineers. Therefore, probing for descriptors to define behaviors associated with the potential for engineering leadership was an important strategy. Kim et al. (2008) utilized probing questions to ensure descriptions of the behaviors were included in the interview. Strategies utilized in the design and implementation of the interview protocol included, always asking for a specific example, asking "what" instead of "why" questions to avoid abstractions, and asking non-leading questions (Spencer & Spencer, 1993). Mager (1972), Kim et al. (2008), and Spencer and Spencer (1993) informed the initial interview protocol used in the pilot studies, which subsequently informed the final interview protocol based on the feedback provided from the pilot study interviewees. Below is a table linking the research questions and the in-depth, semi-structured interview protocol questions. The interview protocol can be found in Appendix A.

Table 2. Interview Questions Corresponding with Research Questions

Research Question	Interview Questions (appendix A)
1. What leadership characteristics are important for early-career engineers to exhibit as indicators of emerging engineering leaders?	1, 3, 9
2. Which interpersonal behaviors of early-career engineers are associated with leadership characteristics identified for emerging engineering leaders?	2, 4, 5, 6, 7, 8

Data Analysis

Analysis of the data requires both creative interpretation of the story emerging from the data and systematic grounding of data in emerging concepts validated through comparisons across the data (Corbin & Strauss, 2008; Patton, 1990). The qualitative approach to data analysis in this study relies on generating, developing, and verifying concepts within the context of the engineering profession to ensure meaning from the in-depth interviews is clear and accurate (Corbin & Strauss, 2008). The nine in-depth interviews were collected and transcribed word for word and distributed to each participant for review and edits to check for accuracy and representation. The word documents were then uploaded to Dedoose software where the coding process could begin.

Coding the Data

Using Dedoose software, an open and axial coding process was employed as the first stage of data analysis. Open coding is the process of breaking apart data into concept groupings

(Corbin & Strauss, 2008). During the open coding phase, it is important for the researcher to use questioning techniques in order to reflect on the data and begin uncovering analytic leads for further exploration (Merriam, 2009; Saldana, 2009). 'Questioning the data' is a qualitative technique used during the open coding phase which allows the researcher to continually question what they are reading and why it might be interesting, allowing for not just the expected but also the surprising and conceptually interesting (Saldana, 2009). The next step uses axial coding which is the act of relating concepts or categories (Corbin & Strauss, 2009). Open-coding breaks data apart into concepts; axial-coding puts the data back together into related concepts (Corbin & Strauss, 2008). Figure 3.2 outlines the framework used for coding the data.

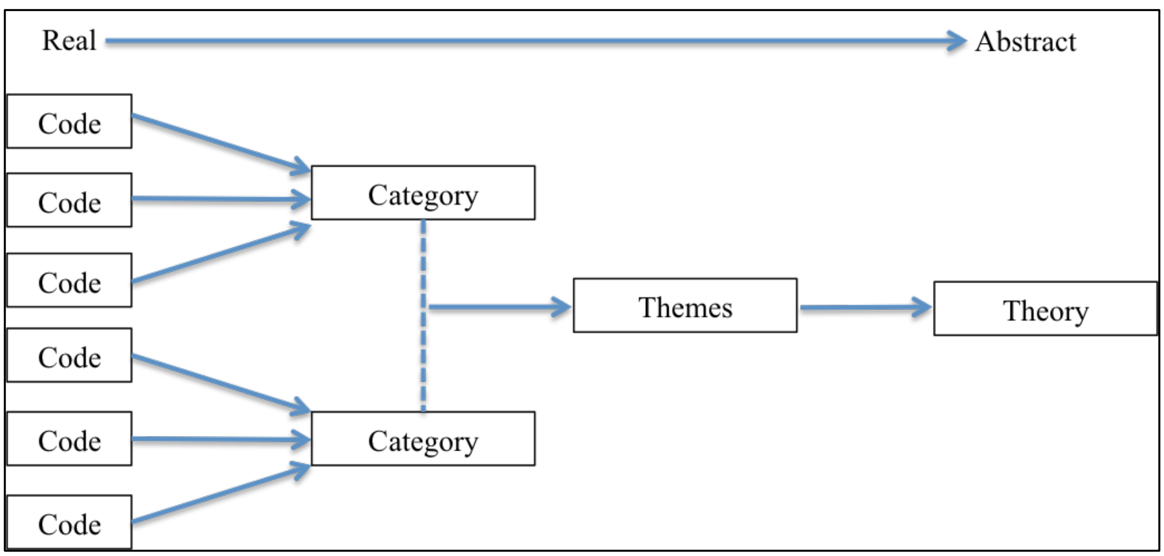


Figure 3.2 Open and Axial Coding Framework. Adapted from Saldana, J. (2008). *The coding manual for qualitative researchers.* Thousand Oaks, CA: SAGE

Strategies to Judge Trustworthiness of the Information

Trustworthiness of qualitative research relies on a researcher being trusted through methodological rigor (Lincoln & Guba, 1985; Patton, 1990). The following sections outline strategies for trustworthiness in the areas of credibility, dependability, and conformability.

Credibility refers to the quality of the research design and involvement of the participants whose reality is being studied (Lincoln & Guba, 1985). Lincoln and Guba (1985) describe techniques such as triangulation of data, member checking, and multiple investigators as methods for establishing credibility. Dependability addresses the dynamic nature of a particular context and subsequent impacts on the research design (Lincoln & Guba, 1985). Audit trails and external agent reviews provide transparency to increase the dependability of the study (Given, 2008). Confirmability is related to objectivity in that the findings are based on the data and “not altered due to researcher bias” (Given, 2008, pg. 112). Confirmability ensures that the phenomenon is studied through the perspective of the participants and that the researcher’s interpretations are grounded in the context of the participant (Lincoln & Guba, 1985; Given, 2008). Transparency in data collection, audit trails, triangulation, and member-checking are examples of strategies, which enhance the confirmability of a study (Lincoln & Guba, 1985; Given, 2008).

Triangulation

Internal validity, how well research findings align with reality, is commonly achieved through data triangulation (Merriam, 2009). Triangulation strengthens the study by using a combination of methodologies and data to study the phenomena in question (Patton, 1990). Denzin (1978) proposes four types of triangulation: multiple methods, multiple sources of data, multiple investigators, or multiple theories. In the current study, triangulation is achieved through multiple sources of data. Triangulation using multiple sources occurs when data are compared and crosschecked across interview data from different perspectives (Merriam, 2009). Another method for triangulation is through the use of experienced qualitative researchers to verify the coding. Termed triangulation analysis by Patton, the process requires two or more independent researchers to analyze the data and then compare findings (Merriam, 2009). Patton (1990) argues that this type of triangulation produces important insights due to "the different ways in which two people look at the same set of data" (p. 383). For this study, the second coder utilized in analyzing the data was a graduate student in Workforce Education, trained with professional expertise and experience in qualitative methodology. The second coder's research expertise focuses on exploring the concept of employability as it relates to students' abilities in communicating both technical and non-technical skills to potential employers. This background aligns closely with the work in this study with a focus on early-career individuals and their demonstration of knowledge, skills, and abilities to employers. The second coder reviewed key passages of transcribed interviews related to both leadership and interpersonal behavior codes. After reviewing the excerpts, Kappa's coefficient was calculated to determine the level of agreement corrected for chance (De Vries, Elliott, Kanouse, & Teleki, 2008). For this study a Kappa of .72 was calculated indicating good agreement according to Landis and Koch (1977). Coding issues and any disagreements were resolved through discussion between coders (Lombard, Snyder-Duch, & Bracken, 2002). The researcher and the second coder had minor disagreements in relation to semantics referencing similar concepts. Those minor differences were resolved through discussion between the two individuals. Once the second coder completed the verification of coding, a subject matter expert was consulted to confirm the themes generated through the data analysis. The subject matter expert, utilized to review the themes generated from this study is a current Director of an Engineering Leadership Development program in an academic setting. The Director has over 30 years of experience leading and managing engineers in the corporate world and has been in the director role for the leadership program for five years. A review of the themes by the subject matter expert, revealed alignment with discussion centered on the numerous communications themes emerging from the data. Consolidation of the communication themes emerging from the data is noted in the cross company analysis section of chapter four.

Audit Trail

The audit trail enhances confirmability and dependability by documenting processes and interpretations of the data, which may alter the course of the study (Given, 2008). The audit trail for this study consists of an excerpt from the data showing codes assigned to the transcribed interview and journaling or memos created during data analysis. This is important to the confirmability and dependability of the study to provide detailed documentation for replication of the study as well as rationale for any changes in the study of the phenomenon (Given, 2008). The audit trail strengthens confirmability and dependability by exposing the strategies used in coding to ensure the researcher's bias is adequately controlled and findings are grounded in the perspectives of the participants. The audit trail information can be found in Appendix E.

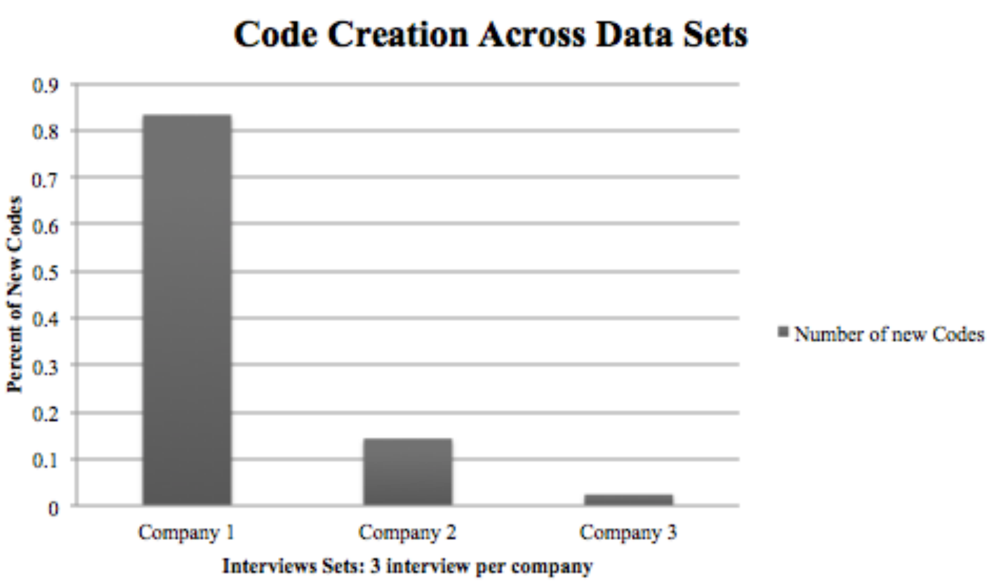
Member-Checks

Member-checking is a strategy most commonly used to establish credibility within a study (Lincoln & Guba, 1985). Member-checks consist of reviewing interpretations of data with the participants being studied. Through this method, the intentions of the participant's words can be confirmed and clarity can be obtained for interpretations of data and language, providing an opportunity to summarize (Lincoln & Guba, 1985). Member-checking occurred through selection of three participants, one at each data-collection site, who were asked to review and comment on a summary of the data analysis and final interpretations of the compiled data. Of the three submitted for formal member checks, two completed the member checking procedures by providing feedback and additional comments. The comments were used in adjusting information in chapter four and five, in particular the emphasis on the importance of technical knowledge and an adjustments to the original list of interpersonal behaviors found in the cross-company analysis in chapter four.

Data Saturation

The research methods outlined in this chapter seek to answer the research questions and address trustworthiness in the study's results. Specifically, the methods related to purposive sampling, semi-structure interviews and triangulation assist in achieving data saturation, an important element in a qualitative research study design. Data saturation as defined by Guest, Bunce, and Johnson (2006) is the point during data analysis when new information produces little or no change in the codebook. Qualitative methodologists suggest that samples sizes for interview studies should be determined by reaching theoretical saturation but that research design impacts at what rate saturation is obtained (Fusch & Ness, 2015; Guest et al., 2006). For this particular study design, saturation was reached after completing the nine interviews and is attributed to particular elements of the study design. Saturation based on code generations across the three companies is shown in figure 3.3.

Figure 3.3 Code Creation Across Data Set. Adapted from Guest, G., Bunce, A, Johnson, L. (2006). *Family Health International. 18*(1), p. 59-82.



First, purposive sampling was used in which a pre-determined set of criteria were used to identify the participants which was relevant to the research objectives (Guest et al., 2006). As outlined in an earlier section of this chapter, a panel of experts was utilized to identify criteria by which the interview participants were selected. The purposive sampling resulted in a very homogeneous group of interview participants. Full details of the participants' homogeneity can be seen in Appendix F with a summary of their characteristics being:

- All had been in a leadership or management position for more than nine years with an average of 17.9 years in leadership or management positions.
- All currently supervised engineers ranging in numbers from eight to 200 direct reports.
- Over their careers participants' average supervision counts ranged from the high 70s to more than a 1,000.
- All participants had been promoted during their career.
- Eight out of the nine have worked in multiple companies.
- All held numerous positions throughout their career.
- All acted as a mentor to younger employees.

Participants also commented on their personal leadership traits identified as important from the engineering leadership expert panel. The traits included being highly self-aware, good verbal communicator, patient, and very reflective with all participants self-identifying with at least one or more of these traits. The homogeneity and the relative expertise in the subject matter, engineering leadership during the early career-stage, is an indicator of reaching data saturation at an earlier rate. "The more similar participants in a sample are in their experiences with respect to the research domain, the sooner we would expect to reach saturation" (Guest, Bunce, & Johnson, 2006, p. 76).

Second, the study utilized semi-structured interviews which are also shown to be a method by which data saturation is reached (Fusch & Ness, 2015; Guest et al., 2006). With a semi-structured approach and list of questions utilized in each interview, this study design element ensured participants were asked the same questions to address the research questions. The semi-structured interview guide focused on a strategy to elicit behaviors from interview participants helping to keep a focus to the questions allowing data saturation to be obtainable. Figure 3.3 reveals the number of codes generated from the first three interviews associated with company number one and the subsequent codes added after completing the next six interviews. By using a semi-structured and consistency within the interviews, data saturation was achieved as a minimal number of new codes were introduced in the later interviews conducted in this study.

Finally, triangulation of data also ensured saturation was achieved in this study as data triangulation is said to ensure data saturation (Fusch & Ness, 2015). In the current study, triangulation is achieved through multiple sources of data. Triangulation using multiple sources occurs when data are compared and crosschecked across interview data from different perspectives (Merriam, 2009). As figure 3.3 demonstrates, the agreement across companies emerged as a minimal number of codes were added as data was analyzed. By employing these particular strategies, saturation was achieved in the current research study.

Role of the Researcher

The researcher has worked in higher education for thirteen years in student development and instructor capacities. As the director of a Career Services unit, the researcher developed a deep knowledge of employer-identified skill-gaps in recent graduates, through interactions with employers, conferences, and researchers. Within each of the researcher's roles in a university setting, she was in charge of developing leadership among undergraduate students. The researcher took a particular interest in developing non-technical skills in technical majors, such as accounting students, and conducted an initial pilot study while in her role as the Career Services director of a business school. During this time, the researcher transitioned to a faculty appointment where she teaches and conducts research on developing non-technical skills in engineering students as a part of the Engineering Leadership Development program. Through these experiences, the researcher has developed an understanding of post-secondary students' transition to work, employer perspectives, and leadership development theory.

The researcher also has experience in conducting interviews. Through the Center for Credentialing and Education the researcher achieved certification as a Career Coach as of March 2012. This training and subsequent experience in career coaching helped the researcher to develop skills in asking open-ended, powerful questions with clients. Through her roles in career services, the researcher has honed and practiced this skill through one-on-one career coaching appointments with students. In addition, the researcher is collaborating on another study with a peer within the Workforce Education Department. The goal of the study is to explore the experiences of seasoned recruiters in working with students' transitioning from postsecondary-to-work. This study uses a grounded theory approach to explore the experiences of recruiters in terms of identifying employability in students during the recruiting process. The themes generated from this study will provide evidence of the impressions formed of students' employability during the initial recruitment for job opportunities. To date, ten interviews have been conducted and transcribed. The importance of this study to the current study is to provide the researcher with additional practice in interviewing techniques designed towards soliciting answers associated with observable behaviors.

Limitations

Limitations with any research study are important to identify due to the impact on the interpretation of the study's findings and applications for practice (Price & Murnan, 2004). The qualitative approach to the current study reveals limitations centered on generalizability of the data across different perspectives. Qualitative findings, being highly contextualized and case dependent, can result in mis-understanding through over-generalization across different perspectives (Patton, 1999). The current study's design focused only on the perspective of engineering leaders, identified by an expert panel, whose average work experience was approximately 18 years. Study participants included eight males and one female, limiting a diverse perspective in the data and also included only large engineering companies. These contextual aspects of the study design align with typical critiques of qualitative research (Patton, 1999). However, three specific study design flaws contribute to the constructed meaning of interpersonal behaviors associated with this study.

First, interviewing from only the perspective of experienced engineering leaders negates the effect of human resource recruiters whose analysis of leadership needs during the recruiting process may be considerably different than that of the leaders and managers observing early-career engineers. The lack of recruiter perspective fails to complete the picture of the interpersonal behaviors associated with developing leadership characteristics in early-career engineers. Recruiters are the first industry observers of engineers' competencies during the on-campus recruiting process. Recruiters' perceptions of engineering leadership during the on-campus recruiting process are determined through a variety of behaviors, which may stress different interpersonal behaviors (Handley, Lang, & Erdman, 2016). Combining the perspective of both the recruiter and the engineering leader provides a more holistic picture of the interpersonal developmental needs that should be stressed by engineering leadership programs.

Secondly, this study fails to address the cultural differences in interpersonal behavior. The interview protocol, developed for effective probing and limiting of abstract descriptors, failed to consider the impacts of cultural differences on interpersonal behaviors. Being a western culture, this study is biased toward individualistic, masculine, risk oriented, and power focused work cultures (Hofstede, Hofstede, & Minkov, 2010). Interpersonal behaviors associated with early-career engineers identified within the western work culture paradigm assume that interpersonal behaviors outside these cultural norms are ineffective. Data from 2009 indicates ten percent of US university students were international with a growth of seven percent of international students in 2016 (Institute of International Education, 2016; Sherry, Thomas, & Chui, 2010). Findings from this study, void of the impact of various cultures, fail to provide important information on the impacts of culture on interpersonal behaviors for early-career engineers.

Third, effective interpersonal behaviors, with an evaluation solely from upper-level engineers, fail to consider the perspective from peers within the workplace. Leadership development in the early-career stage is influenced by both upper-level personnel and peers (Komives, Longerbeam, Owen, Mainella, & Osteen, 2006). The interpersonal behaviors impacting the perception of leadership may be different across levels within the organization such as peers within the same level. The current study fails to take into account the impact of peer influence on interpersonal behaviors as well as the perception of leadership based on interpersonal behaviors from a peer's perspective. The limitations from this study's design, while bounded within a particular professional context, fail to consider perspectives across key individuals and cultures impacting the perceptions and performance of leadership associated with early-career engineers.

The current study design, despite its limitations, is not without usefulness to the intended audience. Despite the flaws, the study identifies interpersonal behaviors bounded within the context of engineering leadership. The perspectives of the participants in this study, identified through in-depth, open-ended interview techniques, provide an interpretive approach that best situates the researcher in the world in which the problem-resides (Creswell, 2013; Denzin & Lincoln, 2011). The following chapter summarizes the perspectives from the participants related to the research questions of this study.

Chapter 4

RESULTS

The purpose of this chapter is to report the results of the data analysis. Engineering leaders were identified and recruited from three different engineering companies to participate in the interview study. This chapter details information describing the interview participants and the themes generated based on data analysis. Themes emerging relevant to each of three companies are identified and a summary of themes across all three engineering companies is compiled.

Industry and Participant Profiles

The three sites utilized in this study were based on application of two criteria: (a) appear within the top ten of hiring the most entry-level engineers based on a large northeastern university's job placement data and, (b) engineering organizations hiring across at least three different engineering disciplines. This information was obtained through review of a large northeastern university's annual placement report for undergraduate engineering students available from the college of engineering. The companies considered for the three sites were evaluated based on the numbers of entry-level engineering graduates hired over a three-year time period and the extent to which the hires were from diverse engineering disciplines. The companies selected are multi-national engineering companies in diverse industries such as diversified industrials, defense, and project management.

The criteria used to identify the nine participant interviewees selected for this study were determined based on a panel of engineering leadership experts. Panelists identified key characteristics of engineering leaders, which were compiled and utilized to identify interview participants meeting the criteria. Full details of each participant are outlined in Appendix F. Of the participants:

- All had been in a leadership or management position for more than nine years with an average of 17.9 years in leadership or management positions.
- All currently supervised engineers ranging in numbers from eight to 200 direct reports.
- Over their careers participants' average supervision counts ranged from the high 70s to more than a 1,000.
- All participants had been promoted during their career.
- Eight out of the nine have worked in multiple companies.
- All held numerous positions throughout their career.
- All acted as a mentor to younger employees.

Participants also commented on their personal leadership traits identified as important from the engineering leadership expert panel. The traits included being highly self-aware, good verbal communicator, patient, and very reflective with all participants self-identifying with at least one or more of these traits.

Themes Generated Across Three Engineering Companies

The purpose of this interview study was to explore interpersonal behaviors associated with engineering leadership potential of early-career engineers. This qualitative study describes which interpersonal behaviors of early-career engineers impact potential for engineering leadership roles from the perspective of engineering leaders across three large engineering companies. The research questions were:

Research Question 1: What leadership characteristics are important for early-career engineers to exhibit as indicators of emerging engineering leaders?

Research Question 2: Which interpersonal behaviors of early-career engineers are associated with leadership characteristics identified for emerging engineering leaders?

Through analysis of the data, the researcher identified themes related to engineering leadership potential and the interpersonal behaviors important for identification of engineering leadership potential. Themes are organized for each of the three large engineering companies and then compared for consistency across all three companies to produce a comprehensive list of interpersonal behaviors associated with engineering leadership potential in early-career engineers.

The following sections are organized to first communicate the engineering leadership characteristics of early-career engineers, and second, the subsequent interpersonal behaviors important for the identified engineering leadership characteristics within each of the three engineering companies. For each of the three companies, the first section identifies leadership characteristics associated with engineering leadership during the early-career stage. The second section for each of the three companies identifies the interpersonal behaviors associated with the engineering leadership characteristics identified during the early-career stage. At the end of each company section a table is provided to summarize the leadership characteristics and the interpersonal behaviors. Additional themes emerging from the study are listed finalizing the data reporting for this study. The final section concludes with a cross-company analysis of the leadership characteristics and a summary of the interpersonal behaviors associated with the leadership characteristics important for early-career engineers to demonstrate. Throughout the coding process information provided by the participants may cut across multiple categories of themes and therefore, some excerpts are utilized to demonstrate different aspects of leadership characteristics or interpersonal behaviors.

Engineering Leadership Characteristics: Company 1

The following themes emerged through analysis of the three interviews conducted within company one. Each interview began by asking a question such as: When observing an early-career engineer, what characteristics demonstrate engineering leadership or what does engineering leadership look like at the early-career stage? This question aimed to solicit the characteristics associated with engineering leadership during the early-career stage. The following themes describe the characteristics associated with engineering leadership during the early-career stage for the first set of interviews associated with company one.

Willingness to learn

Willingness to learn emerged as a characteristic of engineering leadership for early-career engineers across all three interviewees within company one. A willingness to learn related to an early-career engineer's **recognition that they are not an expert in their field**.

> **Participant 1.1:** "…our most successful early career engineers are those that come in with that eagerness to learn. **Kind of the willingness and recognition that they're not an expert in their field**. You know they might feel like it when they become graduates. So they're not an expert but they understand and can learn from the experts to identify who the experts are and how best to leverage their skills to get their jobs done."

The participants in company one reported that a willingness to learn includes learning from others, learning from mistakes, and learning from other disciplines. **Learning from others** centered on the idea that early-career engineers are surrounded by personnel with a wealth of knowledge and expertise within the company and that taking advantage of that expertise is central to getting a job done.

> **Participant 1.1: "**if someone's challenged with a problem for example they have an activity or a task they need to complete on a program and they are not a hundred percent sure all the different steps it takes to get it done. Or even what to do within those steps. Right. **So understanding and knowing that who that lead technical person might be to help them solve the technical problem and then who the other individuals are that might be involved in in actually completing the overall solution.**"

Learning from mistakes exhibits how an early-career engineer was willing to learn through taking risks to solve engineering problems, but also recognizing the importance of acknowledging mistakes and learning from experts.

> **Participant 1.3**: "And it's okay to fail. **We all we all make mistakes and we learn from our mistakes and being able to accept that and acknowledge your mistakes and move on.**"

Learning from other disciplines showed how an early career engineer wanted to understand the intricacies of other units within the company and how those units might impact the solution to an engineering problem. In particular, by understanding both the technical and the non-technical functions, engineers can understand how their decisions might impact other supporting roles.

Participant 1.2: "they wanted to continue to learn about their specific role but also **learn about the auxiliary roles that they support**. So they might want to get into financial or might want to get into program management."

Getting a job done

Getting a job done was also a consistent theme across all three participants in company one. Getting a job done involved a young engineer's ability to understand how to get the job done by **being proactive and leveraging the expertise** needed to get the job done.

Participant 1.1: "Those, the ones that come in and recognize that okay there's a lot of people involved in this process, and these are **who I need to go to get this job done as opposed to someone who might come in and maybe have less of that leadership attributes and they're more sitting back and waiting for their tech leader or someone to direct them on where to go."**

"I think those kind of stand out later in their careers as individuals who tend to gravitate towards leadership style positions are the ones who come in and **act a little more proactively in terms of understanding how to get jobs done** by leveraging skills of the people around them."

"When they do it successfully I mean I think it has to do with you know if someone's challenged with a problem for example they have an activity or a task they need to complete on a program and they are not a hundred percent sure all the different steps it takes to get it done, or even what to do within those steps. Right. So understanding and knowing that **who that lead technical person might be to help them solve the technical problem and then who the other**

> **individuals are that might be involved in in actually completing the overall solution**."

Getting the job done also included a **leadership mindset of seeing the bigger picture**. Solutions to engineering problems are not solved within one group, but take into consideration how the solution fits into the bigger picture. A specific example was given from participant one within the context of a software developer:

> **Participant 1.1:** "So if you're if you're a new developer you don't necessarily know that hey there's not only the technical piece of it but there's also the how do I put this into my configuration math environment or how do I go through and verify that the change that I made didn't negatively affect any other portion of the code that I'm working on. Or once I roll this out what kind of ripple effect does it have on my documentation that might affect people within my logistics organization or wherever else. **So it's just understanding kind of the bigger picture."**

Decision-making was also an important aspect of getting the job done. Engineers identified as potential leaders, also made decisions confidently without laborious time periods deciding which direction to take. They were timely and direct, taking ownership of the decision to ensure the job was done.

> **Participant 1.2: "They so they're not afraid to make decisions.** So that a lot of people especially early career people they make decisions. They don't, they don't labor on things. Okay this is where we're going to go forward with it."

“He took ownership of his tasks, and he did everything to make that project successful fully recognizing that he couldn't be successful given what he was given. **Rather than putting blame on others he took the direction**.”

Lastly, engineers who got the job done were **hardworking** and willing to put in the time to get the job done in a timely and thorough manner.

Participant 1.3: “You know willing to **put in the time when needed. Working hard at the job** not taking a whole lot of breaks right. Not, not a whole lot of small talk goofing around right. You're serious about work. You get down to business.”

Career Maturity

Career maturity is an in vivo code describing an early-career engineer’s ability to recognize the various situations they are in and demonstrate appropriate behaviors for each specific situation. Early-career engineers demonstrated career maturity related to engineering leadership when they acted professionally, recognized and handled politically charged situations, adapted communication styles to fit the audience, and gave a voice to the group.

In general, **professionalism** was described as being responsible, not having bad language, being on time, dressing appropriately, and meeting deadlines. Professionalism also involved being non-judgmental of others, avoiding gossip, and not taking things personally.

Participant 1.3: “Its easier to describe what professionalism is not. So I mean certainly you know bad language being judgmental of others or critical of others. We we always want to encourage people not to discourage them so we try to keep things positive all the time. Professional just as far as **always being on time**

> **you know responsible both getting to work communicating your status so that people know where you are what's up and getting things consistently done on time."**

> **Participant 1.2:** "So I had a career type person working on this task and working with the testers directly. And so maybe a little bit of an awkward position there. But this particular individual was just very good about **keeping it all business nothing personal** just hey here's a tool that can do this job you know in a in a better way and was just very professional about presenting it all business."

Early-career engineers **recognized the politically charged situations** surrounding their work. Getting a job done, as noted in the previous section, requires working across different functions and leveraging others' expertise. Management decisions and priorities also come in to play when determining the best solution to a problem, and young engineers can find themselves stuck in the middle between an appropriate technical solution and a directive from upper management. Recognizing the politically charged situations and taking direction showed career maturity for early-career engineers.

> **Participant 1.2:** "So what the engineer who was kind of the lead was kind of stuck in the middle. So what so it was more of a **political thing**. So we had internal pressures to go a different route. **And because of that so the lead had to make progress on the development of the product in parallel knowing that there's a possibility they were going to go a different route**. He took ownership of his tasks and he did everything to make that project successful fully recognizing that he couldn't be successful given what he was given. Rather than putting blame on others he took the direction."

Career maturity also centered on an early-career engineer's ability to **adapt their message to meet the level of understanding from the audience**. Communicating in dense technical language is appropriate for certain audiences and in others not.

> **Participant 1.1**: "And some of the things that you notice very quickly of them is how they handle situations. How they address the groups is very important. And they have the **ability to change their presentation with the level of understanding of the group.** What I'm saying if they're talking to somebody very detailed they might be talking about this and that and as they talk to somebody as they go up the chain with less understanding of it they can quickly change their representation to choose that person's level of understanding rather than telling them about the bit level but tell them more at the macro level."

Finally, career maturity was also demonstrated through **being the voice of the group**. Early-career engineers who stepped up to be the voice of the group to management by communicating the important things related to the group, demonstrated engineering leadership. These early-career engineers also recognized when others' voices may not be heard and would ask questions and solicit answers to ensure every voice was heard for optimal problem-solving.

> **Participant 1.2:** "So in a group of people they will be **the ones that voice their opinion.** I think of something else I've seen. They like to help out in other areas and be the voice of the group. So if you have somebody say okay they'll be the ones that go to management and go to the lead and say hey here are some things that we see. **So they become the voice of the group a lot of times**."

> **Participant 1.3:** "Well for example say you have a meeting with a group of people. You're talking through some ideas or plans and some discussion with the group but **maybe there's one person who hasn't contributed a lot. So at some**

> **point in the meeting maybe you just say hey so and so we haven't heard much from you. What do you think about this plan or could you suggest something more**. Just some way to engage them and not just a yes or no question. Something that will demand more of a statement or some thought."

Leadership characteristics identified in company one, which demonstrated engineering leadership during the early-career stage, included a willingness to learn, getting the job done, and career maturity. The following section identifies the interpersonal behaviors associated with each of the three leadership characteristics identified in company one.

Interpersonal Behaviors Associated with Engineering Leadership- Company 1

After soliciting information on each of the leadership characteristics associated with engineering leadership during the early-career stage, the interview turned towards a focus on the interpersonal behaviors associated with the identified engineering leadership characteristics. The information below was gathered using questions like, 'what do you observe about interpersonal that is important for the engineering leadership characteristics identified', and helped to determine the interpersonal behaviors associated with engineering leadership for entry-level engineers. For company one, the following interpersonal themes related to engineering leadership and the observable behaviors are listed.

Willingness to learn- Humble Confidence

The participants defined a willingness to learn as an early-career engineer who was able to recognize that they are not an expert in their field and the importance of learning from others or their own mistakes. Participants identified interpersonal behaviors related to the leadership characteristic, willingness to learn, as humble confidence, an in vivo code. Humble confidence describes interpersonal behaviors associated with a willingness to learn through two key behaviors: willingness to say they do not know and accepting constructive criticism.

Willing to say they do not know. Young engineers working and taking the lead on projects demonstrate effective interpersonal behaviors related to a willingness to learn when they act confidently, admit they do not have all the answers, and ask for help.

> **Participant 1.1: "**[Engineers demonstrating humble confidence] may not be experts in every area but they're confident in themselves and the team that they're working with and knowing that if they aren't the expert they will find out who is and they're again confident in getting it done. The humble piece being that they're not overly confident. **So they know they'll figure out what to do but they also know that they're not the expert**."

> **Participant 1.2:** "The other thing from a junior person is they're **not afraid to say I don't know.** Let me get back to you on that. A very strong leader. They recognize they're not expected to know everything."

A negative perspective reveals that early-career engineers not demonstrating humble confidence related to "a willingness to learn" tend to talk excessively instead of admitting they do not know. Those who recognize they are not expected to know everything will admit they do not know and take action on what they need to learn.

> **Participant 1.2: "**They recognize they're not expected to know everything. But when they don't know something they quickly admit that, and they'll take an action and move on where somebody less senior thinks that they need to know everything at that point. And then **those people have a tendency to just talk**

and talk and people quickly realize that they don't know what they're talking about."

Young engineers demonstrating humble confidence recognize the importance of asking for help in demonstrating a willingness to learn.

> **Participant 1.1:** "I remember sitting with our program leadership team and talking about the status of what was going on and what was left to do. And it looked like mission impossible ahead of us, but again he would end everything with. I don't know everything yet. **I'm still learning this all but don't worry we'll get there. If he had hit a road bump you know a roadblock and he got back to me and say listen I need help with this. Can you help me with that?** We gave him what he needed and he kept right on going. He's confident in knowing I don't know everything."

Accepts constructive criticism. Effective interpersonal behaviors related to humble confidence for potential engineering leaders included accepting constructive criticism and taking action to adjust based on the information. Individuals effective in this area tend to listen to the feedback regardless of the source, adjust behaviors relevant to the feedback, and avoid letting feedback impact confidence.

> **Participant 1.1:** "I think that you know above and beyond that you know being able to self-assess right being able to look back on what they've done and understand what they did **well being able to receive constructive criticism and not necessarily turn it away as someone I don't value that person's opinion but being able to kind of reflect back and say yup that may be an area I can improve on**."

Participant 1.2: "So for example, when they don't agree on something and they sit in the room and they just continually hold that stance and battle with a teammate on that. And then you give them feedback on the fact that says hey listen some forms aren't the right forms. This is better to have a battle about your stance about what should be done. Right and it kind of gives them that sort of how to deal a little better with that interpersonal relationship right how to be more constructive in that kind of situation. **And they tend to just not listen or not recognize it. Or similarly, if someone gives them feedback and they don't necessarily value that individual's opinion.** Right they look at him like oh that person's an idiot. I don't really care what they say."

Participant 1.3: "Confidence that you know your idea is valuable enough I can put it out there and also if the team doesn't buy your idea or agree with it not just climbing you know climbing back or rescinding or clamming up and not sharing anything more but okay. **I understand you didn't' accept that but hey here's another idea right. So not letting that stop them."**

One participant gave an account of a technical lead, who did not demonstrate humble confidence, but after accepting constructive criticism and adjusting interpersonal behaviors, the early-career engineer became a highly sought after technical lead.

Participant 1.2: "Because the guy thought he was better than everybody else and condescending if you will. And he would send out [condescending] emails and stuff like that. It turns out once you got to know him. **Some of his cockiness was confidence and some of his behaviors was he did not know he was doing. And once we identified some of the things to him with very candid feedback he quickly changed.** He's probably one of the strongest technical leads that we have now in the corporation. So like I said he's now anybody and everybody wants to work with him and nobody can get him because he's always on he's always in high demand. So from an intellectual point of view he was by far one of the smartest people I've ever met. The lack was the interpersonal skills. He handled situations to the point. And he took that candid feedback. And a lot of things he was doing he didn't realize. **So he got that candid feedback and like I said the guy is a super star and everybody and anybody wants to work with the guy."**

Giving recognition to others. Another key behavior of humble confidence, related to a willingness to learn, was in an early-career engineer's ability to give recognition to others. This also involved saying thank you for the help and the learning that was received.

Participant 1.1: "Right and they also know that you know they're not necessarily looking for all the recognition right and I've got and I think back on some of the people that I see as some of my greatest technical leaders you know they **almost get uncomfortable when you recognize them for all good accomplishments. Well you know it was yeah but it was the team. It was a team effort.** And you look at it and say yes it was but the team would've never known what to do or would've never marched in that direction or they never would've stayed on task if it wasn't for you showing them the way to get there."

"Customer was you know super thrilled that they had it. So we gave him a small award you know a cash award and said hey great job. Take the rest of the time off. Enjoy some vacation. Here's some cash to go along with it. And then the humble piece comes back. **Wow you really didn't have to do that. It really**

wasn't necessary. It really was more than just me. I had a whole bunch of people supporting me on this. You know this person and this person and so on"

"I think giving feedback to those people and especially in cases where they really being able to **recognize them and thank them for what they did. I think is a big part of sort of those I guess external interpersonal skills that we tend to see**."

Getting the job done- Builds trust and exhibits a can-do-attitude

Getting a job done involved a young engineer's ability to understand how to get the job done by being proactive, seeing the bigger picture, making decisions, and being hard-working. Participants identified interpersonal behaviors related to getting the job done as building trust and exhibiting a can-do attitude. Building trust was described through two areas, demonstrating confidence in getting the job done and effectively leveraging the relevant expertise related to the engineering problem.

Demonstrates confidence in getting the job done. Early-career engineers built trust by communicating confidence in being able to meet the goals of the project and following through with the commitment to get the job done.

Participant 1.1: "But he's got a great support team and he knows how to work with them. He also got a lot of pushback from the senior guys. Right the mechanical guys. The electrical guys. They looked at him as this junior guy with less than a year and they're sitting there going you're going to put him in the role of test lead. This makes no sense. He doesn't know anything about it. He's not experienced. And so they were questioning even his ability to do that work. And so and he knew that. And so I think that you know him kind of taking it all in saying you know what, **‘I recognize that I'm not an expert in these areas but I have a job to do and my lead and my management are relying on me to do it**.’”

“And it looked like mission impossible ahead of us but again he would end everything with. **I don't know everything yet. I'm still learning this all but don't worry we'll get there. And I think he just that that those simple words left the entire team with yeah you know what. When this guy says something history shows that he figures it out so even though he's not giving us a lot of great news like don't worry I solved this this and this**. He's generally telling us he's going to figure it out and I think that that just sets the whole tone for everyone”

Trusting others’ expertise. For early-career engineers demonstrating engineering leadership, building trust includes trusting in the expertise of others to get the job done and being willing to leverage that experience to get the job done.

Participant 1.1: “We're trusting and we believe that you'll do really well in that position so recognize the fact that you're not going to solve the mechanical electrical problems that pop up. Right. **There are guys who have been doing this stuff for a very long time. And they are experts in that field. And in order for us to all be successful you have to trust in their abilities**. And trust in in the fact that you know when a failure occurs or something occurs then you can rely on them and recognize that they’re the experts in that area. And I think having the junior guy work with those engineers in the lab right leading up to that event and having them learn from that and having them kind of reassure them that, hey listen I recognize that I'm not going to solve all these problems and I’m really really hoping you guys can help me out. I think that went a long way.”

Participant 1.1: [The junior engineer] Looked at it and said yeah you know what. If it's got to be done in four weeks we'll get it done in four weeks. No matter what. And we'll figure it out. And at that point that confidence level of just demonstrating and saying yes we will. **And then he went off and he started querying everyone he could when it came to you know scheduling with certain people. He made it happen.**

Trusting others’ expertise to get the job done includes communication to ask for help, for clarification, and to ask questions when running into a challenge. One participant described an experience with an early-career engineer who did not trust others when trying to get a job done, resulting in missing deadlines.

Participant 1.1: “They did a very poor job in communicating. Not necessarily recognizing where they could leverage help you know. They were trying to almost boil the ocean themselves right. So they'd run into a challenge. Then run into another challenge. They wouldn't necessarily go to any of the technical leadership for assistance. **They wouldn't necessarily go to some of the other expertise.** Right. They would find when they realized there was a discrepancy between the design application that we have here at the design authority and the design documentation that was in the manufacturing organization. **You know they didn’t leverage expertise in the manufacturing organization to try to roll those changes back in. In fact, they kind of figured them out on their own**. Um when it came to you know meetings and deliveries. You know kind of getting this new stuff delivered [inaudible] and delivered. **They struggled with communicating any challenges along the way and basically what resulted in missing multiple delivery dates.**"

Building trust and showing trust in others is an interpersonal aspect of getting the job done, and when done well can result in an early-career engineer being requested for future project opportunities. The following quote summarizes these two aspects of building trust as an interpersonal characteristic of getting the job done.

Participant 1.1: "You're asking for a very aggressive schedule to get out with the field testing but I'll do everything I can to make it happen. **And we'll be ready. And ultimately at the end of the day ended up building a really positive relationship not only with his [inaudible] team but also with the customer**. To the point where the internal team leads and the customer requested him to come back and support the next program that was going to be [inaudible] about a year afterwards. Probably about six months or so afterwards."

Getting the job done also involved exhibiting a can do attitude. The participants regularly described the engineering work environment as being a very challenging environment and getting the job done required a 'can do attitude' that centered on positivity in the face of difficult challenges.

Positive attitude. A can do attitude is observed when an early-career engineer focuses on the positivity by bringing people together to talk about challenging situations, offering up solutions instead of dwelling on things that are wrong, and thinks about the big picture to move forward despite a lack of understanding.

Participant 1.1: "I think one of the biggest observations that I always notice about them, they generally have a very positive what we used to sort of coin here as a kind of can do attitude. So an attitude that you know kind of looks at. You know a lot of times we end up in a very challenging environment. We end up you know working paths that are very schedule driven very cost driven and so that tends to **put a lot of pressure on people especially when it's a major technical challenge and so when you're when you're really battling all three hurdles right a technical cost and schedule being able to kind of maintain that positive attitude and saying you know what we can get this done. We can meet the deadline. We can do it within budget, and we can come up with a really good solution. I think is one of the biggest skills that stands out."**

"Well the tech lead was transitioning off the program and he was a senior engineer and he was handing it off to a very junior engineer. That junior engineer had less than a year's work of experience. That junior engineer was going to be the test lead now at the customer facility. But supported by the two very senior electrical and mechanical engineers. It was a pretty overwhelming situation because this guy was relatively new to the environment. Was new to the customer, new to the equipment. But generally demonstrated you know up until that point this can do attitude of yes you know what. **We're not ready to go into internal tests but I'm going to work nights and weekends to make sure we get there. And so he maintained that can do attitude by saying you know. I will get it done and I'll find a way to work both with my internal team** that he knew was not happy with the fact that he was selected to be the representative. **Also maintain that positive attitude of working with the customer and saying okay. You're asking for a very aggressive schedule to get out with the field testing but I'll do everything I can to make it happen."**

The next quotes contrast positive and negative behavioral examples describing a can do attitude related to offering up solutions instead of dwelling on the negative and keeping a positive focus on the business goals and objectives.

Participant 1.1: "I think you know as far as the positive can do attitude piece of things. **You know the person was you know basically under the table in many occasions kind of talking about you know all of the things that were wrong and not necessarily focusing on offering up any sort of solutions for those things that were wrong or focusing on how they can be successful in getting the job done**. It was more like oh my gosh these designs. The documentation's just a mess. This design is all obsolete. You know it was it was basically kind of a throw your hands in the air and you know not my problem kind of thing."

Participant 1.2: "…rather than listening to program direction started doing what they thought was right. So like and then **rather than having conversations and understanding the business side of it and some of the things they just took the negative attitude and said well this is what we think**."

Participant 1.1.: "And I think it was an interesting comparison because when you look when you looked at those two situations we ended doing in this particular situation was assigning another engineer who really kind of has those traits that we just talked about right who really is a an up and coming design authority demonstrates a lot of these interpersonal leadership kind of skills. He kind of came in and said okay listen right. **I realize we're you know pushing a rope uphill here, but I think we can do this. And here's what we need to do.**

Let's just sit down. Let's articulate all the issues. Let's list them all out. Let's look where we can off load some of the some of the things that we aren't necessarily experts in to experts in other locations and elsewhere. And let's figure out what we need to do to get from A to B so we can be successful in this."

Career Maturity- Emotion regulation and management

Early-career engineers demonstrated career maturity related to engineering leadership when they acted professionally, recognized and handled politically charged situations, adapted communication styles to fit the audience, and gave a voice to the group. Emotion regulation and management describes the interpersonal behaviors associated with early career engineers demonstrating career maturity. Specifically, the behaviors associated with emotional regulation and awareness within the career maturity category consist of: regulate emotions, empathetic listening, and communication.

Regulate emotions. Early career engineers showed career maturity through regulating emotions with all interpersonal dealings. Participants described these behaviors as 'keeping it all business' or 'sticking to the facts' or 'keeping emotions out.' Each participant spoke about the importance of regulating emotions due to the challenges associated with solving engineering problems and politically charged situations.

Participant 1.1: "And one of the greatest things he brought to our organization was that ability to try to and build relationships right whether it be in a meeting between the two organizations and **trying to keep it as fact based as possible right.** Not necessarily [inaudible] to you know personal opinions on things. Trying to keep emotion out of out of the discussions right. Emotion being well you guys just don’t want to do anything kind of thing. **He was able to kind of layout the facts that here's where we are today. Here's where we need to get to and here are some of the challenges we are running into**.”

Participant 1.2: “**And letting emotion come in because what ends up happing is how you present data a good leader will present data and let the team figure out what you're trying to say through the data as opposed to putting up there this is what we need to do.** If you present the facts and pros and cons with the risks then people can engage in a conversation. If you're a more as you say if you don't have interpersonal skills and you just come in and say if you don’t do this we're going to fail. There is no conversation. It's just an opinion in there. And I use an example if you don't present facts you're just a bunch of bitching engineers that you need to have fact behind your your to substantiate your your theory if you will. I guess in summary would be the interpersonal skills would be how they present the data. They add emotion into it and unnecessary verbiage almost attacking if you will.”

“..engineers they sent out a very detailed [email] technical description of a problem and at the end they threw in that ‘if we don't do it this way we're going to fail and management are a bunch of buffoons.’ And what and what everybody remembers about that email is not the two the two pages of very technical data. It was the one sentence at the end. **So if they did this that individual rather than they let emotion get in there and their communication skills suffered because of the emotions.**”

Empathetic listening. Empathy describes an early-career engineer's ability to focus on the others' perspective. Participants described empathy with terms such as 'giving the benefit of the doubt', 'peace keeper', 'non-judgmental', 'taking the others' perspective' and 'active listening'. These behaviors applied to internal relationships as well as external, such as the customer. Early-career engineers, demonstrating empathy, acted out of awareness of politically charged situations and professionalism dedicated to understanding the perspective of others before making decisions.

> **Participant 1.3**: "Well I guess I'm kind of making things up here but suppose that there was some conversation where maybe they were critical of the other person whether to them directly or even to someone else right. We as professionals we shouldn't be talking about other people's performance unless you know it's between the manager and the employee in a performance kind of review. But other than that folks should not be criticizing or judging each other's performance. **We give everybody the benefit of the doubt but everybody's trying working hard.** So one thing would be to counsel on not judging and not sharing those kind of comments with other people."
>
> "**Not judging others but giving others you know the benefit of the doubt that everybody's got good intentions**. Not judging people but really taking time to evaluate things. Not jumping to conclusions prematurely."
>
> **Participant 1.1:** "And then in situations where you know maybe it wasn't it didn't make the most sense for him to have everyone in one group. He would schedule you know individual discussions with either side. And he would go down and say okay well listen tell me where you're having problems

manufacturing [inaudible] so that I can help engineering give you what you need. And he would listen kind of to their perspective of things knowing that he was coming from engineering but they were very open to kind of telling him well listen this is our frustration. **These are the things that really bug us about what engineering is doing. And he would take that with a grain of salt right and he would kind of say okay well this is kind of where I think engineering's head was when they made that decision. But I can understand what you're feeling. Or why this is frustrating to you. Let me take it back and figure out what we can do to resolve that.** And he would you know conversely head back to the engineering organization. It was done separately and say listen this is the situation. This is how our products are being used. This is the challenge they are running into. I understand your frustration with them but please understand the environment they're in and what they're trying to accomplish. Right. They're trying to meet delivery schedules. They're trying to do you know a lot of different things under a lot of pressure and while some things seem trivial to you it's costing time and effort and frustration on their end. So this is why it's a good idea for us to make whatever change it might need. **So I think that that person who kind of did that almost like a peace keeper or the person who is able to work from on both sides.** Trying to keep emotion out of the decision. They're trying to make everything fact based. But something that I think went a long way in terms of building the relationships of these two organizations."

"But if they say if someone says something even if you don't value their opinion it's still an opinion and something you ought to care about. Right because it's a perception and a lot of us know that perceptions are typically reality in someone's mind. Right."

Active listening as a part of empathetic listening involved early-career engineers who took the time to think before responding to questions, asking questions, and clarifying communication to understand the others' perspective.

Participant 1.3: "**One thing is taking time to think before responding. And that's something for example in interviews a lot of times candidates are very uncomfortable with a quiet moment.** They feel they have to jump in right away with an answer. And I think you know taking that that moment to just reflect and think about what you want to say before you say it shows a level of maturity. So I think that's one example is taking that moment to think before you speak."

"Asking questions and this is part of the listening language. **If you're trying to understand what somebody else is saying a lot of times you have to ask questions to get clarification. Sometimes those can be very leading questions**. Or they can be very open-ended questions and and having the the knack to ask the appropriate questions without without necessarily trying to lead or sway somebody. I think that's a skill that it's a valuable skill that not everybody has."

Participant 1.2: "So as I grew in my career I wanted to make sure hey let's make sure everybody's on the same page. Here's where what I meant to say. What did you guys think I said? So I'd ask them as follow up feedback. Through my career I would just I would just fire off and just assume people knew I was trying to get at. **Later on in my career I realized that you had to follow up**

and say hey this is what I think I was communicating. How did you guys how did you guys perceive what I was saying?"

Participant 1.1: "And I think in the same sense you know going back to the technical team and saying hey listen. **The customer brought this up. What do you think?** And some for the things they ran into were problems where certain parts of the design were not detecting what they were supposed to detect. Right and so then go back to the electrical designer and then say well they're claiming that you're not compliant because you didn't detect this. The electrical designer would say well hold on a second. They never made that a requirement and so I think the junior guy kind of played the intermediary kind of in-between and going okay I see your point. Yeah I understand where you came from. We'll go back and push back on it. Right so not necessarily approaching them like hey you didn't't' do you job. You didn't't' meet the requirement **but it was more of a hey can you help me understand what you did meet and what you did do and where your head was with this because right now they don't get to be compliant. And once they heard the other side of the story it was oh yeah. That makes sense**."

Calm and influential communication. Early-career engineers demonstrated Career Maturity through interpersonal communication that was calm and influential. A calmness in communication reflected Career Maturity through the choices made to express disagreement in a group setting.

Participant 1.2: "I think a lot of engineers have Asperberger's right. They don't have interpersonal skills. I've been in meetings. We have some of the sharpest people and you'll be in a meeting and some [inaudible] it will be a bad design and they will be well that is stupid right in a room full of people. **Where if somebody else with interpersonal skills would say hey that's beyond that design seems like it seems like it has some issues or faults with it and here are some of the reasons you don't set up your sets that way.** You [inaudible] to be distributed across it so this might be a better solution for it where as opposed to saying your designs sucks. And I’ve heard those actual comments in large groups of technical meetings. Now those people will never be in front of the customer or never lead strong teams so.”

Participant 1.3: “Well I think I think it's partly being you know kind of laid back easy going not a loud voice. Not one to yell or be real forceful. Not a lot of stress under pressure but here's reality let's address it right. Trying pose things to be more in-between right if you're working between two parties trying to find that compromise in-between so so not voicing opinions or whatever that are actually one sided. **Trying to keep the discussion more centered and let the whole group come to a compromise a consensus together**.”

Influential communication centered on an early-career engineer’s ability to recognize and adjust communication based on an understanding of personal differences. Participants recognized influential communication in presentations and consensus building.

Participant 1.2: “How they address the groups is very important. And they have the ability to change their change their their they change their presentation with the level of understanding of the group. And that what I'm saying if they're talking to somebody very detailed they might be talking about [inaudible] messages and [inaudible] this and that and as they talk to somebody as they go up the chain with less understanding of it they can quickly change their representation to choose that person's level of understanding rather than telling them about the bit level but tell them more at the macro level. **And they'll be able to quickly without making that person feel inadequate**. Just saying hey this is what we're doing and stuff like that. So they're good presenters. They understand that their audience and they adjust their presentation to their audience."

Participant 1.3: "So everybody's different and getting to know each individual and understanding where they're coming from in order to establish that rapport and it probably takes some one on one time maybe not with the whole group but maybe some individual time as well. **Everybody's different. It depends you know how you can relate to that person.** And maybe that's a skill that some people have kind of naturally and other people have to work at it while testing out that particular individual with what will work and how do I relate with that person. **So it's kind of adjusting your style to their style and meeting them more on their side or somewhere in between**."

"I think showing respect for the other person whether it's position or just experience, show anybody you know that person's going to have new ideas maybe from you know a prior work assignment or school or whatever. It's still having respect again respect to the respect for others and giving everybody the benefit of the doubt even if somebody isn't buying your new idea right away

gives them the benefit of the doubt and the burden is kind of on you to explain your new idea to be the salesman to get them bought into it as well."

Table two summarizes the leadership characteristics, interpersonal themes and behaviors associated with engineering leadership potential during the early-career stage from the perspective of company number one.

Table 3. Company 1- Interpersonal Behaviors of Early-Career Engineers Demonstrating Engineering Leadership Characteristics

**Items are not meant to correspond directly with items in the adjacent column, rather provide associated categories of behaviors within each of the themes represented in each column*

Engineering Leadership Characteristics	**Interpersonal Behaviors**
Willingness to Learn - Recognize they are not an expert - Learn from others & mistakes	*Humble Confidence* - Willingness to say they don't know - Accepts constructive criticism - Gives recognition to others
Getting a Job Done - Being proactive - Leverage others - Big picture thinking - Decision-Making - Hardworking	*Builds Trust* - Demonstrates confidence in getting the job done - Trusts others expertise *Exhibits a Can-Do-Attitude* - Positive attitude
Career Maturity - Acts professionally - Recognize & handle politically charged situations - Adapts communication for audience - Gives a voice to the group	*Emotional regulation & management* - Regulates emotions - Empathetic listening - Calm & influential communication

Engineering Leadership: Company 2

The following themes emerged through analysis of the three interviews conducted within company two. Each interview began with asking a question such as: When observing an early-career engineer, what characteristics demonstrate engineering leadership or what does engineering leadership look like at the early-career stage? This question aimed to solicit the characteristics associated with engineering leadership during the early-career stage. The following themes describe the characteristics associated with engineering leadership during the early-career stage for the first set of interviews associated with company two.

Willingness to learn

Willingness to learn emerged as a characteristic of engineering leadership for early career engineers across all three interviewees within company two. As with company number one, a willingness to learn related to an early-career engineer's **recognition that they are not an expert in their field**.

> **Participant 2.1:** "I think a willingness to learn...putting yourself in positions to learn about either a new part or a new process and not thinking that you know everything. I try to...even now, today after all these years try to put myself in positions to learn new things."
>
> "So he really wanted to learn and and not assume that he knew the answer to all of the questions. So he volunteered so he was highly motivated self-motivated to learn new things and he volunteered to go out and and lead this team, which meant that he had to go take the trainee. So he signed you know he signed himself up and had a high willingness to learn."

The participants in company two also reported that a willingness to learn includes **demonstrating curiosity**. Early-career engineers demonstrated leadership characteristics when they were curious about other disciplines and processes.

Participant 2.1: "So he was organized, had a strong willingness to learn, curiosity about the process and about the part that he was working on to fix."

"I think there are some people that are more inclined to be leaders because they have **higher curiosity**; **they want to learn more outside their area of expertise**. So they may develop some area of expertise but then they also want to go and learn about this part of the engine or that part of the engine; this process for manufacturing or that process or analysis or whatever. So I see that in young engineers that are recognized. They have a very **high curiosity** factor. They really want to learn. They raise their hand and they volunteer to go to go and learn these things, whether it's to be a team leader or to lead a you know a services type project or a volunteering project."

Participant 2.3: "I think that engineers should demonstrate an active **curiosity** in the way they approach the job and their responsibilities. So they're eager to go beyond the narrow scope of what they may have been assigned."

Early-career engineers demonstrating a willingness to learn also **took the initiative and volunteered** to learn new things. Participants in company two cautioned that focusing on moving up too soon is seen as a disservice to the learning process necessary for leadership roles. Taking the initiative to volunteer and help with other projects is a way to build the necessary knowledge for moving up in a career.

Participant 2.1: "They really want to learn. **They raise their hand and they volunteer to go to go and learn these things**, whether it's to be a team leader or to lead a you know a services type project or a volunteering project."

"They would go to the **other experienced engineers and see where they could help** and and keep me up to speed and up to date on what they were working on. You know. So it was all projects that needed to be done and they were going out and and kind of seeking out those those kind of projects themselves. **So they had the initiative, the drive to go out and interact with the organizational team to find out where other projects were as well."**

"It's stepping up and volunteering to do just part of the job or that part of the job, so you know **it's being willing to participate and volunteering to take on different roles.** And those roles could be the technical roles. It could be something like a people plan."

Managing Strategic Problem Solving

Like company number one, getting the job done was an important leadership characteristic of an early-career engineer. However, company number two used language to describe getting the job done as managing strategic problem-solving. Managing strategic problem-solving showed how an early-career engineer took ownership of a project and completed strategic steps to meet project goals and objectives. Key aspects of managing strategic problem-solving included leveraging historical expertise and confidently making decisions based on the information gathered. Managing strategic problem-solving required an early-career engineer to own the problem by **leveraging the historical perspective** of experts within the company.

Participant 2.2: "But being ready to, to--the, the ownership comes into the style, I think. Someone who, who wants to understand the history maybe. If we could talk about it in terms of an early-career engineer who's now a design owner of a component. They, when, when people say--you know--that this one widget. You're now the owner of the widget. **So you'd better know the history of that widget. You better talk to some people who, who, who worked on it in the past.** You'd better talk to people, other people, who own similar widgets and, and network so that you are the expert on that even though you might have only just graduated. You have to create, turn yourself into the expert on that thing. And that, that comes into networking--you know."

"**I want the guy or gal to know what, what they need to go and leverage from other people and know what tasks are really the nuts and bolts of the problem they've got** and, and manage that as a tech-managing the technical challenge and managing their own time…"

"You're going to be able to know the people who, who have experience in what you're doing and know how close you can get to the, to the answer to a challenge by leveraging other people's experience--maybe even understanding where some of the pitfalls are. And then from that point, then leaping off and do, doing your, your last run-opt in some Mt. Everest kind of thing from the last camp. That, that's kind of what I'm looking for is, **is knowing how to manage your strategic problem-solving.** That's what I would say."

Participant 2.1: "Whenever they're working on something if they kind of get stuck, I want to make sure that they don't kind spin their wheels trying to solve it themselves. **You know, they can they can work on it for a little bit, trying to solve it, but then, don't spend a whole week trying to solve something that you know this person over here, that's their expertise and they know how to**

do that within a few minutes. So you know I think curiosity for the for the young team leader, curiosity definitely is a bonus; asking questions; not just relying on the experienced people, but you know pulling the information out of them."

Participant 2.2: "So I'd go out and talk to groups of people and, and get all of the information I thought I could before even starting to think about solutions. So that when someone said to you, said to me can--you know--describe to me the problem, **I would be able to describe where the bodies were buried and, and what the potential pickles were, and why my strategy was the best** [inaudible] several that I'd been told."

The historical perspective allowed early-career engineers to have an understanding of the background of the project and allowed for effective **decision-making** that included the **bigger picture** when managing the strategic problem-solving process.

Participant 2.3: "And in the process of connecting with more experienced people or people in cross-functional type positions that they need to interact with, **they end up not only getting the information that they need to be successful with their task but also gaining a lot of understanding and knowledge about what those people do** and what's some of the history has been. So curiosity that the other functions as well as people who have a key interest in kind of the history of the engineering work that's going on in that work place. **It's a way to understand what have the experts done? What have the successful business leaders, what have they done in the past that led them to the point that they're at today."**

"But if you listen to someone who is involved in the development of a product 10 to 20 years ago, and kind of get a perspective of what they went through and what it was like to discover some of the unknown findings that were associated with that product development cycle, and then **the young engineer can kind of reflect on that and be able to take those into account in the way they're approach the current day product development or engineer problem-solving task they're doing."**

"**Was able to take some of that information and then relate to the other senior engineering function on the design side** where there had been kind of an antagonistic relationship between the test lab and the design side group for some years. **This young engineer was able to also then understand some of the concerns that the senior folks had** on the design side and why they were concerned. What they had seen. Some of the product data that led to that."

Participant 2.2: "And, and I didn't--you know--I, I didn't always feel like I had to do what someone suggested. In fact, quite the opposite; I--you know--I went to talk to people who had done a similar type of, or performed a similar type of challenge. And I was, spoke a couple of them because I knew that they would do something completely different from the way I would do it. And I wanted to, to hear how that worked. When, and, and it helps you, you to understand that there was a better way that was completely, wouldn't have dawned on you. But also it would help me enforce the idea you already had sometimes as well from just again, just going out and being a listener."

Team Oriented

Team orientation emerged as a focus of early-career engineering leadership due to the important understanding that engineering is about people.

> **Participant 2.2**: "**It's about people. And in fact, I think engineering is almost only about people.** You just have to know the engineering part of it to be able to do it. To be, be--you know--every, every time we have a, we have a, a product, it's either a good product because people made it that way; or it's a bad product because people made it that way or designed it that way or . . . [Inaudible], and it always comes back to people--you know--not, we don't, we're not, everything we do is created. **So it, it could be the people side of things is 99 percent of what, what we do when you really boil it all down, which was a big shock to me."**

The importance of a focus on people was demonstrated by the interview participants' focus on team orientation during the hiring process, particularly, the interview stage.

> **Participant 2.1**: "There are some one-on-one sessions, but then there are also a couple of things that we do...some team exercises where we have we'll pull together four or five of the candidates onto a team and have them do some specific task. **And then we will observe how they interact as a team. So can they pull the team together? Can they kind of offer up leadership in the team, and show the excitement?** So you observe it during the interview process as well."
>
> **"So the kinds of examples we like to look at are people that can lead that small group of four or five candidates and very quickly get people into roles and and pulling together as one team to try to solve this problem that they're**

working on and not be the people that wants to go try to solve it all by themselves. So we want to look for people that are you know engaging and seeking out and asking the other team members you know for their thoughts and trying to organize all of that into one effort."

Participant 2.3: "**But also we do look for delegation skills and the ability to share work with others. To not have to micromanage**. I guess even at the entry level, we are looking for signs of is this person able to trust another individual--another peer--with the task and not have to be intimately involved in absolutely everything."

Upon transition to the workplace, early-career engineers demonstrating a team orientation **recognized the importance of teams** and **built strong teams with the right expertise.**

Participant 2.1: "I think when they transition, I think there is a realization or maybe not a realization that where we are in the company. We have a huge company and a ton of experience and you **know not any one person is going to solve any any big project or big issue and that they all need, and and the company encourages the need for teamwork.** And that's why we emphasize it so heavily in the interview process with the the interview team exercises, is that you know we're a team. Not everybody is an expert in every field, but we have experts in every field, you know relative to our product that we have at aviation. And and you know these experts are kind of at our fingertips and we have to, as team leaders, as managers, **we have to often very often reach out to them and pull them into our teams. No matter where we are in our career, we have to work with other people very well and be open to their ideas and their thoughts and and kind of pull those ideas and thoughts out of them not just**

be open to them but also curious about their positions and curious about why they think this or why they think that."

Participant 2.1: "So I had another person who was kind of the opposite of that. **So he was not really team oriented. He didn't really look outward**. Engaged **he didn't really engage either his group that he worked in with me and he didn't really engage his you know his network** of younger engineers who were in other organizations also. **So so he was not really kind of team oriented**. He didn't have that that drive to go out and learn about other things or to you know raise his hand and take an initiative to lead a team to go help solve a problem. He was more of one of these guys that would work on a project that you gave him and do do a fine job, but it was a project that he was you know he was all of the solution. You know he had to go do an analysis or something like that, but didn't require input from other groups. And then when he was done with that project he required another project to kind of follow on."

"he volunteered to take on this issue, this problem, to do the root cause investigation...to come up with a redesign. **And this wasn't all just himself so what that required him to do was to pull together a team of experienced people and to rely on on that team**. Basically he was kind of a project leader or manager reaching out and setting up the meetings with this team of experienced engineers."

Interpersonal Behaviors Associated with Engineering Leadership- Company 2

After soliciting information on each of the leadership characteristics associated with demonstrating engineering leadership, the interview turned towards a focus on the interpersonal behaviors associated with engineering leadership characteristics identified by the participants. The information below was gathered using questions such as, 'what do you observe about interpersonal that is important for those areas that you listed of engineering leadership in an early-career engineer,' and helped to determine the interpersonal behaviors associated with the potential engineering leadership for entry-level engineers. For company two, the following interpersonal themes related to engineering leadership and the observable behaviors are listed.

Willingness to learn- Humble Confidence

As with company number one, humble confidence is the term used for describing the interpersonal behaviors associated with a willingness to learn. Engineering leadership characteristics associated with a willingness to learn in company number two included, recognizing that they are not an expert, demonstrating curiosity, and focusing on current learning opportunities. The following codes identify the behaviors associated with humble confidence related to a willingness to learn.

Accepts constructive criticism. Early-career engineers demonstrating humble confidence, act with confidence in their decisions and communications, but willingly accepted criticism and actively seek feedback in order to learn and improve performance.

> **Participant 2.3**: "So certainly with dealing with very senior people and displaying eagerness, confidence with the and the message in hand, enthusiasm for the work I'd been assigned. **But then also being willing to accept criticism.**

To not be defensive to . . . and listen to their coaching and then learn from the experiences of work. I didn't do a particularly good job or where I failed in a particular task in their view. Making sure that I showed the willingness to bounce back, to be resilient, to take their feedback under consideration and act upon it."

"Seeking out the input and the feedback from different members of a team. Those are very important characteristics I've seen. I've seen young, talented young engineers exhibit."

Participant 2.2: I would say that I want to see someone come in and be able to be an adult, discuss and be somewhat humble but **also exhibit the fact that they've got knowledge and they're learning and they understand that they've got more to learn**. But--you know--they can share their opinion but don't necessarily expect themselves to be right every time and to be okay at saying well, explain that to me; why is that? What, what am I missing? What don't I know? So the humility is, is, is important because you have to be ready to, to find out that you're not coming out of university and going to be king of the hill in five years. [Inaudible] they, it's almost like the degree nowadays is actually the thing that gets you in, in the door. And it's, it's not that you have to forget it all, but you have to be ready to start at, to, to start over to some extent and, and say I'm, **I'm re-embarking on yet another stage of my education instead of thinking right I'm done learning**.

Acts responsibly. Early-career engineers have a humble appreciation for the knowledge and education level currently obtained. They demonstrate a responsibility to learn everything possible within the scope of the position they are currently in, not wanting to skip ahead just to move-up in the organization. Early-career engineers act responsibly by not thinking too highly of themselves at an early career stage and take ownership of their career path by learning everything possible with the role they currently occupy.

> **Participant 2.2**: "There, there's a different one of a female who in a manufacturing environment--manufacturing engineering. **She was extremely good at car checks, car checks. She, she, she was, it was, it was her forte. And, and she, she became the humbleness.** She was working with people on the shop floor but never did you ever get a feeling like--you know--she, she was the person with the degree. She was the one who could have told them, "Hey do this; do that." But she was very much more part . . ., participative than dictatorial. And, and people felt like they were part of a, a team when they were working with her. So they responded and. **So it was, again it was this humility that, that [inaudible] this generally feeling accepting the fact that, that you're starting at the bottom. And, and being okay with that because you want to learn, you want to learn things properly. You don't want to short-cut things**."
>
> "But I'm, I'm, I'm thinking about one particular guy now who, who, who was in, very impressive in terms of, of, of working. He, he, he never felt like he--and the guy was really smart. And he talked to him about what he, he'd done as a, as hobbies as, as a kid--you know. He'd built a Porsche in his, in his dad's barn--you know. And he'd, and he'd, he didn't have any money. So he'd actually made all the parts for it, which was kind of impressive stuff. **So you, but he didn't--you know--he, he wasn't going around, strutting around saying I've got a Porsche. He was a very active listener doing 110 percent, learning faster than anyone I could ever recall**. And--you know--very quickly people were

seeing him as someone who was not only going to be a future leader but a very, a very high-up future leader. And that was within months of it showing up. **But of course in his demeanor, his demeanor was, he was a, a sponge who clearly understood what was going on.”**

“He had a very good mentor, and his, his approach to his career was I, I don't want to be the guy who skips any of the boxes. I want to, if I'm going to get on later in my career, I want to know that I've checked all the right boxes so I've got the right experience. **And he, he probably prolonged his time at the bottom of the food chain by about three years on purpose**, taking some pretty--I mean--but unstrategic jobs. His, and the only reason he was doing that was because **he wanted to learn** that; and he felt like that particular thing, even though it wasn't going to do anything to speed his [inaudible] rise up, up the pyramid. **It wasn't to build, it was going to create a good foundation to build a strong career on**.”

Participant 2.2: “And, and you have to, you have to build up the guy at the bottom. To know how to lead the guys at the bottom later on even just for that reason. But, but you, **that's when you learn, and that's when you can afford to learn. And that's when there are people there who can help you and want to help you.** I think everything you've . . . I, I feel like people come in and there's, I almost feel like there's a clock ticking. And there isn't. It's, at least not a physical clock that. That what, what is ticking is, there's a, there's, there's a checklist instead of a clock. **And, and the checklist is that you need to learn new things**. And you, and really moving forward until you've finished that checklist. You're cheating yourself later on. The older you will wish you'd done that checklist properly."

Manage Strategic Problem-Solving: Builds relationships and communicates

Managing strategic problem-solving included leveraging the historical perspective, demonstrating big picture thinking and decision-making. These leadership characteristics describe early-career engineers' efforts to get a job done. Managing strategic problem-solving includes building relationships and communicating with the associated interpersonal behaviors described below.

Active Listening. An early-career engineer builds relationships to ensure that historical perspectives are collected for managing strategic problem-solving and understanding the perspective of cross-functional units. Active listening emerged in company two's data as a key aspect of leveraging the historical perspective needed to make strategic problem-solving decisions. Listening to the historical perspective provided an early-career engineer the opportunity to build a relationship as well as credibility when managing the strategic problem-solving process.

Participant 2.3: "So the example I was thinking of is I've seen people go and sort of **listen to the war stories that some of the senior people will share if asked.** So there's, if you think about an industry where there's been evolutionary product developments of things like in heavy industry like where I work where the products generally build off of those that preceded it. It's kind of like being open to story-telling**."**

> “I mean, it's easy to blow off people who want to do story-telling because like hey. I don't, that's not really important to what I'm doing here. And I don't have time to listen to you tell this story. **But I think that it helps people, particularly a big company, to be successful that they can take in time to seek out those stories, listen to them, be able to use that as a way to connect with other people.”**

> “And he was fairly, fairly new--you know--very new in his career in our company. He had a few years of experience in a government-type job. But he was very good about getting into all of the previous reports that had been done, the previous efforts that had been done on this test rig. **And he took the time to understand that. And then also engage with the people at the Boston office in a very effective way.** Took a visit out there. Asked them all the details, all the history around the unit--'cause it's a test-rig that goes back several decades in time when [inaudible] along the way. **Really built some credibility as someone who is interested in understanding the problems**, understanding the, both the benefits and the short-comings of the techniques.”

Active listening also involves listening to the expertise relevant to the problem and asking the right questions to solicit information relevant to the solution. A lack of active listening to those surrounding the problem leads to negative outcomes within a company.

> **Participant 2.1**: **“You are asking the questions that will help to get to the solution for the specific problem that you're working**. So it may take you two or three questions that will use the expertise of the of the person on your team and it will contribute to the problem of the project that that you're working on.”

Participant 2.2: “Yeah, yeah. **There was a guy who, who ended up leaving the company who, who did not listen.** And he, he would, **he was surrounded with people who knew, even on quite simple things. He was surrounded with, by people who knew the answers to the, the challenges he'd been given. And, and if they'd already solved the problem on different widgets. And he, he, he knew we knew, and he purposely didn't communicate.** I think he felt like he'd somehow letting himself down. Or, or somehow he was demeaning himself to, to, to, to, to network that way.”

Engages with others. Building relationships also requires an approachability and willingness to engage with others in the workplace. Showing an interest in others’ work and making time for discussions allow an early-career engineer to build the appropriate relationships to leverage expertise to manage strategic problem-solving associated with a particular job. Engaging effectively with others also required being considerate of others time.

Participant 2.3: **“But taking some time to build a personal connection and then translate that into the discussion that's relevant to work**. If you seem too about business and like give me the answer or show me how to do this. That can negatively affect some people. People who really take the time to acknowledge that hey, I'm here to learn. I'd like to understand your perspectives, your thoughts. And I recognize my role on the team is to complete such-and-such a task. **But I'm also very interested in what are you doing in your role.** What's she doing over there? And how does this all fit together? What's the big strategy or purpose to what we're doing? **So I think to get at those conversations, you have to build a level of rapport with the people around you. I sort of think you hate to say something like you got to be kind of friendly, but you do.** And so certainly people who have a very abrasive style or very fast-moving style that can be detrimental. It's not always totally over common. It's you have to be aggressive but in a way that's engaging 'cause . . . and not in a way that's repelling."

Participant 2.2: "You know. Not, not going and asking the tough questions. **Going, setting up time with people. Going and--you know--if you feel like you need to go visit somewhere, then do it. And even if--you know--even if that means you got to hop in your car and drive 300 miles**."

Participant 2.3: "And to be, to have a very approachable style, **an approachable attitude in the workplace**. I think, too, they have to be proactive in seeking out personal contacts and relationships. **You can't be one just to sit at your work station and try to handle everything virtually**. You have to go **seek out some time for discussions, some time for conversation with other individuals** on your team as well as those who are one of your internal customers, your technical advisors, your kind of technical experts that are around your work place. It certainly helps if--I don't know if conversational is considered an interpersonal skill or not. **But certainly a willingness to spend time engaging directly with others in the workplace**.

"I think today there's, I think that folks have a lot more available to them through say digital resources. **So often making it the personal connection to learn about something or learn about experience doesn't get as much attention**. There's a lot let's say less emphasis on going through the kind of past studies--past similar studies--that have been done or talking to experienced people."

Participant 2.1: "So I wouldn't go and assume that they were going to help with the whole thing, but I would go and ask a specific for a specific part of the project or the program. **And and I wouldn't always go to the same person; I would try to spread that around a bit. So that I was not only getting the answers that I was looking for but also trying to develop a little bit of a network in the group where I was working and organizationally**, in some of the other groups that were parallel to mine. So you know I wouldn't go and take somebody's time you know for a whole day, but I would go and I would say I have a specific question or a couple questions around this one topic which I know you know you're an expert; you're looked upon as an expert in this area; and can you help me with this one thing. **And for the most part, people are pretty open and willing to help young engineers as long as they don't get their time completely monopolized."**

Acts enthusiastically. Building relationships requires a level of enthusiasm to connect with others in the workplace. Early-career engineers who demonstrate an enthusiasm for their project assignment foster willingness from others to help. Enthusiasm builds rapport, further strengthening the strategic relationships needed to manage problem-solving. Ultimately, by building relationships with team members or those outside of the team, the early-career engineer builds credibility to manage the strategic problem-solving process.

Participant 2.1: "Just witnessing...just just conversations mostly. And and probably for that the younger engineers who have **the initiative**. You know they they **show their excitement, they show their excitement to work on that project to lead that project and kind of have that feeling, you know that that excitement feeling that they themselves are invested in that project**. And you know that's something that they would want to reach out and and pull the experienced engineers onto the team as well, and convey that [inaudible]. **So I think the people the younger engineers who don't feel that excitement of ownership,** or feeling of ownership, you know they don't convey that feeling also. **So I think people are less inclined to to work with them or to help them or to to come and be on a team with them**."

"People who have more excitement as a team leader, you know younger engineers or mid-career engineers or whoever it might be...the ones that have excitement can **generate more excitement also and people will be more inclined to to help them out."**

Participant 2.3: "**And if, when young engineers can connect and say, oh, hey. You know, you're the person who was intimately involved in the development of products X for example. It shows a lot of enthusiasm. It builds a level of rapport with that person.** And I think it shows the person is--you know--the young entry-level engineer is keen not to just advance or be successful based on completing tasks but by really absorbing the contexts. And they can turn around and share that. And now I've seen folks who are transitioning into managerial roles earlier in their career. **They have to use this skill quite a lot because it builds a little bit of credibility. It's like, hey. I've talked with this individual about their experiences over time. And I've taken some learnings from that.** And I've talked to another person who'd been through different project and taken some learnings from that. I've found that has helped people transition to leadership earlier when I've seen cases of people doing that around here**. And certainly I've observed that it gives people a lot more I'll say credibility with their more grizzled veterans if you will.”**

Confidently communicates. Early-career engineers managing strategic problem-solving also confidently communicated. Throughout the management of the problem, early-career engineers demonstrating positive interpersonal behaviors consistently communicated updates to upper and lower administrative levels in a confident manner. Confident in their decision-making, they communicate direction to those involved in solving the problem and include the perspective of all stakeholders involved.

Participant 2.1: “So some of the the engineering characteristics for the early stage engineers...**I think really good communication skills; and that's verbal and oral and keeping your manager up to date on what you're doing and not going off and working on something and not giving updates on a regular basis”**

Participant 2.2: “**I think being willing to communicate and give regular communication to your manager; to to the senior leadership; to the other team members; I think interpersonal skills are key to that.** You can have the technically sharpest person who does not have interpersonal skills who is not going to progress in their career.”

Participant 2.3: “The other thing I was thinking of is they have a strong sense of confidence with, when dealing with people at different levels. So those things. Young engineers I've seen with good leadership skills, they're **equally comfortable speaking with say a high-level manager or a high-level technical expert as they are in talking with their peers--young engineering peers. But**

then also people who are support staff also--drafting-type people or lab technicians, test technicians that they might interact with in the job. So they have a real awareness, a 360 kind of awareness that they can, that they're not afraid to talk to those technicians or manufacturing workers who've been essential doing the same thing maybe for a very long time. But then also not intimidated by I'll say engineering general managers or vice presidents."

Participant 2.3: "**This young engineer was able to also then understand some of the concerns that the senior folks had on the design side and why they were concerned. What they had seen.** Some of the product data that led to that. It kind of built a good coalition, used a lot of**--I'll say--clear communication tactics. So having organized meetings, making sure everybody's opinion was heard**. Allowing them to speak and share their concerns and then documenting the decisions that were made so that come back to those decision. It was pretty clear that everybody was in agreement."

Participant 2.3: "So he . . . when I was saying before he was resilient. He got some critical comments about the validity of some of the work that had been done in the past. The validity of some of the work that he was doing. **And he didn't seem to allow that to get under his skin or to discourage him from continuing along the path that he was being** encouraged to go down by others and really kept the focus on data, but not in a cold way like we'll, here's the number. And look; everybody agrees. Here's the slope of the line; therefore, that's the answer. But he kept . . . **he would, he knew how to manage the dialogue--when to engage with somebody separately on the side, outside the context of a contentious meeting**. Or when to engage in a [inaudible]. And when to bring other stakeholders in, add their commentary, or to provide backup to some of the historical data. So really knowing which people to have, being aware of people's history--their sensitivities, their both their positive and negative views of similar work that had been done previously."

Team Oriented- Works collaboratively

Team orientation emerged as an important early-career engineering leadership characteristic as early as the interview process. Upon transition to the workplace, early-career engineers, demonstrating a team orientation, recognize the importance of teams and building strong teams with the right expertise. The interpersonal behaviors associated with a team orientation are listed below.

Leverage relationships to build a strong team. Relationship building, a key behavior in managing strategic problem-solving, becomes important to being team oriented. Leveraging relationships to build an effective team to solve problems is an important interpersonal behavior. Engineering leaders who are able to recognize the need to leverage other experts and not depending on their own expertise, effectively build strong teams.

Participant 2.1: "It is important to note that foundationally, engineering leadership at the early career stage is demonstrated most by teaming. What is teaming, what is the background around teaming. **The interpersonal comes in to play most in a teaming scenario**- in this case, how has an engineer stepped up to take on new opportunities, showing their willingness to learn, and has to get that job that the stepped up for done **through building relationships with the team**, **others outside the team, to leverage expertise**. **They have to leave their ego at the door to be able to do this**. They have to build rapport and trust with engineers their senior and corral their experiences to meet the challenges at hand- and not necessarily the easy answer."

"Oh I think definitely the challenges were that he was you know a relatively young person and **he had to put together the team of people that might have had twenty or thirty years more experience than him**. So I think his challenge was to be able to communicate with them; to be able to let them know the importance **of the of the issue and the importance of being on the team and then pulling the team together, getting that team organized of experienced engineers, and the thirty-year people and just keeping them kind of on track-**working through the set process of the steps that we take to go through that process. So I think his challenges were just to get the team to kind of listen to him, as a two or three-year person. But you know he was able to use the tools that we have and are recognized from this process. He used those very effectively and and was able to drive his communication to the experienced engineers and then also to the leadership team."

"For that for that he would seek out people in other areas of the of the business. So in our group, we did not have a materials person or a [inaudible] person so you know with his network of people with other younger engineers...**he went out and and networked with them to find out who the right materials person was or who the right [inaudible] was or a [inaudible] or a materials person that didn't belong to the team. And then he just reached out specifically to them. So he took the initiatives himself to find the right people to add to the team.** In those cases, you know you need a materials person to do the material behavior and you need a [inaudible] person, you need a [inaudible] person. **So he**

> **took that initiative to kind of build the team out.** And you know every step of the way whenever he was doing that he would kind of check check with me as his manager; check with a few other people who had led teams like this you know recently and make sure that he had the right team in place."

Establishes a culture of openness. Leveraging relationships to build a strong team meant that the early-career engineer was working with more experienced professionals. By establishing a culture of openness, the early-career engineer ensured that the team members could give and take feedback to optimize the problem-solving process. The engineering leader first established this by being open to receiving feedback from the team and further encouraging open thinking to determine a solution considering all perspectives. Establishing openness influenced the successful direction of the team.

> **Participant 2.1**: "So I think part of that is listening skills and willingness to take feedback from the team you know opening yourself up to that feedback and actually taking that feedback from the team so that you can make the team stronger and actually make the team in the first place."
>
> "I think I would coach them, number one, to make sure that they keep an open mind also and just to make sure that they convey that to the team is that it's really kind of starting from a blank sheet of paper. We want to keep an open mind as a team and you know just kind of help them with the process. **So they themselves, the younger engineers, have to keep an open mind and really try to bring out the experience and bring out the the comments and the [inaudible] of all of the experienced engineers without leading them to the end or letting the experienced engineers lead them to the end**."

"So I think thats the challenge is to make sure that with experienced engineers it is valuable to get their experience on the team, **but to have them keep an open mind and work through the process so that we get to the end of the process and we have looked at all of the different scenarios and you know, gone through is not [inaudible], but to come down to what what the real root cause is**. The challenge with that younger engineer is to kind of corral the more experienced engineers to make sure that they don't jump to a conclusion before they actually work through the process."

"But putting that to the side and recognizing the contributions or the experience of the team that they have, and then at the same time encouraging them to work through the process and instilling in the team that they need to work through the process and the younger engineer **recognizes the experience level, but they have to go through the process and make sure that they don't jump to the conclusion**. You know, that we have to go through each one of the steps and agree as a team that you know this step is completed. Would you move to the next step working through until you get to the end with the with the root cause."

"So there were a few times where you'd see somebody in one of these team environments **where they would kind of be a dictator.** They they wouldn't really get feedback from the other folks, they would just sort of assign. OK, you're the timekeeper; you're doing this; you're doing that; and let's go as a team; you know and **not really listen to the other team members**; and then try to you know set themselves up as the leader of this group without getting the **consensus of the group."**

Recognizes the team: An early-career engineer recognizes the successful solution to a problem is due to the work of more than just one person. Recognizing the team demonstrates an understanding of the importance of people and their contributions in the managing of the strategic problem-solving process.

> **Participant 2.1: "**Team orientation also focused on a strong desire to have the team succeed. Early-career engineers demonstrating a team orientation recognized that a problem **cannot be solved by one individual and the importance of recognizing the contribution of those involved."**

> **Participant 2.3**: "What I'm thinking of is people who are willing to talk using language that's reflective of teams and teaming, but also not hiding behind the corporate "We" for anything they do they can articulate and say my, my key role, my contribution on this team was such-and-such. **I think but recognizing that it wasn't just them.** That there were a lot of other pieces. And almost all of the projects that we work were arrived then for the past several years. It's heavily cross-functional. There's a lot of teams. There's a lot of matrix structure/nature sort of organization structure. And so you have to be comfortable in that matrix. **You have to acknowledge that other people are very much critical to both your individual success as well as the overall success of the company**."

> "So it's important for people to recognize that you're not the only--I mean there's some people come in very, **very brash and not show a lot of willingness to acknowledge the contributions of others**. And so they often desire leadership roles, but they're often not successful at very heavily matrix-oriented organization in doing that."

Participant 2.1: "**And you know just a strong desire to have the team be successful. It was one of those things where he didn't need for himself to look successful. He just wanted to have the team itself look successful**. And actually part of the process that we go through, one of the things is you know self-rating the team's successes. We try to drive that you know full and the team leaders, we try to drive down that they're not going to be able to do something or or be successful without a good strong team behind them. So you know recognizing the team also, throughout the process."

"We try to drive that you know full and the team leaders, we try to drive down that they're not going to be able to do something or or be successful without a good strong team behind them. **So you know recognizing the team also, throughout the process."**

Table three summarizes the leadership characteristics, interpersonal themes and behaviors associated with engineering leadership potential during the early-career stage from the perspective of company number two.

Table 4. Company 2- Interpersonal Behaviors of Early-Career Engineers Demonstrating Engineering Leadership Characteristics

**Items are not meant to correspond directly with items in the adjacent column, rather provide associated categories of behaviors within each of the themes represented in each column*

Engineering Leadership Characteristics	**Interpersonal Behaviors**
Willingness to Learn - Recognize they are not an expert - Demonstrated curiosity - Focused on current learning opportunities	*Humble Confidence* - Accepts criticism - Acts responsibly
Manages Strategic Problem-Solving - Leverage historical perspective - Big picture thinking	*Builds Relationships* - Active listener - Engages others

- Decision-Making	- Acts enthusiastically *Confidently Communicates*
Team Orientation - Recognizes the importance of teams - Builds strong teams	*Works Collaboratively* - Leverages relationships to build a strong team - Establishes a culture of openness - Recognizes the team

Engineering Leadership: Company 3

The following themes emerged through analysis of the three interviews conducted within company three. Each interview began with asking a question such as: When observing an early-career engineer, what characteristics demonstrate engineering leadership or what does engineering leadership look like at the early-career stage? This question aimed to solicit the characteristics associated with engineering leadership during the early-career stage. The following themes describe the characteristics associated with engineering leadership during the early-career stage for the interviews associated with company three.

Willingness to learn

As in company one and two, a willingness to learn in company three also focused on an early-career engineer's ability to **recognize that they do not know everything**.

> **Participant 3.1:** I think the I think the behavior that we're looking for is the willing to learn. It's very important because we know that they are not coming in with the full you know set of skills that we need. And in each company that we hire certain people who [inaudible]. So **willing to learn and learn quickly you**

know can you have the aptitude you have the ability to learn quickly is very very important. We don't't' need sometime even the people bring the skill in does not mean that it is the right skill. Or sometime we find that [inaudible] a young grad coming in. **They thought they know everything. They thought they already know the skill and find he still may not be you know appropriate and they think they have it but is not true.**

Company three participants also focused on an early-career engineer who demonstrated a willingness to learn through **going the extra mile and volunteering**.

Participant 3.2: "Early career engineers who I go this guy's going someplace are the ones who volunteer for things. Who when they say we need someone to take the meeting minutes or follow up on this, are the ones who say yep, let me do that for you and they do it and get it done."

"And then when I think of another guy he, I always, I always remember that if he was in a meeting and I needed a volunteer, for the first six months, every time he was the one who always volunteered for anything that we needed."

Participant 3.3: "You know that **is volunteering for things** that that type of thing."

Participant 3.1: "So willing to do the scrum work sometime we call it right. To do to **go the extra mile to help other people** not just for the sake of you know building your credential up."

"So I basically talk to him about this project and he says I want to do it. I want to really you know do this. You know. I say do you want to take the lead. I'm going to put together other people. Yes I would. So after we meet and then we put a team together so he will be the lead. So I gave him all the responsibility to manage that group. So basically we divide up in a team up into different responsibly because there are different roles different you know platforms need to be built like that and then you have to bring in you know speakers. You have to bring in you know people presenting papers and all kind of stuff. **So he worked with the team very closely almost on a daily basis. And don't' forget there's no money for it. It's not like we allocate some time for them to do it. They will be doing it on their own time**."

Get a job done

Getting a job done involved a young engineer's ability to **take responsibility** to complete a task by **working hard, doing quality work, and managing multiple jobs** and tasks at once.

Participant 3.2: "**The second thing is is that I find that leaders take responsibility. Potential leaders take responsibility for the job they're doing and don't look for excuses for not getting things done**. They, they, they recognize that they need to go and do something or they need to get information from a person and they go off and do it."

"Usually the behavior that they're doing is they are coordinating and taking, **taking responsibility for the work that they're doing**. They are going beyond. Our boss told me to do this. Oh I ran into a roadblock. I'm just going to stop and wait and ask another question before I go further. They take the extra step and they realize, and what I'd do is I would be pointing out to somebody saying hey [inaudible]. One of the things is that people will often come to me and say well I want to move up in the organization and I want to be a lead. Well okay, then if you want to be the lead and do things then you have to, **You have to work like a leader, which means that you've got to work independently. You've got to be able to solve the problems and the issues and the obstacles that come in your way without having to have somebody give you direction,** okay?"

"I will say one that I can think of off the top of my head. He doesn't just do his job but he does the research and follows up on all the little things to make certain that when his job is done, it's done right and thoroughly. So we don't have to tell him go search in this database or go do this. **He's already done that. And he takes, he takes control of everything. He just does it."**

"The people that I have the most difficulty with would be individuals who want to become a lead. **And you say okay well you need to then take responsibility. Make certain this gets done and just do whatever it's going to take to have it done. And then they come back and they still have excuses for not completing the job. And it's always somebody else's fault**."

For an engineering leader in company three, getting the job done, also required hard work taking the time to put forth quality work, and managing multiple projects at a time.

Participant 3.1: "In fact we are looking for people we cannot say it but if you have two young engineer come in. One come in on time. It's very good. We're not going to penalize him or anything because the other guy comes in at 6 o'clock. **And put in one extra hour. I think the idea is willing to sacrifice to work extra to go extra mile."**

Participant 3.3: "Yeah there's always like the willingness to go the extra mile. It's like you were saying like you can't you **know maybe staying late coming in early you know just just an overall can do type of attitude**."

"Just another one would be **the ability to multitask. You know so it's not just a focus on just one thing but an ability that perhaps have a primary work task and several secondary ones and being able to carry through them."**

"Sometimes the biggest thing I find is that you know an engineer that comes in is either able to you know get out of their shell and work with others or someone that is solely focused on doing one thing and doing it well and then moving on. **And I guess we need we need engineers that can be focused on things but engineering leadership is going to be someone that's able to multi task able to take on and deal with changes you know**."

Participant 3.2: "And and by the way there comes a time when you go okay, I'm going to, my goal is to get it out the, you know let's say our goal is to get it out before we leave at 4:00 today or whatever. **There comes a time where you might even sit there and go if I try and actually do this the quality of what I'm going to do is not going to be acceptable.** And you sit there and go stop. Even though you need to get it done it's not going to be with the quality we want and getting garbage out is not any good. Garbage in, garbage out is not good. So we're going to stop and not make it and we're going to take our lumps for making a mistake. You work over the weekend or do something else. But at the same time you, so you end up with the stress of trying to meet it and then every once in a while you have to sit back and go but is meeting it really the right thing to do? Because sometimes meeting it is not the right thing to do."

[Engineering leaders] "Are people **who work independently and know how to do all the things to get the job done. And they take the extra effort to make certain that they've done all the things that they were supposed to do**."

Team Oriented

In company three, team orientation focused on an engineering leader who is committed to the **team succeeding** and an ability to **work cross-functionally**.

Participant 3.1: Make all the other people around you successful: So you may work in another hundred mechanical another hundred civil and then a hundred electrical so you're competing with within. You're mechanical. And then you have to compete outside mechanical with civil and electrical before you can rise up above them become the project engineer overseeing the entire engineering group. And then all the department engineer has to compete with other in the work discipline. But some may be management maybe project control maybe procurement maybe construction managers before you become a department manager. Then you compete with all the project managers to become you know a operational manager and become the president of the company. So there's a lot of competition along the way to rise up to the top. But **then if you are competing and try to step on everybody as you go up you're not going to be a successful manager. You have to bring your team with you and make everyone successful so you can go up. Because if you go up there you basically** I wouldn't say kill everybody along the way. The company fall apart right there. We have to keep up the team for the company to be up there. **So to be successful on your own you have to make all the people around you successful.** Not counting the cost. It's very important.

Participant 3.2: And you know and I always make the comment that delegation is one of the most difficult things for a leader to do. **Because you can do it all, and I can do it all right myself. Well fine, but you can't, you don't have enough time, so you delegate it out. Yeah it's not perfect, but now all you have to do is edit it and [inaudible] out the door. You don't have to do it yourself.**

Participant 3.3: **I guess working with others in a collaborative kind of way to produce a product. A lot of the work we do in engineering is not the efforts of one person. It's always a team**. It's always multi-disciplines so someone that's able to kind of work with others to get their work done but also perhaps to support like a team work product.

"…we're looking for someone that you know is always thinking about the the **good of the team the good of the company is not going out on a limb with regard to you know."**

"I know some of the some of the skills and behaviors that you'd want to demonstrate as just being an engineering **leader I really think it's you know you start going from the the me to the we a lot.** So you're trying to motivate the team. You're trying to you know you're always looking for how can we succeed. You're trying a lot to make sure that each of them all the members of the team are you know motivated feeling good about what they're doing. **You're promoting with others**. **You know looking for what might be their next best step in their careers. So you're thinking thinking about members of the team as much as getting the actual work done. You spend a lot of time coaching. You got to be willing to explain.**

"You got everything from mechanical, electrical, civil, geotechnical, seismic, and nuclear all involved in these things and so it's how do we bring that all together into one successful power plant that operates and generates megawatts. And so it's it's getting everyone to understand you got to get your job done and it's got to get done on this schedule because the output of your task is the input to someone else's task. **And you know a lot of times it's it's not getting into the details of everyone's work but it's you know understanding that letting them to kind of work out their differences and then get involved when you need to**."

Interpersonal Behaviors Associated with Engineering Leadership- Company 3

After soliciting information on each of the leadership characteristics associated with demonstrating engineering leadership, the interview turned towards a focus on the interpersonal behaviors associated with engineering leadership characteristics identified by the participants. The information below was gathered using questions like, 'what do you observe about interpersonal that is important for those areas that you listed of engineering leadership in an early-career engineer,' and helped to determine the interpersonal behaviors associated with the potential engineering leadership for entry-level engineers. For company three, the following interpersonal themes related to engineering leadership and the observable behaviors are listed.

Willingness to learn- Humble Curiosity

In company number three, 'seeks perspectives' summarizes the interpersonal behaviors associated with a willingness to learn and is labeled humble curiosity. Behaviors associated with humble curiosity include willing to accept criticism and continuously improves and demonstrates a questioning attitude.

Accepts criticism and continuously improves. An engineering leader seeks perspective into their own performance and willingly accepts criticism. Learning from this information, early-career engineers will demonstrate acceptance of criticism by taking action and improving based on the information given. They seek feedback to continuously improve.

> **Participant 3.1:** "Now that's tied to the early comment I make is **willing to you know accept you know maybe areas of improvement or criticism**."
>
> "**they're willing to accept you know criticism right**…. Sometimes we also both side **but the willingness to learn and accept** you know [inaudible] whatever you want to call it **criticism…. Those are very very important behaviors that we're looking for."**
>
> "Sometimes they get very easily upset because they cannot communicate the idea. Or sometimes they communicate their idea that they do not listen to me and they get upset about it. But they have to learn in a big company or any other company even a small company. When you were young you may not be experienced but some of your ideas are bad. You're not experienced enough to

see the big picture. **Sometimes the idea is good but may not be the right timing to be applied to be implemented in a structure you know in a company in a project. And they cannot accept that.**"

"**And the first question the first two questions you should ask how I'm doing. And if you do annual meetings what should I do to improve next year**. And then when next year he documents it. Next year go back and say how I'm doing according to what you told me. Am I improving? So you're building up a list of improvement."

Participant 3.2: "And and literally that's what I've found. I've never had to go back with that, with with people who are becoming leaders. **Usually you spot something, you tell them and it, it, they immediately correct it and then they move on.** They don't repeat their mistakes. [Inaudible] you make a mistake once, but you don't make a mistake twice. And they, they learn from what they've been told and coached on okay?"

Participant 3.3: "I guess someone's that able to take constructive criticism you know and understands that you're not always going to be successful a hundred percent of the time. **But can can receive suggestive ways to improve and actually does demonstrate a learning lessons and showing improvement so you can receive criticism and then actually demonstrate that it's changing a behavior** or improving the next work project or something like that."

"Yeah I guess thinking two of those things. Let's see here. And you know asking questions inquisitive and then choose improvement. **So can take that constructive criticism and show improvement continuous improvement as**

they you know produce the same or related type tasks. So can actually show you stated here but it's getting each each and every time."

"Yeah you got to be able to listen. You got you know if someone's providing you know constructive criticism or identifying improving opportunities you know you're assuming listening understanding what you did versus what you need to do next time. Not you know not taking it personally. You know the person providing the criticism needs to be you know doing it in a positive way and you need to receive it in a positive way. Almost nothing is perfect and so it's just **a willingness to accept the fact that there's always improvement**. And then once you go through it again it's not demonstrating the same mistakes a second time. You know so you go through and you've done a calculation and you know it comes back from the checker with a bunch of comments on the approach or the references that you used. If you're asked to do that same task again that we wouldn't see those same types of mistakes that having gone through it having understood what the comments were. You're able to absorb that and actually put that into action for the next time you're asked to do a similar task or the same task."

Questioning attitude. Curiosity in learning as much as possible regarding the problem or the scope of the early-career engineer's current position resulted in interpersonal behaviors associated with a questioning attitude. Asking questions focused on gaining perspective of areas for improvement and understanding the larger picture in order to inform decision-making.

Participant 3.2: "They, they, they really do take, the the ones that I see with the potential are the ones who are right there trying to go ahead or **asking good questions, who don't just sit there and accept everything that's said but go**

geez can you explain why this is happening? I want to understand so that I know why this answer is given to me so that in the future when something similar comes up I am able to repeat and give another answer that's very like, that's also going to be acceptable. Really good leaders have a questioning attitude all the time because in order to be a good leader themselves they know, they recognize the fact that there's a logic to our upper management. And if it doesn't make sense or the thing that they would have expected from upper management isn't what they would've done, they want to know why. There's different, they may not always agree with upper management, but at least they understand the logic of what the upper management is doing, okay? So they always have a questioning attitude. Explain it to me. I don't think that's a good way to go. Well that's fine but you're not the guy who's making that decision. Okay. At least he understands where it came from. **They have that questioning attitude all the time. They don't want to just accept it, they want to understand it."**

"Another thing comes to mind would be asking questions. Not not not shy about you know why are we doing this. How do we do this? What's the next step? Where do I fit in? Just inquisitive about the overall process."

Get the job done- Exhibits a can-do-attitude, effectively communicates under stress, acts with respect

Getting the job done included early-career engineers who took responsibility for the assigned project, worked hard to complete the job, completed quality work and managed multiple tasks at once. Interpersonal behaviors associated with getting the job done in company three included exhibiting a can-do-attitude, effectively communicating under stress, and acting respectfully.

Optimistic, positive, & enthusiastic. Early-career engineers with a can-do-attitude demonstrated an optimistic and enthusiastic response to working on a project.

> **Participant 3.3**: "just just an overall **can do type of attitude**. I hate to use all those kind of you know you know cliché type statements but it's really just somebody that shows an overall positive attitude."
>
> "I think it was something that he he was he was glad that people asked him to work on it and then after he got done doing it he described it probably more than anything was just fun to do. **So he just really an upbeat attitude."**
>
> "This is why we're going to do it and kind of get everybody to kind of buy into understand the big picture but then understand their individual role on trying to get there. You got to always be I'd go back to this it's **the you know optimism upbeat**. We can do this you know. It's not as bad as it looks. We're actually going to get there type of things."
>
> **"You know somebody that's enthusiastic**. You know is not finding this to be a I can't believe I've been asked to do this but actually okay I can get this this is something I feel good about.."

Asks for help to get the job done. Additionally, understanding when to ask for help demonstrated a can-do-attitude through an early-career engineer's behavior focused on working hard to get the job done, but also asking for help when needed to accomplish the task associated with the job.

Participant 3.2: "Or to get your, with the job you're working on, a higher priority. And they also recognize when they're running up against a wall and need help to get it done so they go and ask for help to get what they need done."

"And they also ask for help at the right times. When, when that person comes in and says hey, John I need help to get this done. You know that they've done all the things that they could do and now it, I'm going to have to skip some levels to get to an area to get the job done. **People, they recognize when they've done all they can and they know when they need additional help."**

Getting the job done within the engineering context can be stressful. In company three interpersonal behaviors associated with getting the job done included an early-career engineer demonstrating effective communication under stressful situations. Effective communication included calm and persuasive behaviors. Active listening also contributed to effective communication for early-career engineers getting a job done.

Calm and persuasive communication style. Meeting deadlines and solving project problems requires an engineering leader to effectively manage the pressure with calm and persuasive communication.

Participant 3.1: "You can enable negotiate with people in a very maybe you know stressful situation. You know your project is you know falling apart. You know customer is not happy. The regulator is coming. You know at your door and you have to be able to deal with it. **So you have to be able to deal with the stress the pressure and communicate you know in the right way to make you know the final results to be successful."**

> **Participant 3.2: "They they learn that they, how to push to get, to get information or to get their job done**. And they they take control of it and they go get their job done without direction. **They they tend to just, good interpersonal skills is they know when to push somebody or when to I want to say sweet talk them into something**. And there's, and there's a time for each one of those where you have to you know, if you're not going to be able to push somebody to do it then maybe you can sweet talk them into doing something for you."

Active listening. Active listening involved repeating back communications associated with getting a job done which demonstrated a clear understanding of tasks associated with getting the job done.

> Participant 3.3: "Well well kind of like I was saying. Active listening. So you know through communication you're hearing something. **You're asking questions about what you hear and then you're able to repeat it back again or reframe it so that you have a good understanding of of the task**."

> "You know in some cases it even gets to the point of you know some early career engineers we can see as almost immediately are leaders of small teams. **So they're not just an individual contributor or a member of a team but actually you know right from the start you can see that here's a person that's able to actively listen.** You know and we would feel comfortable in someone actually leading that team to produce a work product."

Acts with respect. Early-career engineers demonstrated respect as an interpersonal behavior to get a job done. By acting with respect the early-career engineer recognizes that everyone is working towards the same goal and respecting the work being accomplished to get the job done. Acting respectful also includes respecting decisions from upper management and building consensus on the team to move forward and get the job done.

> **Participant 3.2**: "**I'm going to, I'm going to go back to treating everybody with respect.** And recognizing that everybody's working towards the same goal. And that, as part of that then they, yeah, that that, they work independently and they work to get their job done, doing all the things they need to do.
>
> "**good interpersonal was that they, they treated everybody with respect and that they did what they said they'd do."**
>
> **"You know, treating everybody with respect. Trusting that they're all working towards the same goal, helping each other, you know? Communication and earning trust."**
>
> "But once you agreed on a path forward whether you're happy with it or not, this is what we're going to do. And everybody's you know sort of salute the flag and go out and do it. Okay? **And so you, there's times when you can argue your position, there's other times when you have to sit back and say okay if this is the position that we're going to do, we've got to back up our upper management and get the job done**. [Inaudible] We didn't, you can, you can, you can object to it. You can disagree with it, but there comes a time when you have to say hey guys no more discussion for doing this. **Let's go get it done. Everybody's got to agree to that."**
>
> "Sometimes you'll find a person who's getting into a leadership position and they **think too much of themselves and talk down to people**. If you see that you

really don't want that to happen okay? It ends up, then a lot of things occur and there's, the group becomes dysfunctional and they don't succeed in what they're doing."

Team Oriented- Focused on the "We"

Team oriented characteristics included an early-career engineer recognizing the importance of the team succeeding and working cross-functionally. Interpersonal behaviors associated with being team oriented are categorized by an early-career engineer's focus on the "We" instead of the "Me". A focus on the "We" includes serving others and acting with integrity.

Serving others. An early-career engineer serving others focuses on the "We" by being willing to take the time to build others up and to help others to complete tasks. Serving others is not focused on serving others to move up in the organization, but a genuine attitude to help everyone succeed.

Participant 3.1: "**So there's a lot of interpersonal relationship willing to sacrifice yourself. Willing to take time to help somebody become a successful you know leader."**

"**To do to go the extra mile to help other people not just for the sake of you know building your credential up. That's important too. But learn how to serve other people help other people make everybody successful and you benefit from it.** I think that is a very important you know I would say attribute of the person. Lot of kids come in and say what if you know what is my return. If I do this are you going to pay me more money you know or I'm getting a raise or I'm getting promotion."

Participant 3.3: "**Well I mean you're not self-centered**. You know you understand you're part of a team. **It's not only your success but the team's success so you understand that I need to get this done but I also need to support someone else on the team** so you got to be able to balance the priorities of your own work with what other team members might might need."

"You're promoting with others. **You know looking for what might be their next best step in their careers. So you're thinking thinking about members of the team as much as getting the actual work done**. You spend a lot of time coaching. You got to be willing to explain. You got to you know this is what we're going to do and take the time to explain and actually receive input you know you're going to get different opinions and viewpoints."

Acting with integrity. Early-career engineers acting with integrity focused on the "We" by honoring commitments made to a team and speaking up when noticing a situation that may impact the integrity of the organization.

Participant 3.3: "A big thing is that you're accountable you know that when you make a commitment you honor that commitment. You carry through on it. And you know if anybody's looking for things that went wrong or could've been improved that you're accountable for yourself and for your team. You you know you're standing up for what it makes you know when no one's looking you're you're doing the right thing and you're standing up for the team so."

> "**You know if understanding you know you might see something or you might be involved in something so you want to ask question to make sure that you fully understand either what you're seeing or what you're being asked to do.** You want and try you know obtain data to the extent that the that you think there's some unethical situation or that you're being asked to do something unethically or you're is my action unethical? You're you know you're trying to understand with resources the company has or other things just obtaining data to find not what this is a fact and acceptable situation. You're willing to go talk to others. You know if you get into a situation where this doesn't feel right. You don't hesitate. You don't you know talk in a corner with somebody in hushed tones but you're actually out there asking. This doesn't you know just being honest about the fact that this doesn't feel right and willing to talk about that with others."

Table four summarizes the leadership characteristics and interpersonal behavioral themes associated with engineering leadership potential during the early-career stage from the perspective of company number three.

Table 5. Company 3- Interpersonal Behaviors of Early-Career Engineers Demonstrating Engineering Leadership Characteristics

**Items are not meant to correspond directly with items in the adjacent column, rather provide associated categories of behaviors within each of the themes represented in each column*

Engineering Leadership Characteristics	**Interpersonal Behaviors**
Willingness to Learn - Recognize they are not an expert - Volunteering	*Humble Curiosity* - Accepts constructive criticism & continuously improves - Questioning attitude
Getting a Job Done - Takes responsibility	*Exhibits a Can-Do-Attitude* - Optimistic, positive, & enthusiastic

- Hardworking	- Asks for help
- Complete quality work	*Communicates Effectively Under Stress*
- Manages multiple tasks	- Calm & persuasive communication
	- Actively listens
Team Oriented	*Focused on the "We"*
- Focused on team success	- Serves others
- Works cross-functionally	- Acts with integrity

Additional Themes Emerging From Data Analysis

Throughout the nine participant interviews, specific comments and themes emerged related to generational differences. Early-career engineers who could defy stereotypes related to their generation seemed to demonstrate both engineering leadership characteristics and the interpersonal behaviors associated with engineering leadership. The first theme involved both the positive and negative use of social media. Utilizing social media to connect others and get the job done, was seen as a positive. However, social media as a part of multi-tasking was seen as detrimental to an early-career engineer's performance and leadership characteristics associated with the job.

> **Participant 3.3: "He's you know a lot of early career engineers have a very good handle on social media and some of the more innovative ways of communicating with other early career engineers but also getting big career and later career engineers involved** and so he's been able to come up with the you know different pieces of this technology fair from interactive web site to videos to Twitter feeds to all that type of thing kind of **pulling into play all the all the different ways of communicating so we're kind of reaching out to you know like I said engineers in different phases of their career.**"

Participant 3.1: "We you have young engineer come in and they they by let's say 9 o'clock in the morning somebody will start at 7. Let's say 7 o'clock in the morning now. **Then they turn on the computer immediately they go to Facebook. They go to Twitter. They open up their email and they have their IPhones you know on you know the table and they have the text message and then they turn on to our own web site and then pull up our project. Now they start doing work. And they immediately put on a ear phone so they have the music is on. So you tell me if I'm the supervisor walking by and they're looking at the guys. The guy's working or he guy's actually doing his own thing.** [inaudible] to a guy or communicating as friends. Right and we end work very as especially government work. You normally you start at certain time you end at a certain time. People go home **and so in between if you do text message to your friends and all kinds of stuff you lose some concentration**. Now that's tied to the early comment I make is willing to you know accept you know maybe areas of improvement or criticism. And because this is a very common issue that we find. **Because of the distraction that we believe from the older generations that they have so many you know multi-tasking stuff that throughout the work the quality of the work that comes out is not as good**. And so I think there is one of the behavior that you may want to put in your report. And the multi- tasking is causing a lot of problem in the industry."

Participant 3.1: "The other behavior is you can see people now I think that is also turning the older generation into that problem too. So I think okay we are very safety conscious. We actually put our safety bulletin. Every meeting we have is safety related. The first thing we talk about is safety. **And you will see people as holding the IPhone walking around the hallway in office either answering phone or text message. They will bump into doors. They can bump into doors. They can open a door and bump into somebody else and get hurt.** We file as a company when we're very proud of our safety record. Every month every week we publish our safety record. Nobody injured in a construction site. Ten million hours no injury. But we have problem. It's not because people injured at you know at a construction site fall down from a maybe a scaffold or something. **It's actually people actually fell you know the stairs because they are text messaging on their IPhone. So those are behavior I think the young engineers have to accept because it's their culture….That is type of behavior that we seeing that is to us is disruptive.** Is not very productive and also not helping the young engineer to advance to learn. This is a big one. That's the one I talk about in mentorship workshop a lot."

In many of the stories where participants described a positive or negative interpersonal behavior of an early-career engineer, generational perceptions and stereotypes emerged. Participants described many early-career engineers as wanting to get ahead too quickly or wanting to jump to the next level before they were ready.

Participant 1.3: "Sure without too much detail but the gist of it was the individual as many as many early career folks are **was just so anxious to get ahead to to prove himself right that he's valuable and worthy and just overly anxious. But it kind of turned off other people**. And also was maybe **overly aggressive to the point of invading a little of other people's responsibility** and and it wasn't a terrible thing. It was just enough I think that I that it made people feel uncomfortable that hey this guy's coming in stepping on our toes which like I said sort of turned them off and built up some resistance."

"**Right he could've taken more time to build that relationship that confidence with his immediate team first before trying to impress management right.** He needed to focus more on the job at hand and the team he was working with. Get their buy in. Build that relationship first before trying to advance further."

"I think we had a situation even in an interview where one where a candidate is interviewing for a particular position. **They may spend a fair amount of that interview time asking about the next position the next advancement promotion beyond that. It's it's good you know to to have those aspirations but when we're looking somebody we're looking to hire somebody for this job**. And yeah granted hopefully the [] that they will advance beyond and beyond that but right now I need somebody for this job right. **So too often I think we see folks who are just looking ahead and and they're already looking beyond the immediate job in front of them."**

Participant 2.2: "You, you, you've been successful doing X, Y, and Z. You're a great sports person--that helped grow you. You've got parents who care that helped grow you. You've got an education. No one wants to down play that, but you have to be ready to, to relax a little bit. **And, and you have to, you have to build up the guy at the bottom.** To know how to lead the guys at the bottom later on even just for that reason. But, but you, that's when you learn, and that's when you can afford to learn. And that's when there are people there who can help you and want to help you. I think everything you've . . . I, **I feel like people come in and there's, I almost feel like there's a clock ticking. And there isn't. It's, at least not a physical clock that. That what, what is ticking is, there's a, there's, there's a checklist instead of a clock. And, and the checklist is that you need to learn new things. And you, and really moving forward until you've finished that checklist. You're cheating yourself later on**."

"What I've seen in, what I've seen in, in the, in the past, particularly recently--and I think it's somehow hooked into the fact that people's spending so much money on their educations now, **but universities are having to tell them they get to be chairman on the board within five years when they leave college to, to justify getting them to spend as much money as they do. But you see a lot of people coming in with very, with unrealistic aspirations on how long it's going to take to be, to get the lead** . . . a leadership role and, and, and a lack of understanding of what that is."

Participant 3.1: "Lot of kids come in and say what if you know what is my return. If I do this are you going to pay me more money you know or I'm getting a raise or I'm getting promotion. If they keep asking for reward you're not going to get there. **You're almost have to to to pay the dues first**. And then somebody remember you and then bring you up. **So they have to learn the reality in the industry in the commercial world that's how we work**."

Participants also commented on early-career engineers' being in shock with the transition to the corporate world. This shock centered on the idea that early-career engineers think they are experts early on in their career and it comes as a shock when they realize they are not.

Participant 2.2: "checking your ego in at the **door even if you think you're the smartest person on the planet, and you're--you know. And, and you've, you've been told that since you were at high school.** I had a guy who, who works for me who was **extremely cocky**. I mean, it was, he was off the charts. He went to an Ivy League kind of school. **And I was having to get him, and what he didn't understand when he showed up was that--you know--he'd been top of his class since he was probably 11- or 12-years-old.** But so had everyone else around him, and this was the first time he'd ever been in that kind of environment where being top of the class was just average. **So I, I had to tell him in this review that he was, he wasn't--you know--out of, out of his peers, he was at the bottom of the pile. And his response was, "Well, what am I going to tell my grandmother?" And, and, and it has always struck me that a little insight into his world was that he, he, he was still living in that world where--you know--your grandmother tells you you're the greatest person ever, and, and you might well be in your grandmother's world. But, but you're, you're amongst people who've all been top of the class who've all got extremely good degrees from great schools."**

"But that's, that's, that's, that's what I think. I mean we get, and it varies from college to college and obviously varies from person to person. But I, I've, I've had a, a variety of--and like I said, it seems to be a, you know, **that used to be somewhat of a correlation with let's say the status of the end, of the college where they've come from. But some people from what would be seen as more prestigious universities coming with a bit more of a, an attitude of I got it; I'm from here. You know--let me through. I'm going to solve all the**

world's problems. And they, they, they've put people's, they put people on--you know--people don't like that. And, and it--you know--and they're not listening.”

Participant 1.1: “Kind of the willingness and recognition that they're **not an expert in their field. You know they might feel like it when they become graduates.”**

Another key theme that seemed to be foundational to understanding the context by which early-career engineers demonstrate leadership characteristics and subsequent interpersonal behaviors is technical knowledge.

Participant 1.2: I'm running a project. I’ll be the lead systems engineer and I’ll work across multidiscipline teams and I don’t' have to know everything about in depth. My pool is not that deep but it's very wide. Versus the subject matter expert my pool is very deep. You know more like a well so that's an effective leadership. **So to be a manager of a technical team you're not so many you're not as technical but you're still a technical lead leading a group of technical people**.

Participant 3.2: “One is the engineer has to be a good engineer. They have to be able to do their job well. Okay? **If they're not a good engineer and they're not technically solid and know what's going on, they'll have difficulty in the future as a leader** because they won't know when they've gotten a good answer or a bad answer from another engineer.”

“And if they're, if they're not, **if they're not technically good, they, they may get information but it'll be bad information they get and they won't know that it's bad,** go down the wrong path and then run into an issue.”

“The the other thing that I've seen with leaders that we've had or people that you could go okay how is this person going to be as a lead? We've put them in there and they've made poor decisions, poor technical decisions. **And so the information that comes out of their group or the detail or the design that they've done hasn't been technically good. And therefore you go okay can I trust what this person's giving me?** And you you realize they've got a good, they've got technically qualified people under them but because they are not technically strong their decision they've made is not good.”

“**And it comes, it comes back to that they've got to be a good engineer. First and then everything else comes after that**.”

Across Company Analysis

The following section describes the cross-company analysis based on the leadership characteristic themes and the interpersonal behavior themes. Leadership characteristic themes for early-career engineers are discussed first, followed by the interpersonal behavioral themes. The section concludes with a table describing the interpersonal behavioral themes emerging from the data across all three companies.

Leadership Characteristics

The leadership characteristics for early-career engineers described by the nine engineering leader participants foundationally centered on strong technical knowledge, skills, and abilities. After a strong technical foundation, the participants' described four broad categories: willingness to learn, getting the job done, career maturity, and being team oriented. Willingness to learn and getting the job done were clear themes throughout each of the participants' interview. However, the career maturity theme, associated with company one, and team orientation themes, associated with company two and three, had overlapping aspects. For example, career maturity's descriptors, acting professionally, handling politically charged situations, adapting communication to an audience, and giving a voice to the group, were described within the context of a team setting. This suggests that the team orientation aspect was an underlying theme associated with the characteristics of engineering leadership in company one. Alternatively, the excerpts associated with team orientation focus on the importance of people and building strong teams. It could also be said that the career maturity descriptors help an engineer to focus on the team, suggesting that career maturity is also an underlying theme for a team orientation. So while the in-vivo code of career maturity was unique to company one, the elements of career maturity and team orientation could be seen in all three companies. Differences in language could be due to various managerial levels of participants, leadership or management training, or company culture.

Interpersonal Behaviors

The interpersonal behaviors associated with the engineering leadership characteristics included eight different descriptors. However, it is important to note that defying generational stereotypes was a common thread throughout the companies when describing interpersonal behaviors. As with the leadership characteristics, defying generational stereotypes was foundational to interpersonal behaviors associated with engineering leadership during the early-career stage. As with the leadership characteristics, differences in interpersonal behaviors across companies varied by the extent to which the themes were discussed. For example, in company one, where career maturity emerged as a theme, the interviewee tended to speak more towards emotional awareness and management than did others; however, these themes were also present in the other two companies but were associated with active listening or perspective taking. Table five summarizes the interpersonal behavioral themes related to engineering leadership for an early-career engineer.

Table 6. Interpersonal Behaviors Associated with Engineering Leadership Across All Three Companies

Interpersonal Behavioral Theme	**Descriptors**
Demonstrates Humble Confidence	- Accepts constructive criticism - Willingness to say they don't know
Builds Relationships	- Establishes trust - Builds strong teams - Leverages relationships to get the job done
Demonstrates a Positive Attitude	- Enthusiastic - Optimistic - Remains positive in the face of challenges
Effective Communicator	- Calm, manages emotions - Influential - Adjust to audience
Active Listener	- Listens to others - Asks questions

This chapter outlined the results associated with this exploratory study. Comparing the results across all of the participants and companies show differences in language used to describe leadership characteristics and interpersonal behaviors. Key themes across each company, but distributed across different interpersonal themes, include effective communication, being humble, positive attitude, and being other oriented. Participants also identified technical abilities as foundational to engineering leadership characteristics. An ability to defy stereotypes was an important theme across both leadership characteristics and interpersonal behaviors associated with engineering leadership characteristics. The following chapter discusses the implications of these findings and recommendations for future research.

Chapter 5

DISCUSSION AND RECOMMENDATIONS

Study Overview

The understanding and application of leadership is described as a necessity within the context of engineering and the global work environment (NAE, 2004). Interpersonal competencies are included in descriptions of effective leadership and are noted in emerging literature seeking to define engineering leadership (Cox et al., 2009; Hartmann et al., 2015; Rottmann et al., 2014). However, little research exists as to which interpersonal behaviors are impactful for leadership within the engineering context. Many engineers reject traditional notions of leadership that position success as highly charismatic and outgoing behaviors (Rottman, et al., 2014). Therefore, the aim of this study was to explore interpersonal competencies through the unique context of the engineering profession. The knowledge gained from this study is an important contribution to the literature seeking to define leadership within the engineering context and can be used to help shape curriculum, training, and coaching initiatives to help develop the appropriate leadership behaviors for engineers working in today's highly competitive global environment.

This qualitative study describes the leadership characteristics and the important interpersonal behaviors associated with early-career engineers from the perspective of engineering leaders across three large engineering firms. The qualitative approach to this study is indicative of the need for exploratory analysis of interpersonal competencies within the context of engineering. Investigation of the research problem occurred through interviews with nine identified leaders in the engineering profession across three engineering companies. The qualitative approach to this study focused on individual interviews as the sole method of data collection with the purpose of interpreting meaning and identifying patterns and categories within the engineering context (Boyce & Neale, 2006; Kvale, 1994; Jansen, 2010). The research questions listed below, informed the study design as both leadership and the concept of interpersonal are large and ill-defined constructs, which require a qualitative approach to derive meaning and understanding (Rose et al., 2015). The research questions for the study were:

Research Question 1: What leadership characteristics are important for early-career engineers to exhibit as indicators of emerging engineering leaders?

Research Question 2: Which interpersonal behaviors of early-career engineers are associated with leadership characteristics identified for emerging engineering leaders?

The nine participant interviews were transcribed and analyzed using open and axial coding to produce themes associated with leadership characteristics important for early-career engineers to demonstrate and interpersonal behaviors associated with the leadership characteristics. The researcher utilized in-vivo coding wherever possible to align the findings within the engineering context.

Trustworthiness of qualitative research relies on a researcher being trusted through methodological rigor (Lincoln & Guba, 1985; Patton, 1990). This study successfully utilized triangulation by cross analyzing the interview data from each of the three participants at each company and by second coder analysis of themes, resulting in a Kappa co-efficient of .72. The remaining portions of this final chapter discuss the findings of this qualitative interview study in alignment with the two research questions. Interpretations, recommendations, and future research are provided for next steps and considerations for practitioners.

Discussion

The findings introduced in chapter four outline the leadership characteristics and interpersonal behaviors within the context of the engineering profession for an early-career engineer. The results provide a contextual picture of the interaction between person and environment through the emerging behaviors associated with engineering leadership during the early-career stage. The first research question informs the context by which the interpersonal behaviors are observed.

> *Research Question 1:* What leadership characteristics are important for early-career engineers to exhibit as indicators of emerging engineering leaders?

Four major themes emerged from the data to describe the leadership characteristics appropriate within the context of early-career engineering: willingness to learn, getting a job done, career maturity, and team orientation. Underpinning these characteristics is the idea that technical knowledge and skill is foundational to leadership within the context of engineering.

The literature review described engineering leadership broadly as a concept that required technical mastery, collaboration and teamwork, problem-solving, and autonomy (Ahn et al., 2014; Hartmann et al., 2015; Mallette, 2005; Robledo et al., 2009; Rottman, et al., 2014). The findings from this study add to the current literature by providing perspective from the engineering leaders observing early-career engineers and describing leadership characteristics appropriate for the early-career stage. The leadership characteristic themes emerging from this study align with current research on engineering leadership. A willingness to learn was characterized by early-career engineers' recognition of the continuous learning associated with being an engineer and demonstrated drive and initiative to master the technical aspect of the current job by which they were performing. Getting a job done involved decision-making, hard work, and proactively seeking answers to solve a problem. This aspect aligned with the autonomous context of engineering leadership as well as innovatively solving problems based on organizational needs (Mallette, 2005; Robledo et al. 2009; Rottman et al., 2014). Career maturity and team orientation focused on the collaborative nature of the engineering context. Career maturity required effective communication, acting professionally, and recognizing the political situations involved in working within and across teams. Team oriented leadership characteristics focused on the need for building strong teams within the engineering setting.

The data in this study describes the context by which early-career engineers enter the workforce as involving complex problems, team-driven solutions, and requiring autonomous proactivity. A high technical orientation is imperative for demonstrated leadership characteristics of early-career engineers as demonstrated by the willingness to learn theme, which emerged across all nine participants. The alignment of this theme within current literature provides a more unified picture of the context by which engineering leadership is observed for early-career engineers in today's global engineering environment. Through the leadership characteristics described in this study, further exploration of behaviors associated with leadership can be explored, resulting in a full competency model related to engineering leadership at the early-career stage. Specifically for this study the interpersonal behaviors associated with engineering leadership characteristics at the early-career stage will be explored through research question two.

The literature review revealed that interpersonal competencies emerged in leadership research as early as the first part of the twentieth-century (Avolio, Reichard, Hannah, Walumbwa, & Chan, 2009; Dinh et al., 2014; Hunt & Baruch, 2003; Riggio & Lee, 2007). In competency models for leadership, interpersonal competencies are arguably the most difficult to conceptualize and define due to the complexity and ambiguity of the concept, and the inconsistency in describing the phenomena within the huge and fragmented volume of interpersonal competence research (Kim et al., 2008; Spitzberg & Cupach, 1989). Because competencies are perceived when behaviors are judged as effective and appropriate within the context of a situation, the second research question informs the basis for the identification of behaviors associated with engineering leadership during an engineer's early-career stage (Spitzberg & Cupach, 1989).

> *Research Question 2:* Which interpersonal behaviors of early-career engineers are associated with leadership characteristics identified for emerging engineering leaders?

Identifying behaviors is central to this study because behaviors demonstrate the underlying characteristics associated with competencies. An engineering leadership competency model would include numerous competencies and would list the subsequent behaviors important for desired performance outcomes (Bartram, 2005). Interpersonal behaviors associated with leadership characteristics for this study arguably align with what Spencer & Spencer (1993) defines as hidden competencies: motive, self-concept, and traits. Hidden competencies are more difficult to observe and to develop (Spencer & Spencer, 1993). For example, accepting constructive criticism is not easily observed as a behavior and may involve the individual's level of achievement motivation to be willing to accept the criticism and take responsibility to improve. Exhibiting a can do attitude such as, being positive, optimistic and enthusiastic, are observable behaviors that come from self-concept rather than skill or knowledge. Building trust and trusting others arguably align with trait and self-concept characteristics. One could make a case of these behaviors falling into one underlying characteristic or another; however, the importance of this observation is that the interpersonal behaviors identified in this study, while bringing some clarity to the term interpersonal within the context of engineering leadership for early-career engineers, still include challenges to identify and develop as a concept.

The complexity of interpersonal as a concept, combined with the results of this study aligning interpersonal more closely with hidden competencies, confirms the challenges with both identifying and developing interpersonal competencies. However, it is these underlying competencies, whether hidden or surface, that lead to or cause effective or superior job performance within a particular context (Boyatzis, 1982; Spencer & Spencer, 1993). The interpersonal behaviors emerging from this study align with research associated with emotional competencies and are commonly referred to as emotional intelligence. Research has described interpersonal as a skill such as those who need to improve "people skills," dealing with relationships, and in more recent years the term emotional intelligence has become synonymous with the construct of interpersonal (Riggio & Lee, 2007). Emotional intelligence competency is defined as " an ability to recognize, understand, and use emotional information about oneself or others that leads to our causes effective or superior performance" (Boyatzis & Sala, 2004, p. 5). Emotional intelligence has been researched as both a mental ability model and mixed model approach, which includes motivation, trait, and skill approaches. For purposes of this research, the mixed model approach aligns most closely with the findings of this study. Boyatzis, Goleman, and Rhee (2000) empirically analyzed competencies for emotional intelligence and determined four competency clusters: self-awareness, self-management, social awareness, and social skills. By comparison, the interpersonal behaviors associated with engineering leadership characteristics during the early-career stage from this study align with these emotional intelligent competency clusters as demonstrated by the excerpts below.

Goleman (2014) describes the competency clusters in more detail based on how they may emerge as behaviors in star leaders. Pairing Goleman's more detailed descriptions with codes from the interpersonal behaviors emerging from this study provides more clarity on the connection between emotional intelligence and the interpersonal behaviors of this study.

Self-Awareness. Goleman (2014) describes behaviors associated with this competency cluster as leaders who recognize how emotions impact job performance, when to ask for help, where to focus on building strengths, and a sense of self-assurance that stands out. Examples of interpersonal behaviors from this study aligning with the self-awareness competency cluster include behaviors from the humble confidence grouping such as a willingness to say they do not know, asking for help, and accepting constructive criticism. Participants regularly referred to self-awareness as an early-career engineer who "left their ego at the door" or "recognizing that they don't know everything."

> **Participant 1.1: "**[Engineers demonstrating humble confidence] may not be experts in every area but they're **confident in themselves** and the team that they're working with and knowing that if they aren't the expert they will find out who is and they're again confident in getting it done. The humble piece being that they're not overly confident. **So they know they'll figure out what to do but they also know that they're not the expert**."

> **Participant 2.2**: "**checking your ego in at the door even if you think you're the smartest person on the planet,** and you're--you know. And, and you've, you've been told that since you were at high school.

These quotes and alignment with self-awareness also demonstrate the strong underlying theme across all participants, which was the idea that an early-career engineer who could defy their generational stereotype was seen as having engineering leadership characteristics. Early-career engineers lacking leadership were described as cocky, emotionally unstable in politically charged situations, and thought they knew more than they did. This finding relates to the self-awareness competency cluster, relating to accurate self-representation, self-confidence, and emotional self-awareness. Defying a stereotype requires that an early-career engineer develop self-awareness of their generational tendencies as well as the awareness of the other generations in the workplace to effectively develop appropriate interpersonal behaviors. Defying ones stereotype requires an ability to adjust behaviors to fit into the perception or "world-view" of another generation. This finding is important for engineering leadership educators because of the importance of incorporating awareness of the perception of early-career engineers in the workplace, but also the awareness of behaviors and actions of the multiple generations within the workforce. One participant in particular was very vocal of the behaviors of the young generation of engineers. This individual was also not native to the United States. Early-career engineers, then, must also understand how both generations and other cultures perceive their behaviors. Developing self-awareness of perceptions of early-career engineers' generational tendencies is important for effective leadership development and subsequent interpersonal interactions in today's global work environment.

Additionally, self-awareness of leadership development as a theme emerged in the pilot study conducted with recruiters hiring entry-level engineering students. The goal of the study was to explore from the recruiter's perspective, the important leadership behaviors associated with engineering leadership demonstrated during a career fair (Handley et al., 2016). The study reported that engineering students who could articulate to recruiters what they learned from a leadership experience rather than only referencing positional leadership to recruiters demonstrated engineering leadership. This finding aligned with the ability of an early-career engineer to be self-aware of their leadership development within various experiences (Handley et al., 2016).

Self-Management. Goleman describes the self-management competency cluster as leaders who can stay "calm and clear-headed under stressful situations" (2014, p. 51). Leaders move from awareness of emotions to managing emotions and display an optimism to get the job done through initiative and establishing trustworthiness (Goleman, 2014; Goleman 1998). Examples of interpersonal behaviors from this study aligning with this competency cluster include behaviors from the groupings: exhibiting a can-do-attitude, emotional intelligence, and building trust. The following quotes demonstrate the importance of building trust as an engineering leader.

> **Participant 1.1:** "And it looked like mission impossible ahead of us but again he would end everything with. **I don't know everything yet. I'm still learning this all but don't worry we'll get there. And I think he just that that those simple words left the entire team with yeah you know what. When this guy says something history shows that he figures it** out so even though he's not giving us a lot of great news like don't worry I solved this this and this. He's generally telling us he's going to figure it out and I think that that just sets the whole tone for everyone"

> **Participant 2.1**: " The interpersonal comes in to play most in a teaming scenario- in this case, how has an engineer stepped up to take on new opportunities, showing their willingness to learn, and has to get that job that he stepped up for done **through building relationships with the team**, **others outside the team, to leverage expertise**. **They have to leave their ego at the door to be able to do this**. They have to build rapport and trust with engineers their senior and corral their experiences to meet the challenges at hand and not necessarily the easy answer."

The element of trust highlighted in this quote and aligning with the Self-Management competency cluster of emotional intelligence, in the researcher's opinion is one of the most important elements of engineering leadership and the interpersonal behaviors associated with engineering leadership characteristics. First, an engineer has to be trusted in their technical abilities. Trust in an engineer's work is central to the profession's code of conduct, which supports the importance of technical abilities as a foundation to engineering leadership. Second, trust is an important element of engineering leadership because of the need to establish trusted relationships to leverage expertise to get a job done. As an example, one participant in this study noted an early-career engineer who did not build trust and relationships to leverage expertise and consequently failed the project, ultimately destroying trust in their technical abilities as well. In the quote above, the participant stated, "When this guy says something history shows that he figures it out." This established trust demonstrates self-management through conscientiousness of acting with integrity and initiative and achievement orientation to get the job done. Trust has been researched as a key aspect of effective leadership within organizations (Brower, Schoorman, & Tan, 2000; Zeffane, 2010). Developing engineering leadership in early-career engineers requires incorporating recent leadership and trust theories, like relational theory of leadership, that incorporate interpersonal trust as a key aspect of the model and implementation. This study shows that to establish a strong technical foundation, early-career engineers must learn from others and to learn from others, interpersonal trust and relationship building is imperative.

Social Awareness. Goleman describes this competency cluster with empathic listening, ability to grasp the others' perspective, political understanding, organizational awareness, and service to others (2014). The interpersonal behaviors aligning with this competency cluster emerge from the humble confidence, demonstrates a positive attitude, effective communication, and active listening behavioral themes associated with this study. Additionally, those engineers who could understand the culture of the workplace and defy stereotypical generational behaviors could demonstrate social awareness through organizational awareness. The following excerpts demonstrate negative generational behaviors of early-career engineers that can be associated with a lack of social awareness.

> **Participant 3.1: "**We you have young engineer come in and they they by let's say 9 o'clock in the morning somebody will start at 7. Let's say 7 o'clock in the morning now. **Then they turn on the computer immediately they go to Facebook. They go to Twitter. They open up their email and they have their IPhones you know on you know the table and they have the text message and then they turn on to our own web site and then pull up our project. Now they start doing work. And they immediately put on a ear phone so they have the music is on. So you tell me if I'm the supervisor walking by and they're looking at the guys. The guy's working or he guy's actually doing his own thing.**
>
> "I think we had a situation even in an interview were one where a candidate is interviewing for a particular position. **They may spend a fair amount of that interview time asking about the next position the next advancement promotion beyond that. It's it's good you know to to have those aspirations but when we're looking somebody we're looking to hire somebody for this job**. And yeah granted hopefully the that they will advance beyond and beyond that but right now I need somebody for this job right. **So too often I think we see folks who are just looking ahead and and they're already looking beyond the immediate job in front of them."**

Once again, these excerpts are indicative of the power of generational differences in the perception of leadership. An early-career engineer whose ability to recognize the corporate culture and defy traditional stereotypes is perceived as having engineering leadership characteristics. Lack of social awareness in an organizational setting impeds the perception of leadership within the context of engineering.

Relationship Management. Goleman (2014) updated this competency cluster title to Relationship Management; however he included the same descriptions. Relationship management includes inspiring others towards a common purpose, influencing others through effective communication, building up effective networks to support an initiative, showing a genuine interest in others, and managing conflicts through perspective taking and creating buy-in towards a shared goal. The interpersonal behaviors from this study aligning with this category include builds relationships, effective communicator, and active listener. The following quote demonstrates the importance of the relationship management for an engineering leader at the early-career stage. This participant goes so far as to say, an engineer without interpersonal skills cannot be a leader.

> **Participant 1.2: "I think a lot of engineers have Asperger's right. They don't have interpersonal skills. I've been in meetings**. We have some of the sharpest people and you'll be in a meeting and some [inaudible] it will be a bad design and they will be well that is stupid right in a room full of people. **Where if somebody else with interpersonal skills would say hey that's beyond that design seems like it seems like it has some issues or faults with it and here are some of the reasons you don't set up your sets that way.** You [inaudible] to be distributed across it so this might be a better solution for it where as opposed to saying your designs sucks. And I'm heard those actual comments in large groups of technical

meetings. Now those people will never be in front of the customer or never lead strong teams so."

This quote and the relationship management competencies of emotional intelligence provide the culminating picture of the description of interpersonal within the context of engineering leadership. Self-awareness, self-management, and social awareness allow an individual to effectively demonstrate the relationship management relevant to any situation. In this study, interpersonal behaviors related to emotional intelligence's relationship management category meant that engineers could effectively communicate across functions, with influence, handle emotionally charged situations and conflict, build strong teams, and leverage the expertise of others to get a job done. Refer to Table seven for a summary of the interpersonal behavioral themes of this study and descriptions of the four competencies associated with emotional intelligence.

This discussion of the connection between the interpersonal behaviors emerging from this study and emotional intelligence brings together both constructs of leadership and interpersonal. Beyond the connection of interpersonal and emotional intelligence as established by the literature review, emotional intelligence has a long history of connecting to effective leadership (Bass & Riggio, 2006; Boyatzis & Saatcioglu, 2008; Gardner & Stough, 2002; Goleman, 2014; Langhorn, 2004; Lopes, Cote, & Salovey, 2006; Rosete & Ciarrochi, 2005; Rubin, Munz, & Bommer, 2005; Wong & Law, 2002). Due to this connection of emotional intelligence, interpersonal, and leadership, the researcher believes this is an important observation emerging from the data. Many of these studies focus on emotional intelligence in a business context, for example, Boyatzis (2001) reports on a longitudinal study of the development of emotional intelligence of MBA students. The results of this study demonstrate the need to also study emotional intelligence within the context of the early-career stage for engineers, and not only within an educational context of business.

Table 7. Interpersonal Behaviors Associated with Engineering Leadership Across All Three Companies and Emotional Intelligence Competencies

**Items are placed in an initial pairing with Emotional Intelligence and the Interpersonal Behavioral Theme associated with this study however overlap is evident and expected.*

Emotional Intelligence Competencies:	**Interpersonal Behavioral Theme**
Self- Awareness: Leaders who recognize how emotions impact job performance. Self-aware leaders know when to ask for help where to focus on building strengths, and self-assurance that stands out (Goleman, 2014)	*Humble Confidence:* - Accepts constructive criticism - Willingness to say they don't know
Self-Management: leaders who can stay "calm and clear headed under stressful situations." Leaders move from awareness of emotions to managing emotions and display an optimism to get the job done through initiative and trustworthiness. (Goleman, 2014)	*Builds Relationships* - Establishes trust *Demonstrates a Positive Attitude* - Enthusiastic, optimistic - Remains positive in the face of challenges *Effective Communicator* - Calm, manages emotions
Social Awareness: Leaders who are empathic listeners with an ability to grasps others' perspectives. Leaders demonstrate a political understanding and an organizational awareness (Goleman, 2014).	*Active Listener* - Listens to others - Asks questions *Effective Communicator* - Adjusts communication to audience
Relationship Management: Relationship management includes inspiring others towards a common purpose, influencing others through effective communication, building up effective networks to support an initiative, showing a genuine interest in others, and managing conflicts through perspective taking and creating buy-in towards a shared goal. (Goleman, 2014)	*Effective Communicator* - Influential *Builds relationships*: - Builds strong teams - Leverages relationships to get the job done

Perhaps a disconnect between emotional intelligence and engineering stems from the stereotypical nature of an engineer, as demonstrated by Mallette's (2005), Robledo's et al. (2009), and Rottman's et al. (2014) work, where engineers failed to connect with traditional notions of leadership and preferred autonomous environments, where energy was stimulated through introverted activities, and much of the work was self-directed. Based on the current study, it is the researchers opinion that these important elements of engineering work not be lost in a focus on emotional intelligence and interpersonal behaviors of early-career engineers. These contextual factors remain important, as early-career engineers must consider these elements of engineering work when employing the interpersonal behaviors emerging from this study. The study did not indicate that engineers should shift from being introverted to extroverted. In fact, the study showed that early-career engineers demonstrating leadership were self-directed and focused to get a job done, worked without having to be told what to do, and effectively managed a problem-solving process. The interpersonal behaviors never focused on being extroverted, but simply focused on connecting with others' expertise on a technical basis to solve a problem. This observation aligns with Bartrum's (2005) work that observing competencies based on abilities alone fail to consider the context by which the behaviors are being judged.

Additionally, the idea that technical skills are foundational to engineering leadership remains important, however, the importance of interpersonal behaviors in successfully completing a job should not be undervalued by the importance of technical skills. Educating and building upon both aspects are important for successful engineers, as evidenced by the changes in ABET curriculum structures and calls by the NAE for professional skills in the successful future engineer. Further, with technology changes that have increased in the use of texting, emailing, and virtual communications the opportunity to practice interpersonal behaviors has decreased. This study supports the importance of incorporating both new technology and “old school” interpersonal interactions like face-to-face communications for engaging with others in the workplace. Further research is needed to explore interpersonal competencies associated with technological advances.

Figure 5.1 outlines a framework for interpersonal behaviors associated with engineering leadership during the early career stage taking into consideration the importance of technical abilities and emotional intelligence. This framework provides an overview of the data analysis for the current study as a summary to consider the implications of this study’s findings. The well-established connection between emotional intelligence, interpersonal skills and leadership is an important research foundation for this study as it demonstrates the need for emotional intelligence education, training, and development within engineering leadership programs. However, incorporating emotional intelligence into engineering leadership curriculum would not be without challenges. The following section describes the implications of this study’s findings for engineers, educators, and training professionals.

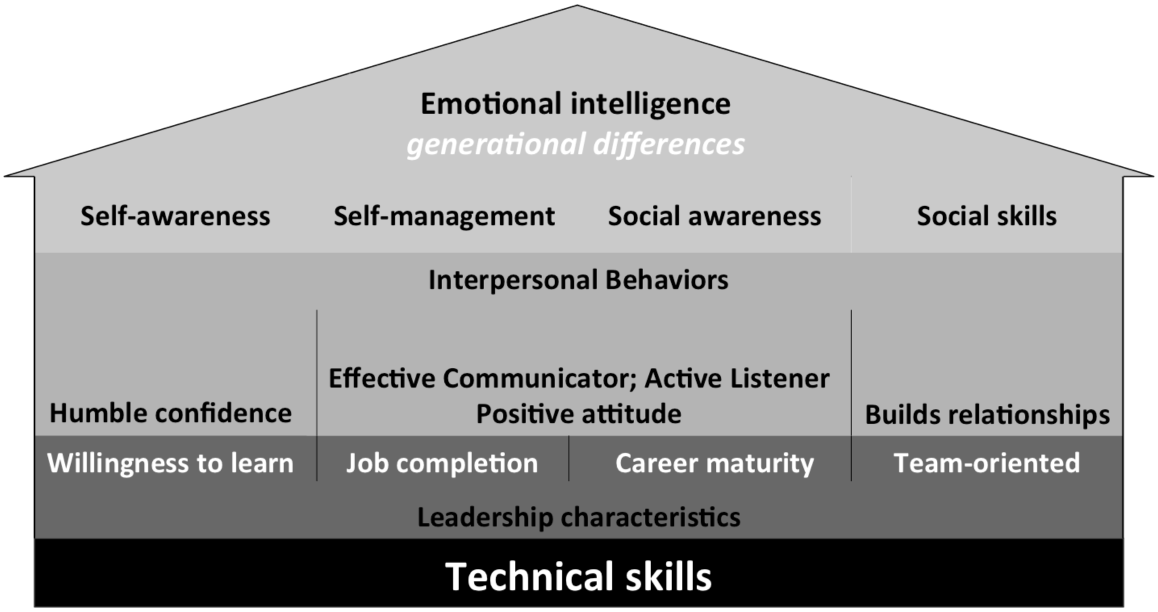


Figure 5.1. A framework for interpersonal behaviors related to engineering leadership at the early-care stage.

Recommendations

Interpersonal as a construct is traditionally difficult to observe and define (Spitzberg & Cupach, 1989). Key findings from this study continue to support the difficulties in identifying and developing interpersonal competencies. These findings align with Spencer and Spencer's (1993) conclusions regarding the difficulty in developing hidden underlying characteristics such as motive, trait, and self-concept. Experts agree that development of these hidden characteristics poses the greatest challenge to educators and trainers (Rothwell & Lindholm, 1999). Aligning the interpersonal behaviors of this study with emotional intelligence does not remedy this issue, as emotional intelligence is also a particularly difficult construct with varying arguments as to validity and difficulty in assessment (Cherniss, Extein, Goleman, & Weissberg, 2010; Murphy, 2006). However, emotional intelligence research suggests a strong and positive base for school-based emotional intelligence programs (Cherniss et al., 2010). The research underscores the importance of educational and training programs that take into account both the cognitive *and* emotional domains of learning which can address the development of hidden underlying characteristics (Dubois, 1993).

Emotional intelligence involves emotional learning, which requires the use of different neural pathways than cognitive learning (Goleman, 1998). As such, different educational and training strategies exist. Cognitive learning involves adding to existing neural pathways, where emotional learning involves creating new neural pathways (Cherniss, 2000). This means that current responses and habits have to be reprogrammed for emotional learning to take place. The emotional learning that takes place not only requires reprogramming learned responses and habits, but also involves change related to core personal identity (Cherniss, 2000). For example, in this study, a key aspect of interpersonal behaviors related to leadership includes accepting criticism. Listening and accepting criticism is likely to challenge a core understanding of one's self and may invoke defensiveness and resistance (Cherniss, 2000). To address these challenges, emotional learning environments require strategies that are significantly different than traditional cognitive learning environments.

Based on an empirically reviewed study of training and development programs implementing emotional intelligence, researchers recommend four key components for successful emotional learning educational and training initiatives: establish a motivation to change, practice over a long period of time, modeling, feedback and support (Cherniss, 2000). This model of learning requires more time, positive and safe relationships between learner and the teacher, trainer, or mentor, and requires encouragement and evaluation to maintain over time (Cherniss, 2000). These types of strategies related to emotional learning require that educators, trainers, and engineering managers consider the impacts of mentor programs, coaching skills, and longitudinal training programs that are experiential in nature.

The following section describes the recommendations and future research for educators, trainers, and engineering managers/leaders. A key research area involving educators, trainers, and engineering managers/leaders would be to complete a comprehensive competency study on engineering leadership for various levels within an organization. The competency model would identify the behaviors associated with all of the competencies related to engineering leadership, where interpersonal competencies and subsequent behaviors would be a category within the competency model. A behaviorally anchored rating scale (BARS) should be explored as a strategy for building the behaviors associated with the engineering leadership competency model. BARS utilizes both critical incident interviews and a quantitatively developed rating scale metric to reduce bias and error by anchoring specific behaviors based on the job analysis (Maiorca, 1997). This would provide educators, trainers, and engineers overseeing, leading, or mentoring other engineers an empirically derived rating scale to utilize in emotional learning programs, training, and performance reviews.

Educators

As a technical field, cognitive learning environments support foundational aspects of engineering education such as science, math, and physics. In a 2012 study, engineering graduates ranked team work, data analysis, problem-solving, and communication as the top four most important competencies emerging from ABET's accreditation outcomes for engineering graduates (Passow, 2012). Passow's (2012) study demonstrates the importance of both the cognitive (data analysis and problem-solving) and the emotional learning (teaming and communication) aspects of engineering curriculum for effective transition to the workplace. Based on the current study, teaming, communication, and problem-solving require interpersonal behaviors to be effective, and therefore would require emotional learning in the classroom. Engineering leadership programs ranging from embedded programs or stand alone certificates or minors, must embrace different educational approaches in order to impact student emotional learning. Classroom structures should involve modeling, experiential learning, practice and feedback (Cherniss, 2000). Engineering leadership programs can start by stimulating a motivation to change by building the awareness of effective interpersonal behaviors associated with engineering leadership.

Research opportunities within engineering education require continued efforts to test emotional intelligence programs in educational environments. The research associated with emotional intelligence programs in schools indicate positive development and school success in students and encourages further research into the uses of emotional learning techniques in the classroom (Cherniss et al., 2010). Additionally, sharing of methods used for meeting the guidelines for optimal emotional learning should be shared within the engineering leadership educational community. Generating ideas such as the use of alumni mentors, coaching techniques, and experiential learning techniques should be tested to determine the best method for engineers to foster emotional learning.

Trainers

The current study's results benefit trainers working to develop leadership in engineers because of the insights for both early-career engineers and later-stage engineers. For training programs designed to develop leadership in early-career engineers, this study reveals the importance of emotional learning environments where training programs should include strategies similar to the education approach noted above. These strategies should include experiential learning techniques, practice and feedback, and support over a period of time. Trainers and other HR professionals must train higher level engineers who may be responsible for on-the-job training, performance evaluations, or mentoring for early-career engineers on the importance of emotional learning environments to develop the interpersonal behaviors identified in this study. Corporate trainers and HR professionals must educate and establish buy-in from higher-level engineers as to the importance of emotional learning in the development of future engineering leaders. Perhaps the best way to create buy-in from higher-level engineers would be to have them complete an emotional intelligence training program involving emotional learning strategies.

Additionally, coaching skills would be essential for higher-level engineers to develop in order to support emotional learning in early-career engineers' development. The emotional learning environment involves strategies to impact behavioral change. The ultimate goal of coaching is to effect sustained change in behaviors that impact performance (Lazar & Bergquist, 2008). This approach for trainers is characterized by developing manager-as-coach which, revolves around providing constructive feedback to impact change and bring out the best in people (Joo, Sushko, & Mclean, 2012). This strategy specifically aligns with participant feedback within the current study.

> **Participant 2.3:** It's not commanded control environment. The expectation is not that you have a supervisory-type manager or supervisory-type leader who intakes a work list from somewhere and then div-ees it out and says okay. You go do this; you do that. Rather it's, there's an expectation that you're going to be given a problem the manager may not be able to solve. They may not be able to tell you exactly how to do it, but you're expected to find the resources and use the guidance you've been given to come to a, come to a solution. **But the leader**

> **then provides a lot coaching along the way** about like well--you know--how, who were you going to? Or how are you approaching this? Are you getting the right types of response from people? You know, what's working? Does this work? Okay that didn't work. Let's think about--you know--what do you think are some other ways that you might be able to attack this problem. **And not just doing the work for the young engineer but guiding them to help discover the answer on their own.**

Development of training programs meeting goals of emotional learning requires conducting research in the transfer of knowledge and skill from the training program. The body of knowledge on transfer of training is broad and ultimately concludes a relationship between cognitive ability and transfer (Blume, Ford, Baldwin, & Huang, 2010). This is a particularly challenging area of research considering emotional learning involves different practices than cognitive learning and results are both longitudinal and prone to setbacks or relapses (Cherniss, 2000). Despite these challenges, research in the effectiveness of emotional learning training programs is essential to understand the best ways in which to develop emotional intelligence and impact interpersonal behavioral change. Additionally, current manager-as-coach research addresses the effectiveness of coach training programs on managers' coaching skills and behaviors (Joo et al., 2012). However, research opportunities exist related to the impact of manager-as-coach strategies in the successful development of emotional intelligence of subordinates or mentees. In particular, research on manager-as-coach strategies within the engineering context is important to foster awareness of the importance of strategies related to emotional learning within a traditional cognitive learning environment.

Current Engineers

The introduction of this study began by noting the professional bodies and engineering curriculum accreditation boards' call for the importance of non-technical skills for future engineering success (ABET, 2014; NAE 2004). This call for the importance of non-technical skills in engineering education and development emerged in the early 2000 resulting in the emergence of various leadership development programs and interest in research. As a relatively new concept within the profession, the continued education and awareness of the importance of non-technical skills in engineering is important. As indicated in the discussion of this study, many of the non-technical skills require a different type of learning, therefore engineers must be open to education, training, and development related to these areas. This shift is indicative of a change within the entire context of engineering education and training and will require a commitment from current engineering leaders and organizations in legitimizing the need for non-technical skills training and the recognition of the difference in learning approaches. Later-stage engineering leaders must also be willing to model effective behaviors associated with ideas such as emotional intelligence as modeling is a key aspect of emotional learning (Cherniss, 2000). Imperative for success is the willingness of engineers to accept these ideas and find ways to ground the concepts within the engineering context. Similar to the findings in Rottman et al. (2014), a blanket approach to applying emotional learning to engineering settings may be detrimental to the successful socialization of both the technical and humanistic (non-technical) elements of the engineering profession. Research and development of competency modeling and associated behaviors developed specifically for engineering leadership will be an important step for acceptance within the engineering profession.

Final Thoughts

This study demonstrates that technical foundations in engineering remain important for demonstrating engineering leadership at the early-career stage. However, key interpersonal behaviors are important for successful engineering leadership during the early-career stage and should not be over-shadowed by the importance of technical knowledge and skill. Interpersonal behaviors evident across all three of the companies in this study related to humble confidence, build relationships, demonstrates a positive attitude, effective communication, and active listener. In addition, those engineers who could defy generational stereotypes were seen as demonstrating engineering leadership during the early-career stage and positive interpersonal behaviors related to the corporate environment. Recommendations from this study include utilizing emotional intelligence as a framework to coach interpersonal behaviors in early-career engineers for engineering leadership. Finally, the increasing research focused on cognitive verses emotional learning provides needed scientific evidence to open conversations with technically focused and naturally skeptical engineers on the importance of and development of non-technical competencies important for engineering work.

Recommendations from these findings suggest that educators, trainers, and current engineering managers implement coaching elements into curriculum and training and development programs to provide sustainable support for development of interpersonal behaviors associated with engineering leadership for early-career engineers. Current engineers, while continuing to stress the importance of technical skills, should embrace the need for development of non-technical skills in early-career engineers demonstrating leadership characteristics.

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Appendix A

Semi-Structured Interview Protocol

1. What does engineering leadership look like during the early-career stage of an engineer?
2. What do you observe about interpersonal skills of engineering leaders at the early-career stage?
3. When observing an early-career engineer, what characteristics demonstrate engineering leadership? What actions lead you to label an entry-level engineer as having engineering leadership?
4. What interpersonal behaviors are viewed as important for early career engineers to demonstrate?
5. Can you talk about a time when an early-career engineer demonstrated positive interpersonal behavior? Describe the situation. What behaviors did you observe?
6. Can you talk about a time when an early-career engineer demonstrated negative interpersonal behavior? Describe the situation. What behaviors did you observe?
7. What does an entry-level engineer who has good interpersonal skills do in an interview? What behaviors demonstrate interpersonal skills during the hiring process?
8. What interpersonal behaviors do you associate with engineering leadership?
9. Which of the interpersonal behaviors important for early-career engineers are important in the identification of potential engineering leaders?

Appendix B

IRB Approval Letter

PENNSTATE

Vice President for Research
Office for Research Protections

The Pennsylvania State University
The 330 Building, Suite 205
University Park, PA 16802

Phone : (814) 865-1775
Fax: (814) 863-8699
Email : orprotections@psu.edu
Web : www.research.psu.edu/orp

EXEMPTION DETERMINATION

Date: October 30, 2014

From: Philip Frum, IRB Analyst

To: Meredith Handley

Type of Submission:	Initial Study
Title of Study:	Interpersonal Behavior in Undergraduate Students' Transition to the Workplace
Principal Investigator:	Meredith Handley
Study ID:	STUDY00001329
Submission ID:	STUDY00001329
Funding:	Not Applicable
Documents Approved:	• 10-29-14 Handley HRP-591 - Protocol for Human Subject Research.pdf (3), Category: IRB Protocol • Handley- IRB Supporting Documents.docx (0.01), Category: Data Collection Instrument

The Office for Research Protections determined that the proposed activity, as described in the above-referenced submission, does not require formal IRB review because the research met the criteria for exempt research according to the policies of this institution and the provisions of applicable federal regulations.

Continuing Progress Reports are **not** required for exempt research. Record of this research determined to be exempt will be maintained for five years from the date of this notification. If your research will continue beyond five years, please contact the Office for Research Protections closer to the determination end date.

Changes to exempt research only need to be submitted to the Office for Research Protections in limited circumstances described in the below-referenced Investigator Manual. If changes are being considered and there are questions about whether IRB review is needed, please contact the Office for Research Protections.

Penn State researchers are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within CATS IRB (http://irb.psu.edu).

This correspondence should be maintained with your records.

Appendix C

Proposal for Use of Human Research Subjects

HRP-591- Protocol for Human Subject Research

Protocol Title: Interpersonal Behavioral Skills Interviews

Principal Investigator:

Meredith Handley, Workforce Education and Development, 814-360-3375, mhh11@psu.edu

Version Date: 4/19/16

1.0 Objectives

1.1 Study Objectives: The purpose of this study is to define interpersonal skills from an employer perspective and determine employer-identified behaviors reflecting interpersonal skills critical for engineering students to transition to the 21st century workforce and potential for engineering leadership roles.

1.2 Primary Study Endpoints: This is a qualitative study

1.3 Secondary Study Endpoints: n/a

2.0 Background

2.1 Scientific Background and Gaps: A consistent descriptor in soft-skill competency needs for today's entry-level workforce is the term interpersonal skills. Review of literature and employer surveys consistently include interpersonal skills as a top category in soft-skill employability factors. Interestingly, a 2009 article concludes that employers rank interpersonal as the fourth most important soft-skill, yet only a portion of schools are emphasizing interpersonal development in their programs. Understanding the exact nature of interpersonal skills may provide educational institutions with an opportunity to develop curricular or co-curricular programming addressing a key aspect of workforce readiness.

2.2 Data: N/A

2.3 Study Rationale: Definitions of interpersonal skills are widespread throughout literature, creating difficulty in developing training or curriculum to address workforce needs.

3.0 Inclusion and Exclusion Criteria

3.1 Inclusion criteria: N/A

3.2 Exclusion criteria: N/A

3.3 Early Withdrawal of Subjects

3.3.1 Criteria for removal from study: N/A

3.3.2 Follow-up for withdrawn subjects: N/A

4.0 Recruitment Methods

4.1 Identification of subjects: Subjects will be identified through contacting recruiter's at the targeted companies. Companies chosen for this study will be large corporations that hire across all engineering majors. Recruiters will identify hiring managers that work with entry-level student workers to answer questions regarding behaviors associated with positive and negative interpersonal competencies.

4.2 Recruitment process: Through established corporate connections through a career office, recruiters will help to identify hiring managers for the interviews.

4.3 Recruitment materials: Consent forms will be produced.

4.4 Eligibility/screening of subjects: An eligibility email will be sent to determine if the selected hiring manager meets the appropriate criteria to complete the interview.

5.0 Consent Process and Documentation

5.1 Consent Process:

5.1.1 Obtaining Informed Consent- N/A

5.1.2 Waiver or alteration of the informed consent requirement: Agreeing to do the interview is the consent of the interviewee. Information of the interviewee will not be disclosed in the study, nor the name of the company the interviewee works with.

5.2 Consent Documentation- N/A

5.3 Consent-Other Considerations- N/A

6.0 HIPPA Research Authorization and/or Waiver or Alteration of Authorization- N/A

7.0 Study Design and Procedures

7.1 **Study Design:** The study is set up as a qualitative study to examine employers' perceptions of positive and negative interpersonal behaviors in students' transition to the workplace. The researcher will utilize interview techniques to obtain the information.

7.2 Study Procedures: Initial steps in the study include identifying the hiring managers and engineering leaders within the company who will serve as the interviewees in the study. The hiring managers must be able to speak towards entry-level performance in the work place. The interviews will be conducted via phone, written answers to the questions, or on campus if the employer happens to be visiting the university and will last no longer than one hour. Interviews will be recorded for transcription and coding.

7.3 Duration of Participation- N/A

8.0 Data and Specimen Banking for Future Undetermined Research- N/A

9.0 Statistical Plan

9.1 **Sample size determination:** This is a qualitative study where the sample size will be determined by saturation. Research typically indicates that saturation occurs between 7-12 subjects.

9.2 Statistical methods: Qualitative analysis will be utilized in this study

10.0 Confidentiality, Privacy, and Data Management

10.1 Confidentiality

10.1.1 Identifiers associated with data and/or specimens: Job titles & company the hiring manager is associated with will be collected in the interview process for coding purposes

10.1.2 Storage of Data and/or Specimens: Data will be stored initially on a voice recorder and on a university issued computer. The data will be stored for the duration of the dissertation.

10.1.3 Access to Data and/or Specimens: Researcher only; May pay an outside source to transcribe the information.

10.1.4 Transferring Data and/or Specimens: If a transcribing company is used, the data will be transferred through audio file. The transcribing company has not been identified.

10.2 Privacy: Working closely with the recruiters at the identified companies, we will ensure the hiring managers receive full-disclosure of the questions to be asked, the purpose of the study, and the confidentiality in obtaining the information. Their names will not be used in the study, nor will the company names.

11.0 Data and Safety Monitoring Plan: N/A

12.0 Risks: N/A

13.0 Potential Benefits to Subjects and Others

13.1 Potential Benefits to Subjects: N/A

13.2 Potential Benefits to Others: Benefits educational institutions to understand the interpersonal behaviors associated with positive transition to the workplace.

14.0 Sharing Results with Subjects:

This dissertation will be shared if the employer would like to review the findings

15.0 Economic Burden to Subjects: N/A

16.0 Number of Subjects: 7-12 subjects

17.0 Resources Available

17.1 Facilities and locations: Interviews will take place via phone in an office on campus or will take place in person in the same office on campus.

17.2 Feasibility of recruiting the required number of subjects: With strong relationships established through the career center, recruiting of subjects will not be an issue. Large companies targeted hiring large numbers of entry-level students across the country. Hiring managers are plentiful and will be easily identified through recruiter relationships.

17.3 PI Time devoted to conducting the research: To complete my PhD I must complete these interviews. Time will be devoted in conjunction with job responsibilities to ensure the interviews are completed in a timely manner.

17.4 Availability of medical or psychological resources: N/A

17.5 Process for informing Study Team: N/A

18.0 Other Approvals:
May have to obtain permission from corporate contacts to conduct interviews

19.0 Subject Stipend (Compenstation) and/or Travel Reimbursements: N/A

20.0 Multi-Site Research: N/A

21.0 Adverse Event Reporting:

21.1 Reporting Adverse Reactions and Unanticipated Problems to the Responsible IRB: In accordance with applicable policies of The Pennsylvania State University Institutional Review Board (IRB), the investigator will report, to the IRB, any observed or reported harm (adverse event) experienced by a subject or other individual, which in the opinion of the investigator is determined to be (1) unexpected; and (2) probably related to the research procedures. Harms (adverse events) will be submitted to the IRB in accordance with the IRB policies and procedures.

21.2 Auditing and Inspecting: The investigator will permit study-related monitoring, audits, and inspections by the Penn State quality assurance program office(s), IRB, the sponsor, and government regulatory bodies, of all study related documents (e.g., source documents, regulatory documents, data collection instruments, study data etc.). The investigator will ensure the capability for inspections of applicable study-related facilities (e.g., pharmacy, diagnostic laboratory, etc.).

22.0 Study Monitoring, Auditing, and Inspecting

22.1 Auditing and Inspecting: The investigator will permit study-related monitoring, audits, and inspections by the Penn State quality assurance program office(s), IRB, the sponsor, and government regulatory bodies, of all study related documents (e.g., source documents, regulatory documents, data collection instruments, study data etc.). The investigator will ensure the capability for inspections of applicable study-related facilities (e.g., pharmacy, diagnostic laboratory, etc.).

23.0 References: N/A

24.0 Appendix: N/A

Appendix D

Audit Trail and Coding

Below you will find examples of the coding and memos utilized throughout the study to complete the data analysis. Code and memo examples were pulled using an export feature in the Dedoose software.

Memo 1/1

Title: Importance of giving facts

Created On: 10/4/2016 by mhh11

Groups: Company 1

Keeping emotions out is coming up as a big theme. A behavior that demonstrates effective interpersonal is giving facts in any situation or team situations. Situations are political and full of challenges. A young engineer who can keep emotions under control is seen as having potential for leadership. They show this through sticking to the facts no matter how emotionally charged a situation is. This is also staying cool, calm, and collected and always sticking to the facts.

Love this quote:

And I use an example if you don't present facts you're just a bunch of bitching engineers that you need to have fact behind your your to substantiate your your theory fi you will.

Codes (1)

- Interpersonal Behavior > Not Emotional

Excerpts (1)

- **Excerpt 1 of 1 from Document:** Company1_2.docx **created on** 9/29/2016 by mhh11

And I use an example if you don't present facts you're just a bunch of bitching engineers that you need to have fact behind your your to substantiate your your theory if you will.

Memo 1/2

Title: Building relationships

Created On: 10/21/2016 by mhh11

Groups: Company 2

For the codes- there is building relationships for the sake of a team, and then building relationships for leveraging behavior. It is important to note that foundationally, engineering leadership at the early career stage is demonstrated most by teaming. What is teaming, what is the background around teaming. The interpersonal comes in to play most in a teaming scenario- in this case, how has an engieer stepped up to take on new opportunities, showing their willingness to learn, and has to get that job that the stepped up for done through building relationships with the team, others outside the team, to leverage expertise. They have to leave their ego at the door to be able to do this. They have to build rapport and trust with engineers their senior and corral their experiences to meet the challenges at hand- and not necessarily the easy answer- perhaps looking into engineering problem-solving literature to figure out where this fits. Where in the leadership literature is a trait about willingness to learn?

Codes (1)

- Interpersonal Behavior > Leverage Behaviors > built relationships to ask for help

Excerpts (1)

- **Excerpt 1 of 1 from Document:** Company2_1.docx **created on** 10/21/2016 by mhh11

He was engaging. He was asking questions of the team. He was asking questions of me. Basically kind of kind of building his network out also at the same time. So not only did he lead the team but he was also gaining interpersonal relationships with the people he was working with.

Interviewer: What did he what did he do to do that to build his network out? What what kind of behaviors or what did you observe that he did to do that?

Interviewee: For that for that he would seek out people in other areas of the of the business. So in our group, we did not have a materials person or a [inaudible] person so you know with his network of people with other younger engineers...he went out and and networked with them to find out who the right materials person was or who the right [inaudible] was or a [inaudible] or a materials person that didn't belong to the team. And then he just reached out specifically to them. So he took the initiatives himself to find the right people to add to the team. In those cases, you know you need a materials person to do the material behavior and you need a [inaudible] person, you need a [inaudible] person. So he took that initiative to kind of build the team out. And you know every step of the way whenever he was doing that he would kind of check check with me as his manager; check with a few other people who had led teams like this you know recenlty and make sure that he had the right team in place.

Memo 2/2

Title: Theme with Company 3

Created On: 11/28/2016 by mhh11

Groups: Company 3 Memo

There seems to be a very strong language of fitting into the culture with Company 3, and breaking the stereotype of young engineers. Review these again to see some of these themes. May need to make a code for it. Seem so much more rigid and not as supportive as some of the other conversations. Seems very closed.

Appendix E

Participant Descriptions

Participant	1	2	3	4	5	6	7	8	9
What is your current role?	Manager	Sub-section Manager	Principle Engineer	2nd Line Manager	Software Manager	Chief Technology Officer	Manager of Engineering Eesign Group	Project Engineering Manager	Project Manager
How long have you been working in this role?	5-6 years	9 years	2.5 months	6 months	5 years	6 years	1 Month	2.5 years	20 years
How long have you been in a management or leadership role?	8 years	9-10 years	20 years	8+ years	10-20 years	30+ years	10 years	30 years	25 years
How many engineers do you currently supervise?	27	8	consulting role/than mgmt role currently/ mentor	24	20	200 sr. engineers/ 1900 oversight	12	200	80
How many over your career?	78	150	200-250: various degrees	100+	200-300	3-4000s all levels and disciplines	75	1000	100's
Promoted	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worked at numerous companies	no	yes	no answer	Yes	Yes	Yes	No	Yes	yes
Held a variety of positions	yes	yes	no answer	yes	Yes	Yes	Yes	Yes	Yes
Acted as a mentor to young engineers	yes	yes	Yes	yes	Yes	Yes/Personally 12; but coordinate a mentor program	Yes	Yes	Yes
Would you describe yourself as: highly self-aware, good verbal communicator, patient, very reflective	good verbal communicator, patient	highly self-aware, good verbal communicator, patient	n/a	very reflective	Patient, reflective	listener, communicator	yes	Yes	Yes

VITA

MEREDITH HANDLEY

Education

Ph.D, Workforce Education and Development (2017)

Pennsylvania State University, University Park, PA

Master of Science, Sports Administration (2005)

Georgia State University, Atlanta, GA

Bachelor of Science, Management (2002)

University of North Carolina at Wilmington, Wilmington, NC

Professional Experience

Associate Director for Engineering Leadership Development, Instructor (2015-Present)

School of Engineering Design, Technology, and Professional Programs

College of Engineering

Pennsylvania State University, University Park, PA

Managing Director, Career and Corporate Connections (2010-2015)

Assistant Director, Career and Corporate Connections (2008-2010)

Smeal College of Business

Pennsylvania State University, University Park, PA