

Career Goals and Actions of Early Career Engineering Graduates

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Abstract

Much of engineering education research focuses on improving undergraduate engineering education. However, in order to help new engineers prepare for and successfully transition to the workplace, and therefore improve retention within the engineering practice, it is vitally important to understand the experiences of these early career engineers. The purpose of this study is to identify and explain the career goals and actions of early career engineering graduates. To accomplish this goal, this research addressed the question “What factors influence early career engineering graduates’ career goals near the end of their undergraduate engineering studies, career-related actions taken in the subsequent four years, and their future career plans?”

Data were predominantly qualitative. Thirty participants were interviewed and surveyed near the end of their undergraduate studies, then completed pre-questionnaires and an interview as early career engineering graduates. Participants were graduates from three different universities and were diverse with respect to sex, race, and undergraduate major. Data analysis was framed by Social Cognitive Career Theory, as developed by Lent, Brown, and Hackett, and followed case study methods.

Results show that early career engineering graduates had diverse goals and interests, but similar influencing factors. They generally wanted to find appealing work and acted towards that goal. Relationships with faculty and expectations of positive outcomes heavily influenced participants’ decisions to pursue graduate degrees, and family commitments geographically constrained career choices while also increasing the desire for stability. The economic downturn impacted job availability for most participants, but many participants were able to broaden their career searches to find interesting and fulfilling work. Participants that exhibited an ability to adapt to changing conditions reported the greater levels of satisfaction with their careers.

The findings of this research provide important information to engineering educators and employers as they mentor the next generation of engineers, and early career engineering graduates themselves as they seek to achieve their goals.

Dedication

To my parents, for teaching me the value of an education.

To my husband, for never letting me give up.

And to my daughter, for motivating me to finish on time.

Thank you.

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1 Introduction

To quote the title of a recent journal article: “An engineering major does not (necessarily) an engineer make” (Lichtenstein et al., 2009). And yet, much of the research on engineering pathways focuses on the Bachelor of Science degree in engineering being the end point. In contrast, this research looks beyond the engineering degree to explore the career paths of early career engineering graduates. Using case study methodologies, I qualitatively and longitudinally examined 30 early career engineering graduates’ career goals and actions. I looked first at goals and actions at the end of undergraduate programs and then again when the same participants were early career professionals. The sample includes graduates of engineering programs at Large Public University (LPub), Suburban Private University (SPri), and Technical Public Institution (TPub). This work is part of the larger Engineering Pathways Study, and also draws data from the Academic Pathways Study. To maintain consistency with these studies, throughout my work I adopt the same pseudonyms for schools and participants used in those studies.

1.1 Need for this Research

Despite efforts towards change, the engineering profession continues to struggle with recruiting and retaining a pipeline of students (National Science Board, 2007; Ohland et al., 2008) and experienced, practicing engineers (Frehill, Di Fabio, Hill, Traeger, & Buono, 2008). Particularly with regard to students, a lack of understanding of engineering careers has been shown to be a contributing factor to departure from engineering before and after earning undergraduate degrees. For example, even among senior engineering students, there is confusion about what engineers do and what engineering is (Matusovich, Streveler, & Miller, 2009). One survey found that 44 percent of senior engineering students were unsure if they wanted to pursue a career in engineering, and 14 percent were definitely not intending to pursue an engineering career

(Lichtenstein, et al., 2009). Attrition continues into engineering practice. For example, a study by the Society of Women Engineers found that about 71 percent of men and 61 percent of women were employed as engineers three years after graduating with engineering degrees, and about one-third of women and half of men were in engineering jobs 18 to 20 years after earning their engineering degrees (Frehill, et al., 2008). In order to better prepare graduates for engineering careers and improve retention, many calls have been issued to change the nature of engineering education (Jamieson & Lohmann, 2009; National Academy of Engineering, 2005). While change is needed, these calls often focus on the opinions of experienced engineers, educators, and policy makers and fail to consider the perspectives of early career engineers, the very people that can best provide insights into the ways they have and have not been prepared by academic programs to succeed

Unfortunately, little is known about the experiences of early career engineers. We do know they face new challenges with unstructured, real world applications of their technical knowledge for which they may not have been prepared in school (Eraut, 2007; Korte, Sheppard, & Jordan, 2008; Polach, 2004). Additionally, they must navigate unfamiliar systems to access the resources they need, and often encounter diverse supports and barriers to which they do not know how to respond (Brunhaver, Korte, Lande, & Sheppard, 2010). At the same time, early career engineers may be still figuring out their identities and goals for their careers (Arnett, 2004; Lichtenstein, et al., 2009; Matusovich, et al., 2009). Therefore, in order to help new engineers prepare for and successfully transition to the workplace, and therefore improve retention within the engineering practice, it is vitally important to understand what factors shape early career engineers' decisions.

1.2 Purpose of the Study

To expand the knowledge base on the experiences of early career engineers, the purpose of this study is to identify and explain the career goals and actions of early career engineering graduates. Career goals and the associated actions are particularly important because “by setting goals, people help to organize and guide their behavior, to sustain it over long periods of time even in the absence of external reinforcement, and to increase the likelihood that desired outcomes can be obtained” (Lent, Brown, & Hackett, 1994, p. 84). Essentially, goals are a crucial source of

motivation for action. This study is framed using Social Cognitive Career Theory (SCCT) (Lent, et al., 1994) because of the theory's utility in describing the relationship among career goals and actions and various other important motivational constructs. Specifically, SCCT identifies pathways from goals to actions and factors that influence these various pathways.

My investigation of career goals and actions is accomplished through a longitudinal, qualitative study utilizing data from both the Academic Pathways Study (APS) and Engineering Pathways Study (EPS). The data primarily include interviews with junior and senior engineering students from APS and then follow-up interviews four years later from EPS. APS survey data from senior year and EPS pre-questionnaires also inform qualitative findings.

1.2.1 Research Questions

Through this research study, I offer explanatory insights into the career choices of early career engineering graduates. In particular, I address the following over-arching research question:

What factors influence early career engineering graduates' career goals near the end of their undergraduate engineering studies, career-related actions taken in the subsequent four years, and their future career plans?

Identifying these factors during the early career phase will explain why early career engineering graduates form certain goals and why they act in various ways to advance their careers. To guide me to an answer to this broad question, I developed a series of sub-questions:

- How do graduating seniors describe their early career goals and their plans for achieving those goals?
- What actions have early career professionals taken to meet the career goals they set as graduating seniors?
- How do early career professionals describe their career goals for the next phases of their careers and their plans for achieving those goals?
- How are these goals and associated actions or plans related to prior career goals and actions?

By breaking the larger question into sequential parts, these sub-questions provide a roadmap for analysis and for the reporting of results.

1.3 Significance of the Study

This research is significant because it develops new knowledge about the experiences of early career engineering graduates and particularly with regard to explanatory insights on career goals and actions. Without understanding the experiences of early career engineers, engineering educators risk ill-preparing their students for the students' intended careers (Brunhaver, et al., 2010; Korte, et al., 2008). The experiences of early career engineers provide current, immediate feedback on the functioning of engineering programs in an ever-changing and rapidly globalizing workforce market. Considering that many engineering faculty do not have current work experiences outside of academia (Morell & DeBoer, 2010), links to recent graduates are vital. In subsequent chapters I will not only identify common goals and actions, but offer the participants' explanations for their decisions. This research will allow for academic institutions to better prepare their graduates to achieve their goals, will help employers to better support their employees and understand the needs of early career engineers, and will provide engineering graduates with exemplars and guidance to achieve their goals.

This significance of this research is strengthened by its longitudinal and qualitative design. The longitudinal aspect of the study allows me to track the changes in goals and actions over time, to see how participants grow and react to various external factors. The qualitative nature of the data allows the participants to express their goals and experiences in their own words instead of being limited by fixed quantitative questions.

1.4 Limitations

The limitations of this research are similar to other studies involving human subjects although the duration of the longitudinal study magnifies some limitations. For example, this work relied on volunteers who were willing to respond to researchers not just once but repeatedly over an eight-year period. Unfortunately, some participants opted out of participating or lost contact with researchers along the way. Additionally, participants were recruited from three institutions. Although the institutions themselves represent diversity, they may not fully represent the breadth of college experiences across the nation. Finally, some of the data used for this study were existing data from a prior research project. While these data are rich and detailed, the data collection instruments did not explicitly address my research questions or framework in great

detail and there were additional questions I might like to have asked. However, none of these limitations diminishes the value of this study and instead provide avenues for future research. These limitations and their implications are further addressed in Chapter 3 and Chapter 6.

1.5 Definitions

While the SCCT framework defines a number of constructs central to this study, as presented in Chapter 2, there are a number of definitions that are important to establish at the outset. For this study, an **early career engineering graduate** is defined as one who earned a bachelor's degree in engineering in the past five years, regardless of present employment field or status. At the time of early career interviews, most of the early career engineering graduates participating in this study were four years past their bachelor's degrees, though some graduated more recently. All participants in this study are early career engineering graduates since completion of an engineering degree was a selection criterion. Details on the demographics of study participants can be found in Chapter 3. An **early career professional** is anyone in the early stages of his or her career in any professional field, while an **early career engineer** is specifically employed in an engineering profession. While all participants in this study meet the definition of an early career engineering graduate, a single participant may also meet the definitions of early career professional and early career engineer. The purpose of defining these terms and distinguishing between them is that this study specifically looks at early career engineering graduates, who may not identify themselves as being employed as engineers. Study populations in the literature are commonly defined by employment status rather than degree earned (Brunhaver, et al., 2010; Eraut, 2007; Trevelyan & Tilli, 2008).

A **career goal** is a "determination to engage in a particular activity or to effect a particular future outcome" (Lent, et al., 1994, p. 85). Goals include aspirations to particular jobs or job functions, such as being a team manager or starting one's own firm, as well as ideal job characteristics, such as being involved in certain cutting-edge projects, working with the public, having a flexible schedule, attaining a certain salary, or working in a specific location. In this study, career goals would also include educational or licensure goals related to employment status, such as desiring a PhD to enter academia, an MBA to facilitate advancement in management, or gaining a professional engineer license to further one's career.

A **career action** is an act taken towards advancing one's career or achieving a career goal. A participant may attend training courses in order to be qualified to work on certain projects, or join professional organizations to facilitate networking before seeking a change in employment. While becoming a licensed professional engineer would be a career goal, gaining the requisite experience and then studying for, registering for, and sitting for the exam would be the actions taken towards achieving that goal.

A **career influence** is any factor that a participant identifies as impacting his or her career decision making. According to SCCT, factors include self-efficacy, outcome expectations, interests, and contextual influences proximal to choice behaviors (Lent, et al., 1994). These contextual influences may include geographic restraints, economic conditions, or socializers such as family members, mentors, or coworkers.

1.6 Summary

Little is known about the experiences of early career engineers, yet engineering educators cite better preparing engineering graduates as one of the major motivations for broad reform across the field. This multi-case study longitudinally and qualitatively explores the career goals and actions of 30 early career engineering graduates within the Social Cognitive Career Theory framework in order to better describe and explain the factors influencing career choices among early career engineering graduates. This work will have broad impacts for engineering educators and administrators as they prepare the next generation of engineering graduates, engineering employers as they hire and train new engineers, and early career engineering graduates then as they seek to better achieve their goals.

2 Literature Review

The purpose of this literature review is to present the relevant research that informs my study. First, the theoretical framework of this study, Social Cognitive Career Theory (SCCT), is presented, with a discussion of applications of the theory in various settings. Next, I present recent works on emerging adults and early career engineers as my participants fit within these groupings. I also describe how my work fits with the previous literature findings from the Academic Pathways Study. Finally, I will explain the importance of qualitative methods and a longitudinal study design in answering the research question.

2.1 Social Cognitive Career Theory

Lent, Brown, and Hackett developed Social Cognitive Career Theory (SCCT) based on Bandura's Social Cognitive Theory (Lent, et al., 1994). Social Cognitive Theory posits that "through exercise of forethought, people motivate themselves and guide their actions in an anticipatory proactive way" (Bandura, 1991, p. 248). In other words, people make choices based on prior experiences and expected outcomes. Social Cognitive Theory could be used to analyze development across a person's lifespan (Bandura, 1989). SCCT was then designed to "adapt, elaborate, and extend those aspects of the general theory that seemed most relevant to the basic career development processes" (Lent, et al., 1994, p. 80). This means that Lent et al. sought to customize Bandura's broader theory specifically to explain early career decisions. The SCCT model was designed primarily to explain how people in late adolescence and early adulthood prepare for and implement career choices. This includes a range of activities from selection of potential career fields to obtaining employment. As higher education is often a prerequisite for entering various careers, the model was initially designed to also be applicable to academic behavior, such as major choices and persistence in education. The model is shown in Figure 2-1 below.

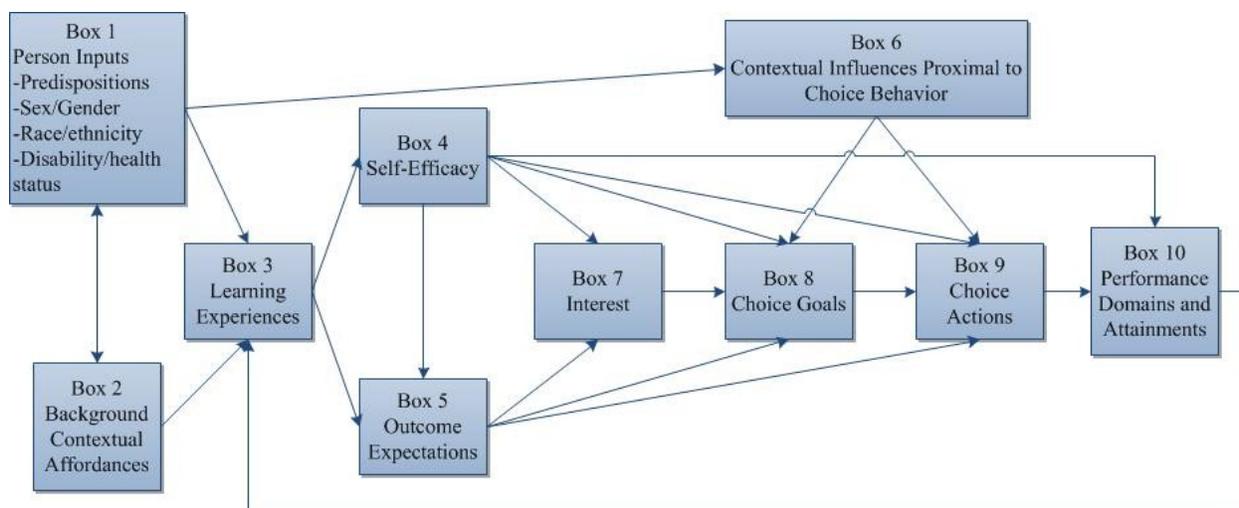


Figure 2-1. Social Cognitive Career Theory (Lent, et al., 1994).

The *Person Inputs* to the model (Box 1) include characteristics such as sex or gender, race or ethnicity, and disability or health status, as well as the person’s predispositions. Predispositions include innate tendencies such as an inclination towards optimism or pessimism. *Person Inputs* influence, and are influenced by, *Background Contextual Affordances* (Box 2), such as prior opportunities, experiences with role models, or cultural socialization that occurred in the person’s past. Both *Person Inputs* and *Background Contextual Affordances* feed into *Learning Experiences* (Box 3), which impact *Self-Efficacy* (Box 4) and *Outcome Expectations* (Box 5). *Learning Experiences* are past occurrences that can shape a person’s *Self-Efficacy* or *Outcome Expectations* related to a future task. *Self-Efficacy* is “a dynamic set of self-beliefs that are specific to particular performance domains” (Lent, et al., 1994, p. 83), or a person’s assessment about his or her ability to perform a task. *Self-Efficacy* may be only moderately related to objective assessments of performance, meaning that it is not actual success that matters but rather perceptions of success. *Outcome Expectations* are beliefs about the physical, social, and self-satisfaction consequences of a proposed action, and include the impact of a person’s values. *Self-Efficacy* and *Outcome Expectations* influence *Interests* (Box 7), which lead to *Choice Goals* (Box 8), which lead to *Choice Actions* (Box 9). *Interests* are attractions to or affinities for certain topics, tasks, or career fields.

Choice Goals and *Choice Actions* are the central constructs for this research study. A *Choice Goal* is “the determination to engage in a particular activity or to effect a particular future

outcome” (Lent, et al., 1994, p. 85), or the person’s decision to pursue a certain path. These goals are then pursued through a person’s choice of actions, i.e., *Choice Actions*. *Choice Goals* and *Choice Actions* are also influenced by *Contextual Influences Proximal to Choice Behaviors* (Box 6). For simplicity, I will refer to *Contextual Influences Proximal to Choice Behaviors* as *Contextual Influences*. *Contextual Influences* may include perceptions of supports or barriers, such as people or institutions, which help or hinder a particular goal or action. *Contextual Influences* are influenced by *Person Inputs* (Box 1), as well as indirectly by *Background Contextual Affordances* (Box 2). *Choice Actions* (Box 9) and *Self-Efficacy* (Box 4) impact *Performance Domains and Attainments* (Box 10), which are the actual outcomes of the *Choice Actions*. *Performance Domains and Attainments* feed back into *Learning Experiences* (Box 3) as the cycle begins again for the participant’s next decision. This feedback loop is important because each experience will influence a person’s self-efficacy and outcome expectations when next faced with a similar situation (Lent, et al., 1994).

Because SCCT was designed to model the early phases of career choice (Lent, et al., 1994), it has been a popular theory among researchers studying college students and adolescents. However, use of the theory has expanded beyond college settings. The bulk of the existing research has been quantitative to confirm various pathways proposed by the model. The following subsections will describe some of the work that informs my research, particularly studies using SCCT with engineering students, studies using SCCT in the workplace, and some of the few studies that have used SCCT qualitatively. Based on the evidence presented below, this model is useful and highly applicable to a study of career goals and actions among early career engineers.

2.1.1 SCCT in Engineering

Many quantitative studies have been conducted over the past two decades to verify the pathways proposed by the SCCT model among college students, and several of those have directly studied engineering students. These studies show that SCCT is a valid and valuable theory for explaining career-related choices among engineering students.

Across these studies, the dependent variable is commonly taken to be professed intention to graduate with a degree in engineering. Depending on the study, this intention is interpreted as either a goal or action. The preceding boxes in the model then represent independent variables

under investigation. The following paragraphs include some examples of findings from current literature.

Self-efficacy has been a commonly studied construct in the SCCT literature. The broad relationship between self-efficacy and persistence in engineering was confirmed through a study which surveyed high school girls at the time of participation in a science, math, and engineering conference and again approximately four years later (Nauta, Epperson, & Mallinckrodt, 2003). Participants that had selected and persisted in an engineering major at the time of the follow-up survey were more likely to report high self-efficacy and anticipate positive outcomes of earning a degree in science, math, or engineering than those that chose other majors. The SCCT model was generally found to be a good fit for explaining the professed persistence goals for underrepresented minority engineering students (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010). However, in this same study, self-efficacy was found to only indirectly impact goals through outcome expectations and interests. This finding does not support the direct pathway in the model from self-efficacy to goals. Another study compared the importance of self-efficacy and interests to race, sex, and university type among introductory engineering students at three universities, including two historically black universities and one predominantly white university. Social cognitive variables, such as self-efficacy and interests, were found to be far more predictive of persistence goals than university type or of students' sex (Lent et al., 2005; Lent, Schmidt, Schmidt, Gloster, & Wilkins, 2003). Social cognitive variables explained 55 percent of the variance in persistence goals, while university type explained one percent and sex was insignificant. This suggested that, for the institutions studied, race and sex were not significantly related to persistence.

Other studies used SCCT to explore perceptions of supports and barriers, or contextual influences in the SCCT model. For students in an introductory engineering course, contextual influences of supports and barriers may be better portrayed as influencing goals and actions indirectly, through self-efficacy, rather than directly (Lent et al., 2003). Examples of supports in this study include mentors of the same race and sex, as well as organizations to specifically support women and minority engineering students. The primary barrier was the perception of engineering as a white male environment. Trenor et al. initially found no difference in women engineering students' perceived supports, barriers, or major choice goals across ethnicities at a highly diverse institution according to a quantitative survey (Trenor, Yu, Waight, Zerda, & Ting

Ling, 2008). Unlike the previous studies that only used quantitative data, Trenor et al. subsequently conducted interviews that did reveal some differences by ethnicity. For example, women of color reported struggling with conflicting role expectations, while Hispanic women struggled with a lack of college-educated role models in their families. This study highlights the ability of qualitative research to identify and explain differences that might not be anticipated in purely quantitative studies.

These studies show the usefulness of SCCT to answer a variety of research questions about the experiences of undergraduate engineering students. While some proposed pathways were questioned, self-efficacy, interests, and contextual influences such as supports and barriers were consistently found to be important to students' persistence goals and actions.

2.1.2 SCCT in the Workplace

When SCCT has been used as a framework to study career choice in the workplace, it has often been used to study underrepresented populations in a specific field, such as women in science or engineering, or underserved populations such as cultural minorities or those with disabilities. For example, studies have explored differences between women that remain in engineering careers and those that leave (Fouad & Singh, 2011), the career experiences of lesbian women and gay men (Morrow, Gore, & Campbell, 1996), the difference in perceived supports and barriers for male and female chemists (Nolan, Buckner, Marzabadi, & Kuck, 2008), the contextual affordances in terms of cultural differences, resources, and barriers of Appalachian individuals (Bennett, 2008), barriers experienced by people with disabilities (Fabian, Beveridge, & Ethridge, 2009), and self-efficacy beliefs among schizophrenics (Harris et al., 2010). These studies all found that SCCT was a good fit for explaining their participants' experiences. Generally, the Person Inputs of minority status led to Contextual Influences of discrimination, negatively impacting Self-Efficacy and eventually diminishing Choice Goals and Actions. However, participants with contextual supports from their social network, strong Interests, or resilient Self-Efficacy beliefs were better able to meet their goals.

Career choice counseling is a particular area where Brown and Lent have recommended SCCT as an appropriate framework (1996). Several articles have been published to advise counselors in applying the theory, with case studies in career interventions for female convicts (Chartrand & Rose, 1996), battered women preparing to leave abusive relationships (Morris,

Shoffner, & Newsome, 2009), individuals with severe mental health disorders (Fabian, 2000), and people living with HIV/AIDS (Trujillo, 2010). Interventions to ease the work-family conflict of teachers have also been developed using SCCT (Cinamon & Rich, 2005). Generally, researchers recommended that counselors consider the pathways of the SCCT model to improve goals and actions. Counselors ought to consider how an individual's self-efficacy, outcome expectations, interests, and other factors influence his or her goals. These studies all show that SCCT does not merely explain experiences, but can also be used effectively to guide interventions to assist in goal attainment.

Together these works demonstrate the broad applicability of SCCT as a valuable theory for understanding career choices in populations other than college students, as well as for informing effective career counseling. However, these existing works focus on barriers to career achievement relative to some minority status, and do not often look broadly across the population. Therefore, the need still exists to understand how and why the relationship between goal and actions plays out among more typical populations of work professionals in the early years of their careers.

2.1.3 Qualitative Data and SCCT

Pathways through the SCCT model have been extensively explored and validated using quantitative approaches. Additionally, several studies have incorporated qualitative data to offer depth of understanding and to better explain how and why people make particular choices. One common method has been to administer traditional quantitative surveys followed by qualitative explorations of the results. As mentioned previously, Trenor et al. utilized SCCT in a mixed methods study, interviewing women engineering students to explain quantitative survey results in depth (Trenor, et al., 2008). Similarly, a survey of college students that were prospective sports coaches revealed significant perceived barriers but positive expected outcomes among minorities (Cunningham & Singer, 2010). Researchers then followed up with focus groups to further explore this finding, determining that minority participants expected barriers in all careers, but the other positive outcomes in coaching.

Several studies have also used SCCT in purely qualitative ways. This approach offers the benefits of greater depth than quantitative methods. Through interviews, for example, female associate professor's decisions to actively pursue full professorship were found to be moderated

by self-efficacy, outcome expectations, and environmental factors (Pruitt, Johnson, Catlin, & Knox, 2010). Similarly, another study drew from interviews grounded in SCCT to recommend career counseling techniques for battered women (C. Brown, Trangsrud, & Linnemeyer, 2009). These women's contextual influences of a history of violence led to lower self-efficacy and poor outcome expectations, which in turn resulted in low career goals and actions. Interviews were also used to explore the contextual supports and barriers experienced by new hires at several engineering firms (Brunhaver, et al., 2010). A study of international doctoral students that had secured academic positions used written narratives, open-ended questionnaires, and focus groups to provide a retrospective look at their job search process (Wang, Lo, Xu, Wang, & Porfeli, 2007). These studies show that SCCT can be a highly informative framework in a qualitative exploratory or explanatory setting, yielding deep and rich findings that would not be answered by quantitative work alone. For example, Trenor et al.'s initial survey found no difference among racial groups, but interviews exposed nuanced differences in the experiences of women engineering students linked to ethnicity (Trenor, et al., 2008). More work is needed to expand the body of knowledge of early career engineering graduates.

2.1.4 SCCT in a Qualitative Study of Early Career Engineers

One recent study using SCCT that is closely aligned with and that informed my research is a study by Brunhaver et al. that used qualitative interviews to explore the supports and barriers that new engineers faced in the workplace (Brunhaver, et al., 2010). This study is particularly relevant to my work because it is a similar population, although focused on a different area of the SCCT model. This study included 59 participants from four different companies in varied fields of engineering who had been in the workplace for six months to two years. Framed in SCCT, the analysis identified supports and barriers to the participants' career progress due to the company, managers, and coworkers. All participants reported at least one support and one barrier, and some participants reported these supports or barriers influencing their job satisfaction. The authors conclude that 1) companies can better manage the transition process for new engineers, 2) engineering programs can provide students with better approximations of engineering practice, and 3) engineering students could better investigate potential employers. This work directly informs my work because, according to SCCT, both career goals and actions are influenced by contextual influences (Lent, et al., 1994), such as Brunhaver et al.'s supports and

barriers. Our studies have the similar goals of examining the experiences of early career engineers to inform employers, educators, and young engineers to help them best support the successes of early career engineers. The work of Brunhaver et al. informed the instruments used in my study and also provide a comparative backdrop for my study and particularly for my findings.

2.2 The Emerging Adult

While my research is firmly grounded in the constructs of SCCT, literature addressing the emerging adult life stage also offers insights to understanding the experiences of my study participants. Arnett defined the period between adolescence and young adulthood, roughly the ages of 18 to 25, as “emerging adulthood” (2004). The participants in my research were 22 to 24 years old when they finished their bachelor’s degrees, and 26 to 28 years old at the time of their early career interviews. In contrast to previous generations, Arnett claims that entry to adulthood is not marked by significant life events like marriage, parenthood, or moving away from home. Instead, adults and emerging adults tend to associate becoming an adult with taking responsibility for oneself. This includes responsibility in relationships, finances, and worldviews (Arnett, 2004).

In the work arena, emerging adulthood is marked by having an uncertain career path. Many emerging adults have not decided on a career path by the time they graduate college, or even finish graduate school. As emerging adults enter young adulthood however, they find a career path that they are satisfied with and plan to continue in. Arnett found a marked difference in participant responses to the question “How do you see your life ten years from now” based on participant age (2004, p. 152). Young adults in their late twenties gave clear, work-related answers about their plans. Emerging adults in their early twenties were much more vague and indicated that they either wanted to change paths or were uncertain about what they wanted to do (Arnett, 2004).

While Arnett does not explicitly discuss engineers, his work is quite applicable to early career professionals with engineering degrees. Previous research has shown that even graduating seniors in engineering might not have a clear perception of what a career in engineering entails (Matusovich, et al., 2009), and one study reported that 44 percent of graduating seniors were not

sure if they wanted to pursue a career in engineering (Lichtenstein, et al., 2009). Based on these studies and the ages of my participants, it would be reasonable to conclude that many participants in my study were transitioning from emerging adulthood to young adulthood during the four-year study period. Therefore, Arnett's findings are particularly valuable in two ways. First, I might expect to see varying degrees of career certainty among my participants and changing certainty over time. Second, Arnett's work suggests a holistic way of looking at emerging adults that draws attention to the participants' experiences outside the workplace that may influence their career choices.

2.3 The Early Career Engineer

Moving from school to the workplace is quite an adjustment in any discipline (Arnett, 2004), and engineering is no different. As graduating engineering students frequently do not know what engineers do (Matusovich, et al., 2009), this transition can be challenging. Studies have explored the roles that the employer, nature of the work, or workplace culture play on a new engineer's experiences. Trevelyan and Tilli repeatedly surveyed recent Australian engineering graduates in two- to three-month intervals about their experiences (2008). Analysis showed that about 60 percent of early career engineer professionals' time at work is spent interacting with others, highlighting the importance of social interaction in engineering practice. In another study involving in-depth interviews with eight engineers at single firm that had been employed for about eight to ten months, several themes emerged (Polach, 2004). Engineers appreciated their firm's easy-going atmosphere, but were concerned about a lack of clarity on how they should spend their time. New engineers also acknowledged the importance of developing friendships at work, which was challenging for them, as well as building their social networks outside of work in their new city. Due to a lack of consistent feedback, many participants were uncertain if their performance was acceptable or felt guilty for not producing more. When they settled more into their positions, they expressed gratification at being able to finally contribute and overall satisfaction with their first year of work (Polach, 2004). These findings are supported by Eraut's work with early career engineers, nurses, and accountants in England (2007). Through extensive interviews and observations, he found that formative assessment and feedback, optimally challenging assignments, and a supportive culture were crucial to enhance workplace learning.

In studies conducted by the Center for the Advancement of Engineering Education, the two primary areas of study with early career engineers involved applying technical expertise and navigating the social and organizational systems in the workplace (Atman et al., 2010). Young professionals faced technical problems that were more complex than those they had dealt with in school (Korte, et al., 2008). Teamwork was different, as well. Student projects had a clear beginning and end, and were rarely interdisciplinary. New engineers were often added to existing projects with teammates of varying experience level, varying disciplinary backgrounds, and sometimes even varying employers (Atman, et al., 2010). Transfers kept some engineers from seeing projects through to their conclusion (Korte, et al., 2008). Some managers and coworkers were supportive and helpful; others were not (Brunhaver, et al., 2010). New hires also struggled to find their roles in their companies and to see the bigger picture (Brunhaver, et al., 2010; Korte, et al., 2008). Finally, engineers needed to adjust to the importance of communication and documentation in the professional world, including communication with non-engineers (Atman, et al., 2010; Korte, et al., 2008).

From these studies, we know that the first years of an engineering career are a time of great adjustment and growth. Several of the studies cited here discuss the roles that the employer, nature of the work, or workplace culture play on the young engineer's experiences, but they do not explore how the engineer shapes his or her own career path. Therefore, further study is needed into the active role that early career engineers play in setting and carrying out their own career goals with consideration for the types of experiences highlighted by existing research.

2.4 Academic Pathways Study

My study is longitudinal in that it draws on both the previous college experiences and goals of the participants as well as their experiences as early career engineering graduates. In order to capture their student experiences, I have used some existing data from the Academic Pathways Study (APS), and key findings from that work that are critical to understanding career choices. APS was a multi-year, multi-institution study designed to understand the experience of learning engineering from the student perspective (Atman, et al., 2010; Sheppard et al., 2004). Research questions were related to the development of engineering skills, engineering identity, education, and workplace preparedness. Participants were recruited from four institutions and the study

deliberately oversampled for women and minorities (Eris et al., 2010). Because my study participants are also APS participants, the broader findings from APS informed my study and are useful in understanding my study. Key findings are summarized here and a more detailed summary of APS findings can also be found in “Enabling Engineering Student Success: The Final Report for the Center for the Advancement of Engineering Education” (Atman, et al., 2010)

While SCCT has not explicitly been used to analyze APS data, persistence in engineering (a choice goal) and engineering student identity (which can feed into other areas of SCCT) are common areas of focus for APS researchers. Matusovich et al. used Eccles’ Expectancy Value Theory to qualitatively explore students’ choice to persist in engineering (Matusovich, Streveler, & Miller, 2010). They found that having a strong attainment value for engineering, i.e., a belief that engineering is consistent with sense of self, contributed strongly to persistence choices and undergraduate experiences. Eris et al. used APS surveys to explore differences in persistors and non-persistors across the four years of survey administrations (Eris, et al., 2010). Students’ self-reported intention to continue in engineering (a Choice Goal) was found to decrease in the semesters before the students actually left engineering (a Choice Action). Another study explored seniors’ intention to pursue engineering careers at two of the APS institutions (Lichtenstein, et al., 2009). Fourteen percent were definitely not pursuing engineering, 44 percent were unsure, and only 42 percent of seniors were definitely planning on pursuing a career in engineering. Interviews illustrated differences in outcome expectations across these groups. Also, students at a technical public institution were far more likely to intend to pursue engineering than students at a suburban private university, which may indicate other contextual influences to their goals and actions in the SCCT model. While not explicitly referencing SCCT, these studies of identity and persistence throughout the college years provide a foundation for exploring the same participants’ experiences, career goals, and actions in the years after graduation within the SCCT model.

2.5 Need for Qualitative Research

The SCCT model shows that career choice is a complex process that occurs over time. Prior studies have confirmed various pathways or applicability to diverse settings, but there is a need

for a deeper focus on explaining factors influencing career goals and how they change over time. Explanatory qualitative methods are ideal for addressing this need. Qualitative methods allow researchers to explore participants' experiences in their own words (Creswell, 2009), and qualitative data "focus on naturally occurring, ordinary events in natural settings" (Miles & Huberman, 1994, p. 10). Furthermore, qualitative data are rich and complex as they focus on lived experiences and the associated meanings, and qualitative methods have the potential to be more flexible than quantitative methods (Miles & Huberman, 1994). Existing qualitative studies demonstrate the success of this approach and support the need for further qualitative work (Brunhaver, et al., 2010; Korte, et al., 2008; Matusovich, et al., 2010; Pruitt, et al., 2010).

2.6 Need for Longitudinal Research

A key strength of the SCCT model is the feedback loop occurring over time, as one experience influences the next (Lent, et al., 1994). Longitudinal research allows for the exploration of this feedback loop, yet few studies have explored these changes over time. Further supporting the need for longitudinal research, Arnett's work has shown that significant growth and development can occur during the early to mid twenties (2004). Longitudinal research during this time can provide an excellent opportunity to capture that growth process. My longitudinal study is particularly powerful because of the richness of the data set concerning participants' experiences as college students coupled with detailed interviews about their experiences as early career professionals.

2.7 Summary

This research is grounded in Social Cognitive Career Theory, which posits relationships between experiences, beliefs, choices, actions, and settings in a person's early career. This theory has been used extensively with college students and through quantitative methods, though other work supports its applicability to professionals and qualitative methods. In combination with this theory, Arnett's study of emerging adults also informs my study, as he explored the "winding road from the late teens through the twenties" (2004, title), which encompasses the age group of my participants. Some studies have explored the experiences of early career engineers and the challenges they face, though none have investigated the engineers' career goals and actions or

the factors influencing those goals and actions. Therefore, my research builds on data from the Academic Pathways Study, which has yielded rich results on the engineering student experience. By framing my research in a reputable theory, establishing a solid basis in the literature, and drawing on qualitative and longitudinal methods, I have constructed a firm foundation on which to best explore the career goals and actions of early career engineers.

3 Methods

In order to answer the research questions posed in Chapter 1, I conducted a longitudinal, multiple case study. This chapter will outline the methods framework I adopted in analyzing the data, introduce the participants, describe the context in which the data were collected, and present the analysis methods of my work.

3.1 Methods Framework

I have chosen to adopt case study methods for this study. Case studies have a long history in other research fields such as public policy and sociology (Yin, 2009). As engineering education has emerged as a research discipline, researchers have advocated for the use of case studies within engineering education, suggesting that case studies methods offer researchers the opportunity to address new types research questions in context-dependent settings (Case & Light, 2011). For example, case studies could be used to determine the effectiveness of interventions or, as in my work, to explore the experiences of specific populations.

Case study methods, as described by Yin, are ideal for research addressing questions of how or why, instances where the researcher has little control over the setting or events, and when the research is investigating a contemporary phenomenon, as opposed to a historical setting for which there is no access to living participants (Yin, 2009). As all of three of these criteria apply to this research study, case study methods are appropriate. First, I am seeking to explain both how and why early career engineering graduates act on their goals by exploring influential factors. Second, the study was not designed as an intervention or experiment so the participants' actions were not controlled by the study in any way. Participants answered interview and survey questions based on their own experiences in work, school, and life contexts. Finally, I investigated contemporary experiences of the participants in that the study period was 2007 to 2011. Multiple case study methods allow for both generalization across cases and in the larger

context of the study, as well the ability to address such issues as policy recommendation. These abilities further support the appropriateness of the case study approach.

3.1.1 Qualitative Methods

My study focuses on qualitative methods through interviews, which are “one of the most important sources of case study information” (Yin, 2009, p. 106). Qualitative data from semi-structured interviews provide rich, deep descriptions of early career engineering graduates’ experiences and beliefs, potentially identify causal links, and allow for exploration beyond the researchers’ original conceptions (Miles & Huberman, 1994; Patton, 2002). Interviews allowed participants to express themselves in their own words, rather than being bounded by the preconceptions of the researcher.

Case studies methods encourage drawing data from multiple data sources (Yin, 2009). My research relies on four sources of data. The interview data from the Engineering Pathways Study (EPS) and Academic Pathways Study (APS) were supplemented by both quantitative and qualitative data from APS senior-year surveys and EPS pre-questionnaires. The analysis of quantitative data focused on informing the individual case, rather than seeking statistical findings across the participants.

Because I use some quantitative data, it could be argued that my study is mixed methods. Creswell and Plano Clark define a mixed methods study as any study that uses some combination of qualitative and quantitative data, citing an example of a quantitative survey with one qualitative question at the end (Creswell & Plano Clark, 2007). According to this strict definition, my study qualified as a mixed methods study because I utilized some quantitative survey data. However, the overwhelming focus of the analysis was on the qualitative data from the interviews and open-ended questions of the surveys. My analysis methods also followed qualitative procedures as described by Miles and Huberman (1994) and not quantitative or statistical analysis methods. Therefore, this study is most appropriately classified as a qualitative study.

3.2 Participants

My participants were originally recruited to the Academic Pathways Study (APS) as traditional-aged college freshmen enrolled in engineering programs in 2003. For this follow-up study, all participants who had completed a longitudinal series of interviews as undergraduates from TPub, SPri, and LPub and who could be located were invited to participate in the Engineering Pathways Study (EPS) in 2011. Note that TPub, SPri and LPub are pseudonyms and additional information about these sites is provided in section 3.3 later in this chapter.

As part of the invitation for this study, potential participants were asked to complete a brief pre-questionnaire with both qualitative and quantitative questions about their experiences since graduation. Of the 87 invitations sent out, 51 people responded to the EPS pre-questionnaire and 36 agreed to be interviewed. A total of 35 interviews were conducted; one potential interviewee had scheduling conflicts. Of those interviewed, 30 had graduated with engineering degrees and all 30 engineering graduates are included in this study. This study is limited to engineering graduates because the purpose of this work is to explain the career goals and actions of early career engineering graduates.

3.2.1 Study Participants

The 30 participants in EPS included 14 women and 16 men. Twelve participants graduated from TPub, 10 from SPri, and eight from LPub. The median undergraduate GPA was B+ (3.2-3.4). Participants were between the ages of 26 and 28 at the time of the EPS interviews. As shown in Figure 3-1, ethnic backgrounds included 18 indicating White/Caucasian, five Asian/Asian American, two Mexican American/Chicano, with five participants reporting multiple ethnic backgrounds. Participants with multiple ethnic backgrounds included White/Caucasian + African American/Black, White/Caucasian + African American/Black + Other: Latino, White/Caucasian + Asian/Asian American, White/Caucasian + Native Hawaiian/Pacific Islander, and White/Caucasian + Other: Unspecified. Note that “ethnic background” is used here because that is how the question was posed to participants. All participants were citizens of the United States. Two immigrated as young children; one participant immigrated to the United States from Europe as a young adult.

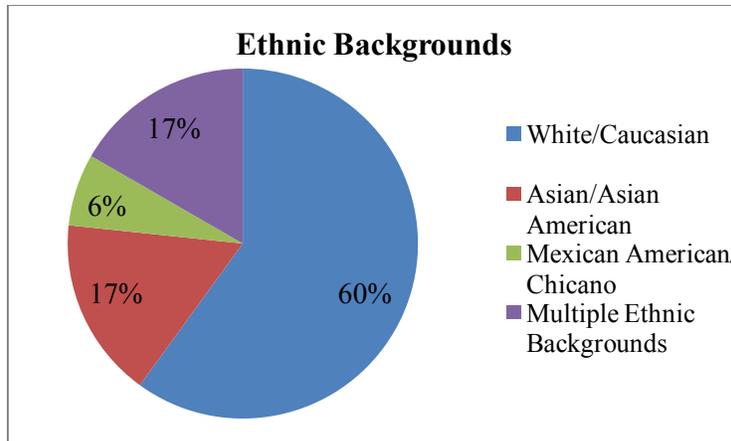


Figure 3-1. Participants' Ethnic Backgrounds

Chemical engineering and mechanical engineering were the most common majors among the participants, with seven participants earning chemical engineering degrees and six earning mechanical engineering degrees. Three participants graduated in petroleum engineering, three in electrical engineering, and two in engineering physics. The remaining nine participants represented nine other majors across engineering, as shown in Figure 3-2.

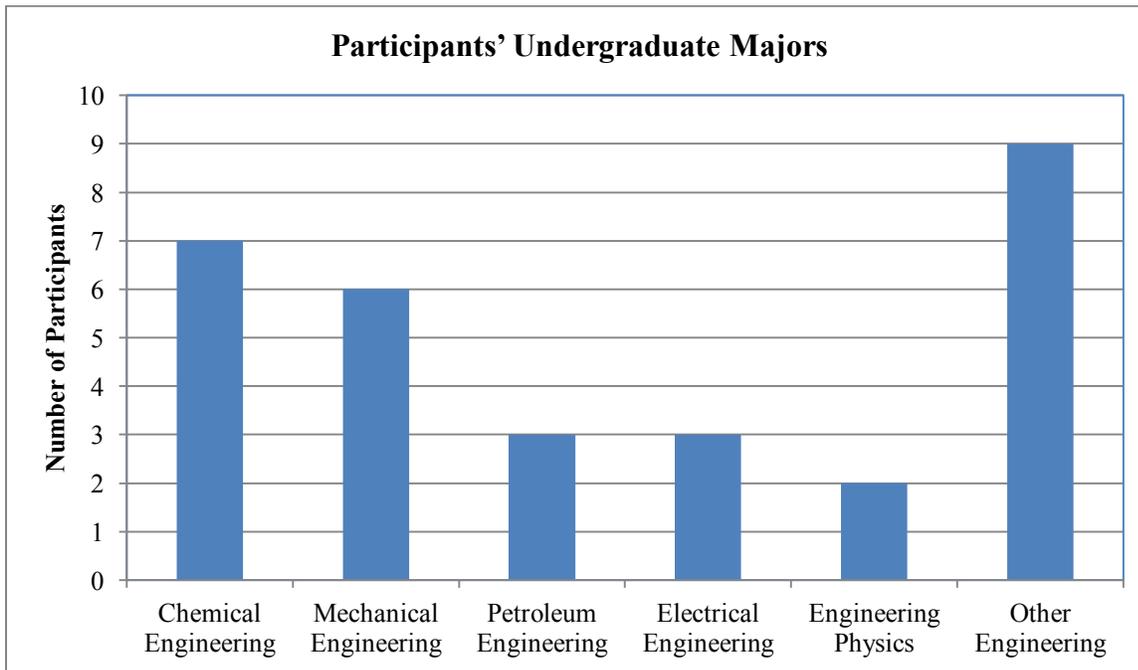


Figure 3-2. Participants' Undergraduate Majors

Participants' school, pseudonym, and sex, are shown in Table 3-1. As previously indicated, data from a variety of sources are available for each participant. Table 3-1 also indicates the data that are available by participant. These sources are described in greater detail in section 3.4.

Table 3-1. Study Participants and Data Sources

School	Pseudonym	Sex	APS		EPS	
			Interview	Senior PIE Survey	Pre- Questionnaire	Interview
L Pub	Austin	Male	Ethnographic	Yes	Yes	Yes
L Pub	Emily	Female	Ethnographic	Yes	Yes	Yes
L Pub	Jesse	Male	Ethnographic	Yes	Yes	Yes
L Pub	Justin	Male	Ethnographic	Yes	Yes	Yes
L Pub	Kara	Female	Ethnographic	Yes	Yes	Yes
L Pub	Lauren	Female	Ethnographic	Yes	Yes	Yes
L Pub	Michael	Male	Ethnographic	Yes	Yes	Yes
L Pub	Samantha	Female	Ethnographic	Yes	Yes	Yes
S Pri	Dana	Female	Ethnographic	Yes	Yes	Yes
S Pri	Grace	Female	Ethnographic	Yes	Yes	Yes
S Pri	Kevin	Male	Ethnographic	Yes	Yes	Yes
S Pri	Nate	Male	Ethnographic	Yes	Yes	Yes
S Pri	Oscar	Male	Ethnographic	Yes	Yes	Yes
S Pri	Otis	Male	Structured	Yes	Yes	Yes
S Pri	Paige	Female	Structured	Yes	Yes	Yes
S Pri	Sara	Female	Ethnographic	Yes	Yes	Yes
S Pri	Vicki	Female	Structured	Yes	Yes	Yes
S Pri	Vince	Male	Structured	Yes	Yes	Yes
T Pub	Beth	Female	Ethnographic	Yes	Yes	Yes
T Pub	David	Male	Structured	Yes	Yes	Yes
T Pub	Joe	Male	Ethnographic	Yes	Yes	Yes
T Pub	John	Male	Structured	Yes	Yes	Yes
T Pub	Josh	Male	Ethnographic	Yes	Yes	Yes
T Pub	Karen	Female	Structured	Yes	Yes	Yes
T Pub	Laura	Female	Structured	Yes	Yes	Yes
T Pub	Leah	Female	Structured	Yes	Yes	Yes
T Pub	Lisa	Female	Unavailable	Yes	Yes	Yes
T Pub	Max	Male	Ethnographic	Yes	Yes	Yes
T Pub	Paul	Male	Structured	No	Yes	Yes
T Pub	Will	Male	Ethnographic	Yes	Yes	Yes

Note that this table does not include major or ethnic background because in combination with other information in the table and throughout this text these categories could potentially make participants identifiable.

3.2.2 Participant Protection

In order to ensure proper participant protection, Institutional Review Board (IRB) approval was obtained for the pre-questionnaire and interview phase of EPS. As the lead institution, SPri developed and submitted the first IRB package, and similar packages were submitted at Virginia Tech and LPub. TPub did not have an IRB, but data collection among TPub graduates was covered by the Virginia Tech approval. My research was covered by Virginia Tech IRB Protocol 10-836's approval because I used the data and methods approved for EPS and my research questions fit under the larger EPS questions.

At the start of the pre-questionnaire, participants were asked to consent to the pre-questionnaire and allow the EPS team to pair the pre-questionnaire with APS data for research purposes. In a separate question, respondents were asked if they would consent to an audio-recorded interview which would be analyzed along with their pre-questionnaire and APS data. Fifteen participants consented to the pre-questionnaire but not the interview and the balance of the participants consented to both.

Once the data were collected, all personally identifying information was removed from the interview transcripts and pre-questionnaires. Examples of personally identifying information include the companies the participants worked for, graduate institutions they attended, and names of people they mentioned. Each participant was assigned an identification number and a pseudonym. All analyses and publications refer to the participant by the pseudonym.

3.3 Research Context

My study is part of the larger Engineering Pathways Study (EPS), which is an extension of the Academic Pathways Study (APS), both of which were funded by the National Science Foundation. Participants in EPS were recruited as APS participants and graduates from TPub, SPri, and LPub. TPub is a technical public institution located in the Rocky Mountains, with an

emphasis on engineering and applied science and 12 undergraduate engineering majors. TPub is classified as a research university with high research activity according to the Carnegie Foundation for the Advancement of Teaching. SPri is a private suburban university located in California and offers nine undergraduate engineering programs. SPri is classified as a research university with very high research activity. LPub is a public, urban university located in the Pacific Northwest that offers 12 undergraduate engineering programs. LPub is classified as a research university with very high research activity. More information on the student bodies of these institutions can be found in Table 3-2. The data in the table are from 2007, as that was the last year of attendance for most of the study participants (American Society for Engineering Education, 2007).

Table 3-2. School Demographics as of 2007 (American Society for Engineering Education, 2007)

Institution	Undergraduate Enrollment	Engineering Undergraduate Enrollment	% Engineering	% Women Total¹	% Women Engineering	% Non-Whites Engineering
TPub	3,300	3,240	98.2	25	21.7	25.9
SPri	6,996	2,150	30.7	49	33.3	63.7
LPub	28,570	3,637	12.1	52	21.0	50.3

¹ <http://colleges.usnews.rankingsandreviews.com/best-colleges>

At the time of the EPS interviews, all of the participants had earned their bachelor’s degrees. About seventy percent were living in the western United States; one participant was working internationally. Of the participants who were working full time, about 80 percent reported working in an engineering job. Nearly a third of all participants had worked for the same employer since earning their bachelor’s degrees. Ten participants were pursuing advanced degrees; six had completed master’s degrees in engineering and entered the workforce.

3.4 Data Sources

Data used in this analysis come primarily from the Engineering Pathways Study (EPS) and are supported by existing data from the Academic Pathways Study (APS). The goal of EPS is to extend the understanding of the pursuit of engineering careers from undergraduate years into the early career years. Framed in Social Cognitive Career Theory (SCCT), EPS followed up with

participants from APS to investigate their experiences after graduation. The overall goal of EPS is to facilitate transitions from undergraduate engineering studies to the engineering workforce by making improvements in university engineering programs. Although the overall study is mixed-methods and multi-phased, my work emerges from the first phase, the qualitative phase.

EPS data collection began in the spring of 2011. This timing was approximately four years after the last APS interview and PIE survey. The first phase consisted of semi-structured interviews with selected APS participants from the three institutions mentioned. The EPS interview team was made up of five researchers from three institutions. Four members of the team shared the load of interviews; I conducted eight interviews. All five team members engaged in regular conversations throughout the interview and initial analysis process. Interview participants were selected based on responses to a pre-questionnaire administered on-line.

EPS data are supplemented by data from APS. APS was a multi-year, multi-institution study designed to understand the experience of learning engineering from the student perspective (Atman, et al., 2010; Sheppard, et al., 2004). Research questions addressed the development of engineering skills, engineering identity, education, workplace preparedness, as well as factors contributing to persistence. In an attempt to capture a diversity of student experiences, the study deliberately oversampled for women and minorities (Eris, et al., 2010). At each institution approximately forty students participated in annual interviews, either ethnographic or structured, as well as seven quantitative “Persistence in Engineering,” or PIE, web-based surveys (Atman, Kilgore, & McKenna, 2008; Ohland, et al., 2008). For my research I used data from the final APS interviews and senior surveys.

Copies of the instruments are available in Appendix A. Data sources available for each participant were presented in Table 3-1. In this section I will describe each data source in the order that it was collected.

3.4.1 APS Interviews

Semi-structured, ethnographic interviews were conducted with 19 of the 30 participants during the spring semester of the first four years of undergraduate studies. The interview guide is presented in Appendix A.1. Consistent with advice in the literature, these interviews were based on an interview guide to ensure the same basic topic areas were pursued with each participant

regardless of institution or interviewer (Patton, 2002). However, the semi-structured nature of the interview guide afforded interviewers the opportunity to probe participants for further details or explore relevant topics that were not mentioned in the interview protocol during the ethnographic interviews. Like each of the other annual APS interviews, the senior year interview protocol contained questions concerning the participant's past, present, and future. Although I analyzed entire interviews, one of the final questions in the protocol was most relevant for this study:

19. This is likely the last time we'll interview you, so I'd like you to talk about what happens for you after this interview.

Tell us what happens next for you? This summer? This fall? Beyond?

(Researcher prompts for information on graduation, job search, grad school, other option, ten year plans)

What do you imagine yourself doing on a day-to-day basis?

(If not planning on being an engineer, researcher asks what engineers do on a day-to-day basis).

Participant responses to this question, as well as their responses to other questions in the interview, revealed their career goals, and intended actions at the end of their senior year. Detailed descriptions also allowed for the identification of relevant pathways in the SCCT model, such as a participant that talks about outcome expectations or contextual affordances influencing his or her career goals or actions.

The remaining 11 participants completed structured interviews. These interviews were much more formal and did not allow the interviewer latitude to probe student experiences. Structured interviews, however, do allow researchers to insure consistency across interviewers, which was beneficial as APS employed multiple interviewers across the campuses (Patton, 2002). A sample structured interview protocol is presented in Appendix A.2. Unfortunately, structured interviews were only conducted during the first three years of APS. Therefore, for these participants, the last interviews were conducted in the junior year. Still, the junior interviews provide insight into the participants' future goals and plans for action. The most relevant question from the protocol was:

27. What is your expected graduation date? What do you see yourself doing after graduation? What type of job would you like to have?

Questions such as this one elicited responses from students about their career goals, and many students further described actions associated with their goals or other factors from the SCCT model that might influence their goals, such as contextual influences or self-efficacy. APS responses were also used in EPS interviews to ask participants how they met the goals they set before graduation.

3.4.2 Senior PIE Surveys

Participants also completed a “Persistence in Engineering,” or PIE, survey each semester of their first three years, and once during the spring of their senior year (Eris, et al., 2010). This survey is included in Appendix A.3. Survey responses are linked to specific participants so interviews and surveys could be matched. These largely quantitative surveys will not be relied on as heavily as data sources as the interviews. Instead, my analysis focused on specific questions about future plans, such as responses to a question asking:

5. Do you intend to practice, conduct research in, or teach engineering for at least 3 years after graduation?
 - Definitely Not
 - Probably Not
 - Not Sure
 - Probably Yes
 - Definitely Yes

The most informative question was the final, open-ended question, which asked:

49. What do you plan to do after graduating from college?

Responses to this question were especially useful for determining the goals of APS participants that had structured interviews and were therefore not interviewed during their senior year. The survey design provided a fairly large box for students to respond with their future plans, and some participants chose to answer in detail about what their goals were and why.

3.4.3 EPS Pre-Questionnaire

The pre-questionnaire, presented in Appendix A.4, was administered online to former APS participants during the early spring of 2011 and contained both quantitative and qualitative questions. This questionnaire was designed with a focus on SCCT constructs and to elicit

baseline information on which interviews could build. The items most informative for this analysis include multiple-choice questions on the participants' career paths since graduation, future career plans, and people or groups that have influenced their career choices. Participants were also asked to report the importance of various factors in their career, such as opportunities for advancement and social interaction. These questions aided in sorting open-ended responses to compare trends among different groups. Two open-ended questions also provided valuable information about participants' career goals and actions:

16. Are there any events that have happened since you've graduated that you think have been important to your career decision-making (e.g., getting married, having children, unexpected opportunities, etc.)?

(Free Response)

18. What kinds of things do you hope to accomplish in the future?

(Free Response)

The answers to these questions vary widely. For example, one participant reported in Question 16:

"My grandmother had some health problems and I now live with her. For this reason I looked for only local employment that allowed for a flexible work schedule" [Beth, TPub, PreQ].

This participant's career actions of searching for a job in a limited geographical area were influenced by a contextual influence according to SCCT, in that her grandmother's health influenced the Beth's actions. For Question 18, many participants reported plans to obtain a graduate degree, while others sought to advance within their current companies or find a different position.

As the SCCT model shows that goals influence actions but are also influenced by several factors, the EPS interview asked about the goals listed on the pre-questionnaire to have the participants describe their associated actions or influential factors.

3.4.4 EPS Interviews

Similar to the semi-structured ethnographic interviews from APS, the EPS interview team developed a shared interview protocol but encouraged interviewers to adapt their questioning based on the participant. The interview protocol was developed within the SCCT framework and

extensively piloted before data collection began, both to provide researchers familiarity with the protocol and to ensure validity (Yin, 2009). The interview guide can be found in Appendix A.5. EPS interviews were all conducted over the phone. Participants were asked to reflect on their prior experiences, describe their current experiences, and describe their goals and visions for the future. As the interview protocol was semi-structured, a participant who was very forthcoming about his or her experiences may have received fewer follow up questions or prompts than a participant who provided briefer responses. Interview questions were adjusted based on individuals' responses to the pre-questionnaire and APS data. For example, one item on the pre-questionnaire asked:

15. Which of the following have had an impact on your career decisions since you've graduated? Check all that apply.

- A family member or friend
- A significant other
- A manager or supervisor
- A research or academic advisor
- A coworker
- A fellow student
- A service, religious, or civic organization
- A literary, visual, or performing arts group
- A sports club or league
- A professional or academic association
- Other, please describe:

In the EPS interview, participants were then asked:

11. In your questionnaire, you mentioned that [insert people/activities] have had an impact on your career decisions. Tell me more about that.

The researcher conducting the interview would then have inserted the participant's response from the pre-questionnaire. In addition to questions about their experiences over the past four years, some of the most relevant questions for this analysis were:

2. Are you currently doing what you thought you'd be doing while you were an undergrad? Tell me about that. In the APS interviews you said you wanted to do [insert from APS], how is what you are doing the same or different?

3. I see from your questionnaire that you want to [insert the participant's plans for the next 5-10 years]. Tell me about that. What specific things are you doing now to realize

that plan? What factors do you think might affect your plans? What are you most worried about? On a scale of 1-10, how confident are you in your ability to achieve these plans?

Question 2 provides insight into how the participant's career goals have changed or remained the same over the intervening years. For example, one participant responded that he was doing exactly what he thought he would be doing and that he was very happy, while another reported that she had changed her goals due to her first job not being as she expected. Question 3 allowed participants to describe their future goals and current actions being taken to achieve those goals. The semi-structured nature of the interviews allowed for interviewers to explore many of the pathways proposed by the SCCT model, such as the relationship among outcome expectations and career goals and actions.

3.4.5 Research Questions and Data Sources

Quality case study research draws from multiple data sources in order to understand each case (Yin, 2009). Information from the APS interviews, APS surveys, EPS pre-questionnaires, and EPS interviews all informed my analysis. As APS and EPS had broader goals than the focus of my research, not all aspects of data collection instruments relate to my research questions. Table 3-3 shows a mapping of the most relevant items on the various instruments to my research sub-questions. Participants frequently talked about topics related to the research questions outside of particular items on the interview protocols, so the entire interviews and surveys were analyzed to identify all data relevant to the participants' career choices.

Table 3-3. Mapping Research Questions and Data Instruments

Research Sub-Question	Relevant Items from Instruments				
	APS Junior Structured Interview	APS Senior Ethnographic Interview	APS Senior PIE Survey	EPS Pre-Questionnaire	EPS Interview
1. How do graduating seniors describe their early career goals and their plans for achieving those goals?	27	19	5, 7, 49		
2. What actions have early career engineering graduates taken to meet the career goals they set as graduating seniors?				9	2
3. How do early career engineering graduates describe their career goals for the next phases of their careers and their plans for achieving those goals?				17, 18	3
4. How are these goals and associated actions or plans related to prior career goals and actions?	27	19			3, 7

3.5 Analysis Methods

Data analysis focused on explanation-building, where my goal was to answer the research questions by developing an explanation of participants' career-related goals and actions. This differs from an exploratory focus, where the goal would be to simply develop hypotheses for further study (Yin, 2009). Due to the richness of qualitative data, explanatory and causal relationships can be determined through qualitative methods without randomized, controlled experiments (Miles & Huberman, 1994). These findings must be noted as my interpretation of the data and justified by the data in order to ensure credibility and trustworthiness (Patton, 2002;

Yin, 2009). The analysis procedure followed the suggestions of Yin (2009) and Miles and Huberman (1994). Consistent with multiple case methods, each case was analyzed individually before cross-case analysis was conducted. The steps in this process were:

1. Making initial hypotheses to answer the research questions
2. Comparing the findings of the first case to the hypotheses
3. Revising the hypotheses
4. Comparing the first case to the new hypotheses
5. Comparing the revised hypotheses to each subsequent case
6. Repeating as needed (Yin, 2009).

For this work, the initial hypothesis was based on the causal pathways proposed by SCCT, namely that participants' career goals and actions over time could be explained in the context of SCCT. Relevant pieces of the theoretical model were identified in individual cases and compared across cases before coming to the conclusions presented in Chapters 4 and 5.

3.5.1 Coding Procedures

Informal data analysis began as soon as data were available, as findings from APS and the EPS pre-questionnaire were needed to inform the EPS interviews. As part of the informal analysis, other members of the EPS interview team and I extracted information from APS interviews and surveys to prepare for the EPS interviews. After each interview, the interviewer completed a contact summary sheet with notes from interviewer to share with the rest of the team (Patton, 2002). These contact summary sheets were used to discuss preliminary themes with the team while the interviews were being transcribed. Once all of the EPS interviews were conducted and transcribed, I began the formal coding process to address my research question using a combination of inductive and a priori coding (Miles & Huberman, 1994) and the MAXQDA software package.

The first round of interview coding directly called on the constructs from SCCT and simply used the a priori codes "goals", "actions", and "influence." Based on SCCT, "influence" initially included interests, self-efficacy, outcome expectations, and the contextual influences proximal to choice behaviors, with an "other" category for items that did not seem to fit the model. Inductive subcodes were then developed as common trends emerged. For example,

participants frequently discussed the economy impacting their actions towards achieving their goals. I therefore added an “economy” subcode to “influence.” When several trends became apparent within “economy,” I then added additional levels subcodes to describe the types of impacts on career goals and actions. Common examples include not being able to change jobs or accepting a less than ideal position due to poor job availability. Other subcodes for “influence” were drawn from SCCT: interests, outcome expectations, and self-efficacy. For example, Kara described her decision to go to graduate school:

“I thought, well I’ll stay, and get my masters, and that’ll give me the tools and the networking that I need to go get the job that will be interesting to me.” [Kara, LPub, EPS]

This passage was then coded as “influence-outcome expectation.” Subcodes were added as more themes emerged. These inductive codes were then grouped and refined after multiple passes through both the undergraduate and early career interviews. The final codebook is presented in the Appendix.

Once my coding structure was stabilized I reapplied it across all interviews in the data set. I formalized definitions for each code in a codebook to ensure that future researchers could follow, recreate, or even transfer my work to another setting. To increase the trustworthiness of my analysis, I trained a secondary researcher on how to use my codebook. This secondary researcher was experienced in qualitative research methods but from outside of this project and engineering education as a whole. She separately coded multiple interviews that were randomly selected, and we then compared our coding and discussed until a consensus was reached.

3.5.2 Single Case Analysis

As mentioned previously, the first step in single case analysis began as the other interviewers and I extracted important data from the pre-questionnaires and APS interviews to inform the EPS interviews. At the end of each EPS interview, the other interviewers and I completed contact summary sheets to share across the team. Once transcripts were available, I coded each interview. I then prepared case reports to answer the research questions individually for each participant, utilizing all of the available data sources for the participant. This approach is consistent with Yin’s (2009) suggestions and ensures that each participant’s experiences are understood. Individual case reports also facilitate analyzing the participants’ experiences across

time, which takes advantage of the longitudinal aspect of this data set. An example case report is included in the Appendix. Because the cases studies are quite detailed, they could make the participants identifiable. Therefore, I have not included them all.

3.5.3 Cross-Case Analysis

After analyzing each case individually, the results were compared across cases to look for common themes. Much of this analysis was informed by Miles and Huberman, who stress that “it is crucial to have understood the dynamics of each particular case before proceeding to cross-case explanations” (1994, p. 207). They then recommend a variety of matrix and other graphical displays for sorting and interpreting data across cases. Following this recommendation, I constructed a “meta-matrix” containing key elements addressing the research questions from the case reports. The matrix included other variables, such as demographic variables, career path summaries, and family status. I used the meta-matrix to easily organize data to identify important themes across participants. For example, the career path summaries let me sort participants who have moved from work to school and note that they were all male, while women were more likely to enroll in graduate school immediately after earning their bachelor’s degrees.

3.6 Research Quality

Research quality is ensured throughout the data collection and analysis process via multiple methods. First, proper case study procedures were followed to ensure quality. Second, extensive researcher triangulation was utilized throughout the project. Finally, I acknowledge my role as the researcher in shaping the findings.

3.6.1 Credibility in Case Study Methods

According to Yin, high quality data collection and analysis for case studies is guided by four principles: following protocols, obtaining multiple sources of evidence, building a case study database, and establishing an explicit chain of evidence (Yin, 2009). Both APS and EPS had detailed interview protocols to guide researchers to ensure consistency across interviewers, despite the freedom of the semi-structured interview format. These protocols not only assisted

members of the APS and EPS team as they conducted interviews, but also ensured trustworthiness by allowing future researchers the opportunity to repeat the study. Multiple sources of evidence were provided through the use of multiple data sources; each participant completed a survey and interview from his or her undergraduate years and another questionnaire and interview from the early career period. This triangulation provides multiple views of the participants' experiences to provide greater detail (Patton, 2002). As part of my analysis process, I constructed a case study database to manage the relevant raw data and preliminary analysis material. This database provides an easily accessible compilation of the data as a reference to reviewers and later researchers seeking to verify my work, which increases the reliability of the study (Yin, 2009). Finally, the trustworthiness of the study is also ensured by maintaining an explicit chain of evidence from the beginning of the study through the analysis process and presentation. This involves tying each step to the previous step and adequately citing data from the case study database, as shown in Figure 3-3.

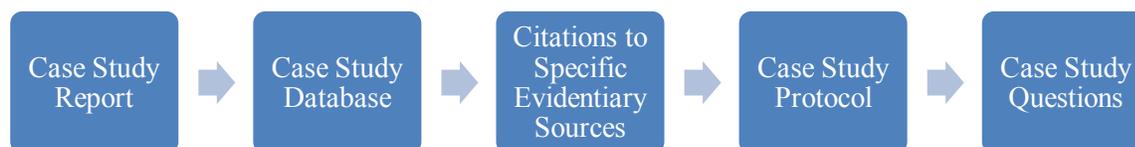


Figure 3-3. Chain of Evidence (Yin, 2009, p. 123).

I established a chain of evidence by providing exemplar quotes with detailed citations to data sources throughout the results and discussion section of this dissertation.

3.6.2 Researcher Triangulation

I utilized extensive researcher triangulation throughout the research process, which reduces potential bias and ensures a comprehensive analysis (Denzin & Lincoln, 2003; Patton, 2002). Important themes were identified with the EPS team through regular conference calls. In addition to presenting ideas for discussion, several researchers verified my coding methods. One EPS researcher coded multiple interviews with early drafts of the codebook and then we compared the results. Another EPS researcher with extensive experience with the data then reviewed the codebook for breadth and clarity. Finally, I trained a researcher from outside the EPS team to use

the codebook and compared her coded interviews to my results and discussed differences until a consensus was reached.

3.6.3 Role of the Researcher

As a crucial part of ensuring research credibility, a researcher must “report any personal and professional information that may have affected data collection, analysis, and interpretation” (Patton, 2002, p. 566). One key factor that attracted me to this study was that I am from the same cohort as these students. While I did not attend any of the three institutions, I was a traditional-aged college freshman in 2003 and earned my engineering bachelor’s degree in 2007; my husband also earned his engineering bachelor’s degree in 2007. Our career paths have been heavily shaped by each other’s opportunities. He moved so that I could pursue a PhD, and I have refined my goals for after graduation based on opportunities in the town where he currently has a job. We have also both changed our goals and actions based on learning experiences, poor economic conditions, outcome expectations, and shifting interests. Our first child was born during the study period, so I was particularly attentive to the experiences of participants as parents.

Being of similar background as many participants was both a strength and a weakness for me in my research. Because of my experiences, I was more sensitive to similar experiences in the narratives of the study participants. In order to prevent my experiences from biasing the results, I relied on researcher triangulation to verify the importance of various themes.

3.7 Limitations

The limitations of this research are similar to most studies. This work relied on volunteers, participants were recruited from a limited number of institutions, and some existing data were used for the analysis.

3.7.1 Volunteer Participants

First, my study is constrained by the willingness of participants to be involved with the study and may be subject to potential sample bias. As this is a longitudinal study, much has been asked of

the participants over the past eight years and not all participants have persisted in the research project. The participants were initially selected from a pool of volunteers in 2003. They were then asked to complete surveys and interviews for four years as part of APS. Only those that fully participated in all four years of APS were invited to participate in EPS. Nearly four years had elapsed since the last APS contact when the EPS team attempted to contact former APS participants in 2011; only 87 of the approximately 120 of the former participants could be reached, due to unavailable contact information. Of those, 51 completed the pre-questionnaire and 36 consented to interviews, resulting in 30 eligible participants in this research.

It is not known why participants have declined to complete the pre-questionnaire or consent to interviews, or how they differ from the interviewees. All of the pre-questionnaire respondents that had earned engineering degrees but declined interviews did report that they were working in engineering jobs. Therefore, it is unlikely that they declined interviews because they no longer associated with engineering. While EPS includes ethnically diverse participants, APS included even greater diversity, such as participants identifying as Native American and more participants identifying as African American/Black. It is not known why these participants did not elect to participate in EPS. Previous research has shown marked differences among minority groups in engineering (Trenor, et al., 2008). Because of these differences, broader applicability of the findings may be limited because we do not know how the participants' experiences vary from the population of early career engineering graduates as a whole.

3.7.2 Three Institutions

This study is also limited in that participants were only recruited from three institutions: TPub, SPri, and LPub. While these institutions are different from each other in terms of programs offered and enrollment rates of women and minorities, they are also similar. All three schools are essentially predominantly white and they are in the western United States, which may influence the campus cultures. It is possible that the perspectives of graduates from these programs may not adequately represent a broader sampling of more diverse institutions. However, by incorporating sufficient descriptions of the research sites and participants, researchers and practitioners from other schools will be able to assess the applicability of findings to their institutional settings (Yin, 2009).

3.7.3 Secondary Analysis of Existing Data

Finally, my study is somewhat constrained because it relies on existing data from APS and EPS. Secondary analysis refers to applying new research questions to existing data sets (Smith, 2008). While the longitudinal aspect of APS data greatly strengthens my study, the survey and interview protocols were not explicitly designed for my research questions. As presented previously in this chapter, the APS data set contains several relevant items that informed my analysis. Secondary data analysis can “reveal new themes from the data and additional results” (Leech & Onwuegbuzie, 2008, p. 660). This is precisely how I am using the APS data: analyzing for career goals and actions that were not the original focus of APS.

I was involved during the instrument development process for EPS, but I did not have complete control of developing the instruments. I also did not personally conduct all of the interviews. Had the data collection instruments been tailored solely for my research questions and I had conducted all of the interviews, I would have been able go into more detail with specific populations. Still, I was extensively involved in conducting EPS interviews and in the analysis process and my research questions are consistent with the goals of EPS.

3.8 Summary

This study utilized case study methods in order to answer the research questions. Data included interviews and surveys from participants as undergraduates that were collected as part of APS, as well as pre-questionnaires and interviews from the participants as early career engineering graduates participating in EPS. I began the analysis with a priori coding as informed by the SCCT and literature, and then added inductive codes as they arose within the data. Each case was analyzed individually to build an explanation of career goals and actions for that participant, and then conclusions were drawn across cases to answer the research questions. Credibility was ensured through establishing an explicit chain of evidence as well as extensive researcher triangulation.

4 Results

This chapter contains the findings from the analysis as described in Chapter 3. As a reminder, the purpose of this study was to answer the overarching research question: “What is the relationship among early career engineering graduates’ career goals near the end of their undergraduate engineering studies, career-related actions taken in the subsequent four years, and their future career plans?” I also posed the following sub-questions to guide my data analysis and the findings:

- How do graduating seniors describe their early career goals and their plans for achieving those goals?
- What actions have early career professionals taken to meet the career goals they set as graduating seniors?
- How do early career professionals describe their career goals for the next phases of their careers and their plans for achieving those goals?
- How are these goals and associated actions or plans related to prior career goals and actions?

In this chapter, I have organized my results to first address the sub-questions before answering the over-arching research question. Quotations from the participants are provided to support my findings. These quotations were generally chosen as typical examples; exceptional cases are highlighted as such. I minimally edited the quotes for readability, consistent with other qualitative research reports (Corden, 2007). Slang and colloquialisms were retained. Omitted phrases are indicated by ellipses and clarifying insertions by square brackets.

4.1 Senior Goals

The first sub-question examines the ways that graduating seniors (or juniors in the cases of structured interviews which were not conducted senior year) describe their early career goals and plans for achieving those goals. As advanced undergraduates, participants expressed a variety of goals that they intended to pursue after graduation. The most common were employment goals and education goals. Other salient goals related to living or working in specific geographic regions and intentions for life outside of work. There were also several participants who were unclear on their goals. These goals, or lack of goals, are described in the following sub-sections through the use of examples from the interviews and surveys. Following the goals, I described the influences shaping those goals.

4.1.1 Employment Goals

Employment goals are the participant's desires related to their job status. As interviews and surveys were conducted in the spring of most participants' senior year, many participants had already found jobs. Therefore, within employment goals, seniors tended to talk more about what they were going to do, as in planned actions, instead of what they wanted to do, which would be their goals. They also talked mainly about their first job and not what they planned to do farther in the future, though I did code any statements that could possibly be interpreted as goals. Desires to eventually move into management positions or into academia were popular among the participants who did discuss longer-term goals. Five participants saw their first jobs as temporary and had plans to change employment after a couple of years. Desires to run their own businesses were also cited as long term goals but only by two participants.

Of those with goals, sixteen participants expressed a desire to work in specific engineering fields, or subspecialties of their majors. These were often statements that simply listed the major or subspecialty with little context given. Twelve participants talked specifically about the types of job tasks they would like to do. Consider Paige, who would like to work for a large engineering firm and then take her knowledge to a non-profit:

"I would like to go into like a non-profit organization and take the ideas, what I've learned from the big company, be able to scale it down and hopefully make whatever systems they're using there more efficient or at least being able to say 'ok, this is how this

works, maybe you'd want to consider that, unless they're already doing that and then I'd be familiar with what they're doing.” [Paige, SPri, APS]¹

Paige mentions both a field that she would like to work in, namely the non-profit sector, and a job task she would like to perform, which would be adapting industry practices to optimize the non-profit organization's operations.

In contrast to talking about what they wanted to do, several participants mentioned things they did not want to do. For example, Nate and Vince clearly indicated that they did not want to work as engineers. Vince was headed into the finance industry and Nate hoped to work in science education.

Additionally, some participants talked about the characteristics of jobs they would like to have. Four participants expressed a preference for active jobs instead of being stuck in the office. Participants also talked about wanting hands-on work and being able to make a difference in the world. For example, Grace wanted to use her product design background to help people:

“I don't want to just design things for people to buy and then put in a case or something, not be useful or not impact their lives or make their lives easier.” [Grace, SPri, APS]

Like others, Grace wanted to be able to see the impact of her work. In their APS interviews, participants overall were not highly detailed in their employment goals, though many expressed preferences.

4.1.2 Education Goals

Education goals are the participant's desires to pursue formal higher education. Education goals included immediately pursuing graduate degrees after undergraduate education, as well as desires to return to school later. Eighteen participants had goals related to graduate work. While most education goals related to obtaining engineering degrees, participants also talked about their interests in MBAs, medical school, education, and even history. Max, who planned to work for a while before returning to school, was particularly articulate about his goal to earn a graduate degree:

¹References to data sources are presented as [Name, Institution, Data Source]. Institutions include TPub (Technical Public University), SPri (Suburban Private University) and LPub (Large Public University). Data sources are labeled as APS (senior or junior undergraduate interviews from the Academic Pathways Study), PIE (senior Persistence In Engineering surveys), PreQ (Pre-Questionnaires from the Engineering Pathways Study), or EPS (early career interviews from the Engineering Pathways Study).

“I have to do it. I won’t ever go back to school full-time. I’ll do it at night. I won’t do it online either, but uh, I have to do it. I have to get my Master’s. I’ve always wanted to have my Master’s.” [Max, TPub, APS]

Max was not interested in staying in school immediately after earning his bachelors but planned to earn an advanced degree. In contrast, approximately a third of the participants did have goals to pursue graduate degrees immediately after earning their bachelor’s degrees. Of these, three participants had already begun graduate studies through a co-terminal master’s degree program at SPri before earning their bachelor’s degrees, and all three expressed the goal of completing their master’s degrees.

4.1.3 Lifestyle Goals

Not all goals were related to specific jobs or schooling. Several participants also hoped for better work-life balance once they started work. I categorized these goals as lifestyle goals. When asked about their goals for after graduation, participants mentioned diverse goals such as traveling or having more time for hobbies. Oscar’s goal was for an improvement in overall quality of life once he finished school:

“I want a more stable life. I want to have regular working hours. I want to work for a while. I think it’s going to be healthier. I’m really tired of not getting enough sleep. Uh, just have a little more regularity and certainty than a student has the luxury of.” [Oscar, SPri, APS]

Oscar’s goal of improved work-life balance and for better health was not tied to a particular job, but was still very important to him.

4.1.4 Unclear Goals

Although many participants expressed some career goals, six participants were not sure what they wanted to be doing a few years after their bachelor’s degrees. These participants did not express clear goals in their interviews. Karen was wavering between graduate school and working at the time of her junior interview:

“I’m going to finish it [engineering bachelor’s degree] and hopefully go on maybe to grad school or practice I don’t know I haven’t decided.” [Karen, TPub, APS]

Even at the end of her senior year, she reported her future plans as:

“Work or attended [sic] grad school” [Karen, TPub, PIE].

Karen was not certain what she wanted to after graduation and had no plans. Other participants with unclear goals were able to tell interviewers what job or graduate program they had lined up, but not actual goals reflecting what they wanted to be doing a few years after graduation.

4.1.5 What Influences These Goals?

All participants were asked what their post-graduation plans were, but the interview protocols did not explicitly ask the participants why they were pursuing various career choices. Although some participants talked extensively about their reasons, not all participants gave reasons. The participants who were only surveyed in their senior year were especially brief, usually responding in the free-response space with only their first job title. When participants did explain their career goals, they often talked about factors that are consistent with SCCT, including learning experiences, outcome expectations, interests, and contextual influences. These constructs are discussed in order, moving from left to right across the SCCT model diagram.

Learning Experiences

According to SCCT, Learning Experiences are past occurrences that can shape a person’s Self-Efficacy or Outcome Expectations related to a future task (Lent, et al., 1994). However, participants in my research discussed direct relationships between their learning experiences and goals, so I am presenting learning experiences as their own category of influence on goals. This does not preclude the pathways described by Lent et al. but is perhaps more indicative of the data limitations described above.

The predominant learning experiences discussed by participants were undergraduate internships, which five participants attributed to shaping their career goals. Internships provided exposure to working environments, which led the participants to being more selective in considering the working environment for their next jobs. Internships also introduced the interns to various job tasks, which they may or may not want in a permanent position. Emily’s experience was typical:

“It was a good experience, and the main thing that I got out of it was what I didn't want to do or what I more like wanted in the firm that I would work at full-time. I did a little bit of structural work, but the rest of the work that I did was -- it was a lot of stuff on the computer and then some just general civil tasks, and I just didn't like any of that stuff, so I knew I wanted to do the structural, and so therefore I looked for specifically a structural firm.” [Emily, LPub, APS]

Emily's learning experience at her internship shaped her goal of working in the field of structural engineering.

Self-Efficacy

Self-efficacy, or the participant's beliefs about his or her ability to perform various tasks, was not raised frequently but uncertain self-efficacy was an influential factor for three participants. Low self-efficacy was evident in the interviews where participants expressed apprehension about moving from school into the working world. For example, Kevin was not sure if his technical skills were sufficient, and Oscar was not certain about his career choices. On the other hand, other participants were fairly confident in their abilities as they approached graduation. When Sara's interviewer asked how prepared she felt to go to work, Sara responded:

“I'd be prepared, it's just a matter of when I want to leave school.” [Sara, SPri, APS]

Sara planned to earn a master's degree before leaving school, but she was still confident that she would be ready to enter industry.

Outcome Expectations

Outcome expectations are participants' beliefs about the consequences of various actions, and were discussed by eight participants. The most common outcome expectation expressed by these participants was that they expected to secure better jobs by attending graduate school. Because of familiarity with their schools and departments, those seeking master's degrees expected the process to be relatively easy. Three of the SPri participants had already enrolled in SPri's concurrent enrollment master's degree program that allowed them to start taking master's degree courses before finishing their bachelor's degrees. Grace talked about how simple she expected the process to be:

“It’s just so convenient to be able to get another or your master’s degree in, you know, just one more year, so might as well do it.” [Grace, SPri, APS]

Because of the expected benefits and convenience of earning a master’s degree, Grace decided to stay at SPri for another year.

In addition to securing better jobs, outcome expectations also influenced what types of jobs participants accepted. Max and Kevin talked about their first jobs as providing experience, with the expectation of more opportunities being open to them in the future. For example, Max said,

“But now I’m gonna’ go down south and I’m gonna’ do spud [initial drilling of an oil well] to sales. And that is huge experience. ‘Cause from that job, I’ll be able to, I won’t just be a drilling engineer looking for the next Intro/Completions job, or Intro/Productions job. I’ll have done the whole gamut with the exception of reservoir engineering, so it’ll way open up the job possibilities for after that.” [Max, TPub, APS]

Max believed that his first job would provide him with a breadth of experience that would open up more opportunities in the future.

Interest

Ten participants talked specifically about their interests, which led into goals to work in specific fields or perform specific tasks. For example, Oscar told his interviewer about one company he would like to work for:

“They’re on my short list for jobs when I graduate, ‘cause they’ve got control stuff they’ve got to work on, and they also make a pretty fast, fun car, that’s also completely electric and pollution-free, and, you know, it ties in with my history with electric vehicles, and it just sounds like a whole lot of fun. So. You can’t drive a satellite.” [Oscar, SPri, APS]

Oscar’s interests in environmentally-friendly and electric vehicles influenced which companies he wanted to work for after graduating. Other participants’ interests included creating products that would be immediately useful to consumer as opposed to theoretical work, working in various technical specialties, and interests in conducting academic research as graduate students.

Contextual Influences

Contextual influences include a variety of factors that are immediately relevant to current experiences and that influence a person's goals. Contextual influences may include perceptions of supports and barriers, such as people or institutions, which can help or hinder a particular goal or action. Contextual influences shaping career goals in my study included participants' financial concerns, geographic preferences, and supports provided by campus career resources. The most salient contextual influence, however, for participants preparing to graduate was the people in their career decision processes. These influential people include two romantic partners, family members (parents, siblings, grandparents, etc.), and one set of lab mates. Faculty members were also important; Michael's math professor encouraged him to pursue graduate studies:

“He told me that my scores were too good for me to be an engineer, and I thought that was really funny, so -- or I was a little confused, so I went in to talk to him, which is the first time I went to talk to him, and he told me he just meant that, you know, make sure I don't just like follow the path of practicing engineer and I should really strive to do something more than just work for someone else, because he thought I had talent. And so it didn't really change anything, but it made me look at engineering in a lot different way and realize all the different aspects of the kind of work you can do.” [Michael, LPub, APS]

After that conversation, Michael set a goal of earning a PhD and being involved in advanced research. Michael's professor exposed him to a broader set of opportunities than Michael had originally considered. This conversation shows a typical way that professors and family members influenced career goals: by providing support or discouragement towards specific goals.

Summary

Participants' goal influences generally aligned with those proposed by SCCT. I did not find any goal influences that did not appropriately fit under the categories of learning experiences, self-efficacy, outcome expectations, interests, or contextual influences. While not all participants explained their goals, several offered stories about various influences. Learning experiences from internships were common, as were interactions with key people, such as family

and faculty members. Participants also set goals based on the expected outcomes, such as one job leading to another, and their interests in various fields or tasks. Self-efficacy was less commonly discussed, but some participants were concerned about their competence as they finished their undergraduate studies.

4.1.6 Summary of Findings Related to Goals and Associated Influences

As advanced undergraduate students, goals related to types of jobs participants would like to have, their educational aspirations, and work/life balance. Potentially due to the structure and timing (close to graduation) of the interviews and surveys, participants did not frequently provide much detail about their goals or how they would achieve them; instead they focused on what they would be doing in the next few months. Most goals were tied closely to participants' interests in various fields or outcome expectations related to pursuing certain jobs or graduate study. With a lesser frequency goals were shaped by relationships with valued people, learning experiences, and self-efficacy.

4.2 Actions

The next sub-question asks about the actions early career professionals have taken to meet the career goals they set as graduating seniors. These actions occurred in the 2007 to 2011 timeframe. Actions were primarily reported in the EPS pre-questionnaires and interviews. An examination of future goals and actions towards those goals is included in a subsequent section. To answer the sub-question, I will first discuss the employment choices participants made after graduation, and then explore the reasons behind these choices. All of the participants followed one of two paths after earning their bachelor's degrees: they entered the workforce or they pursued an engineering graduate degree. I considered both of these pathways to be employment. The paths diverged quickly after the first position, however. Some participants followed the goals they set as seniors, but not all participants' actions lined up with their goals.

4.2.1 Going Straight to Work

As part of achieving initial goals, 19 of the 30 participants obtained full-time jobs immediately after graduating. Eighteen participants accepted engineering-related jobs, while Kevin went to work in investment banking. As shown in Figure 4-1, slightly less than half of the participants that initially went to work still worked for the same employer at the time of the follow-up pre-questionnaire and interviews. About a quarter had changed jobs and another five were in graduate school. Graduate students included three studying engineering, one MBA student, and one PhD student in science education. Only one participant, Justin, was pursuing both school and work. Justin was working full-time and enrolled in a master's degree program part-time; the other four were full-time students. All five participants who went to work first and then graduate school are male.

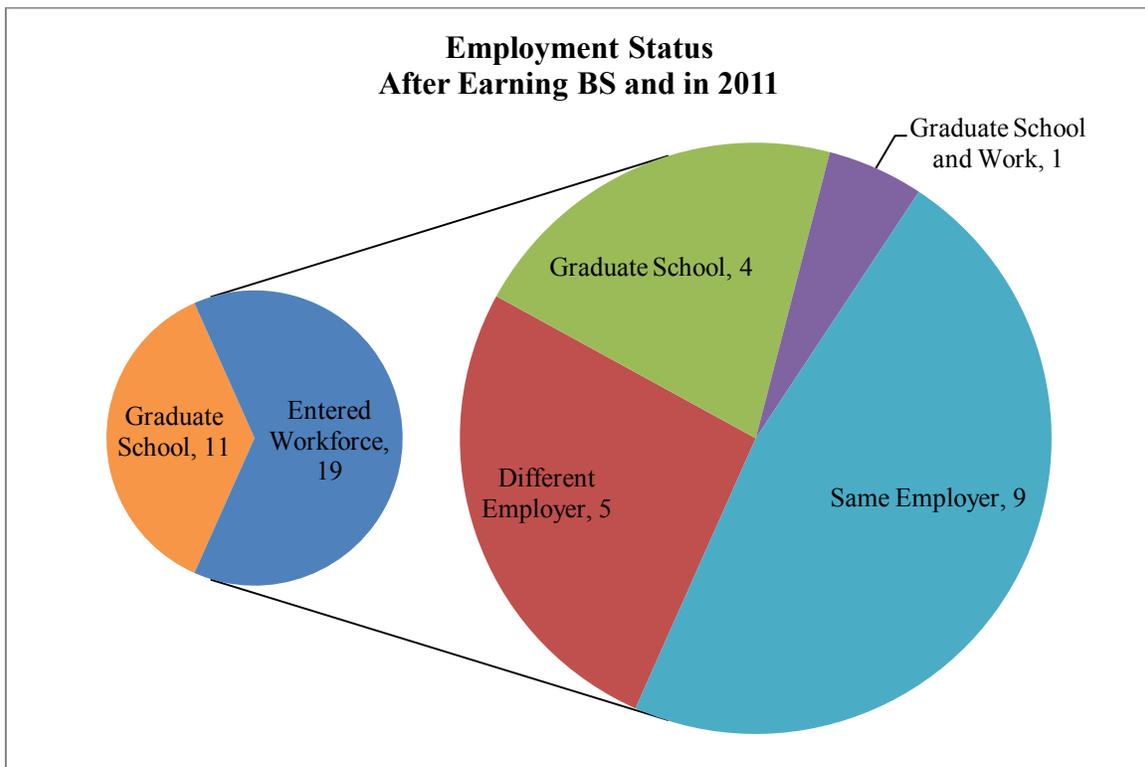


Figure 4-1. Employment Status for Participants Initially Working

4.2.2 Going Straight to Graduate School

The remaining 11 participants enrolled directly in graduate school in engineering after earning their bachelor's degrees. Figure 4-2 shows these participants' status as of the following pre-questionnaire and interviews. Six participants had already graduated and were working at the time, all having earned master's degrees in engineering from their bachelor's institutions. The three participants who were pursuing the same degree that they were seeking when they finished their bachelor's degrees were enrolled in engineering PhD programs at institutions other than their bachelor's institution. Kara and Lisa were the remaining two participants who went straight to graduate school. Kara originally stayed at LPub for an engineering master's degree, and upon completion she decided to stay for a PhD as well. This counted as a change instead of being counted as still being in school because she had planned on entering industry after her master's degree. Lisa stayed at TPub for her master's degree, then went to work as an engineer, and had ultimately enrolled in training for a therapeutic health profession at the time of the EPS interview.

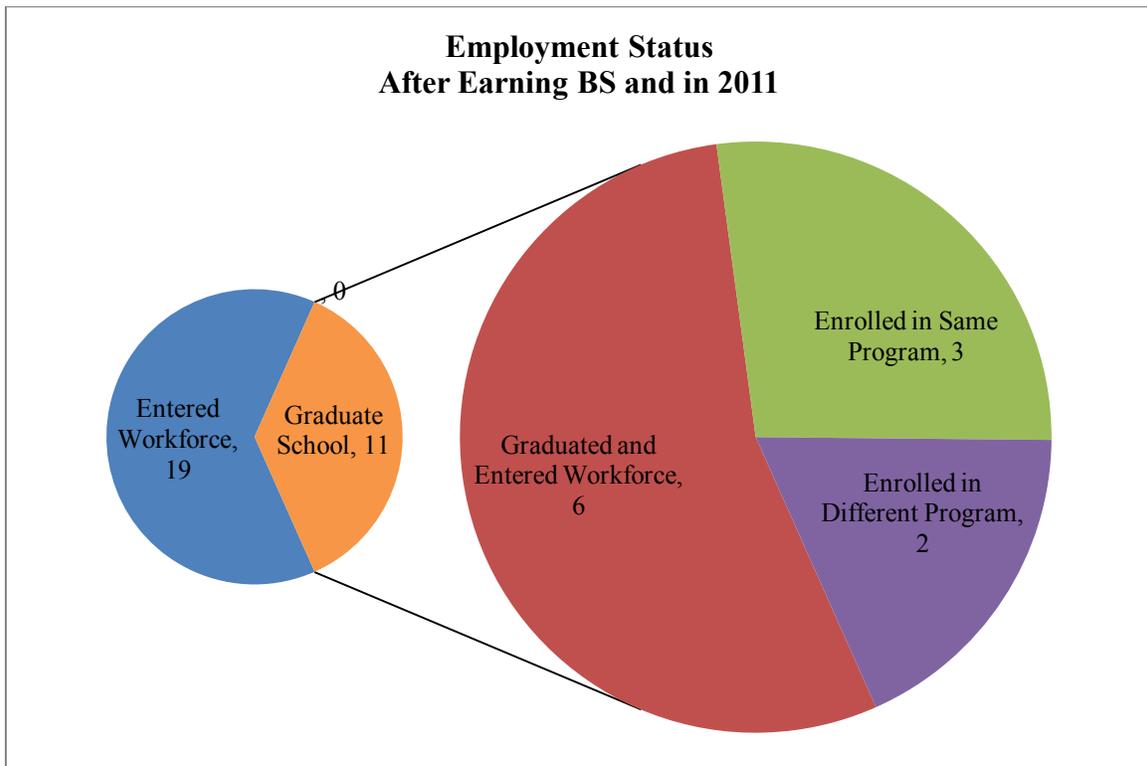


Figure 4-2. Employment Status for Participants Initially Enrolled in Graduate School

4.2.3 Networking to Achieve Goals

In addition to accepting job or graduate school program offers, the only other prominent activity participants discussed engaging in towards achieving their career goals was networking. Networking throughout the study period included discussions with professors and industry contacts from internships, seeking mentoring opportunities, and being active in professional organizations. Eleven participants reported networking activities to help them advance towards their goals or even determine what their goals were. For example, John sought out a mentor when he was planning his next actions:

“When I got out of the training program I kind of had a choice of whether I wanted to do any of those three different disciplines I talked about, I wanted to talk to somebody about it and I chose to talk to that guy who actually interviewed me for my first [Company Name] internship who no longer works at the company but, I went and we sat down over a couple of beers and kind of talked out what I was good at, what I wanted to learn, what I needed to learned, and it kind of came up that he had some recommendations and I made my decision with that input in mind.” [John, TPub, EPS]

After John took advantage of a rotation programs to move around in his company, he took the initiative to seek out a mentor’s advice for shaping his next career moves.

4.2.4 How Have Participants Decided on Those Actions?

Because the EPS interviews were intentionally designed with SCCT in mind and specifically to probe career choices, the data are much richer and offer significantly more explanatory insights. Participants explain their post-bachelor’s degree career actions in a variety of ways. These explanations all fit within the SCCT model and include their goals, learning experiences, self-efficacy, interests, and contextual influences. After discussing participants’ goals, the remaining influences are presented in the order they appear in the SCCT model, moving from left to right.

Goals

The primary reason that most participants identified for engaging in certain career-related actions from college to the present was to achieve their goals. As a senior, Beth said that:

“I’m sort of looking into maybe doing, working for the [government agency #1]. But, not doing like cleanup work, but more like regulatory work” [Beth, TPub, APS]

Beth then completed an internship with that government agency:

“I heard about this [government agency #1] internship so I thought I might as well apply for that and so after working for the [government agency #1] I really liked working with the federal government. And um, you know, when I graduated with my masters this other trainee program [with government agency #2] opened up and I applied for it and there you go.” [Beth, TPub, EPS]

After finishing her master’s degree, she applied for, and received, a position as a regulatory trainee doing environmental work for the government, doing the regulatory work just as she had wanted to. Similarly, Michael had a goal to be involved in high-level research, so he enrolled in a prestigious PhD program. To these participants, their actions were the logical application of their goals; they saw their goals and actions as being in harmony with one another.

Learning Experiences

Twenty eight participants mentioned some kind of learning experience impacting their career choices. Identified experiences included workplace experiences such as rotation programs or temporary assignments and educational experiences from graduate school. Several of these learning experiences could also be considered SCCT performance domains and attainments (Box 10 on the model shown in Figure 2-1) of previous actions. However, these experiences become learning experiences as the next iteration of the model begins. That is, in succeeding at a given task or in a given role, individuals learn from and through that success, so that the experience of success is concurrently both an attainment and a learning experience. The same holds true for failures. Therefore, such experiences are discussed here as learning experiences. This approach is also consistent with the ways participants talked about the experiences, i.e., as precursors not as endpoints. Lauren, for example, described her career as building on telecommunications experiences:

“I think I first got into telecommunications, I interned for [Internship Company] the phone company my sophomore year and that sort of opened the door for my first role at this, at my current job, where I went to a local phone company in another state and then

did some work for [Past Company] and, I would get pulled for other roles based on that previous experience so I would just say it builds upon itself.” [Lauren, LPub, EPS]

Because of prior achievements that served as learning experiences, Lauren continued in the telecommunications specialty. While Lauren’s experiences might have been serendipitous, Kevin explicitly made career choices to seek out learning experiences. He chose to spend two years as an investment banker after earning his bachelor’s degree:

“But I never envisioned myself doing that [investment banking] for long term, so it was kind of expected that I would find a, kind of use that as a platform to get to other places.” [Kevin, SPri, EPS]

After his two years, he left the investment bank to work as a financial analyst and planned to leverage that experience to apply for MBA programs. Similarly, Dana used a company rotation program to gain familiarity with various aspects of her company before settling down in manufacturing role.

Learning experiences have also caused participants to change directions. Jesse thought he was certain about his specialty, but changed his mind in a graduate course:

“I really thought I wanted to work with wind turbines, I’m taking a wind class right now, and its, it’s not a great class, but it also made me open my eyes a little bit to what a wind engineer actually does, and I think I might steer more towards solar.” [Jesse, TPub, EPS]

Once Jesse learned more about the field, he decided to change his plans. Kara’s experiences in graduate school also cause her to change her plans; while she originally intended to leave school after her master’s degree, positive experiences influenced her decision to pursue a PhD.

Self-Efficacy

While SCCT proposes a link between self-efficacy and actions, participants did not mention their self-efficacy influencing their actions between graduation and EPS interviews. Note that participants were asked about their success-related beliefs related to their future goals but were not asked specifically to reflect on how their self-efficacy influenced their past choices.

Outcome Expectations

In contrast to self-efficacy, outcome expectations were a very common explanation for why participants pursued certain actions, especially in the choice of whether or not to attend graduate school. About a third of participants discussed outcome expectations influencing their career goals and actions. Several participants chose to stay at their undergraduate institution for graduate school, saying that either graduate school was more interesting than jobs or that graduate school would get them a better job. For example, Kara from LPub and Joe from TPub both applied for jobs as seniors. They were unhappy with the available opportunities and instead decided to pursue graduate degrees. Joe described his outcome expectations and results thusly:

“I think part of my reason to go to grad school was that it would be a fairly stable position for at least 2 years, and it proved to be such.”[Joe, TPub, EPS]

Joe’s expectations of stability in graduate school and better work after graduation prompted him to pursue a master’s degree. These expectations were common. In terms of the SCCT model, the general goal was a certain type of job. The outcome expectation was that a graduate degree would help with that job. The action was to get a graduate degree, as shown in Figure 4-3.

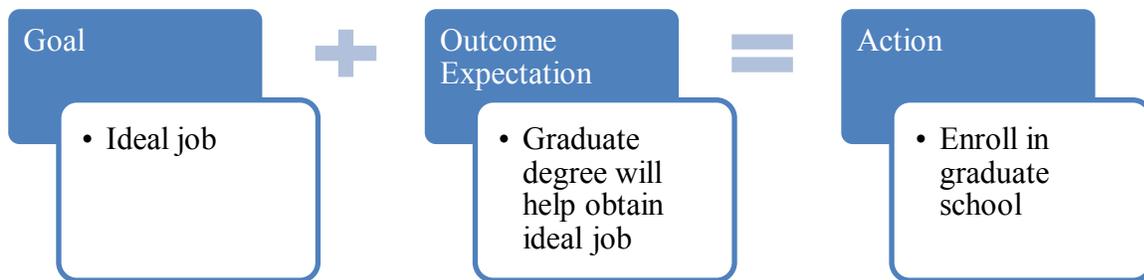


Figure 4-3. Choosing Graduate School

The outcome expectation of better work or more interesting work also was true for those who returned to graduate school after entering industry.

Interests

Participant’s interests influenced their actions by directing the type of work the participants pursued. An interest expressed by seven participants was in being able to see the impact of their work, whether through seeing a solution implemented in a manufacturing plant or improving

living conditions in a third-world country. For example, Jesse was passionate about international development:

“I really like engineering at this level because you know, an infusion from walking 2 miles away to get dirty water, and you know spending half your day as an 8 year old carrying a 40 pound bucket of water on your head to be able to open up a nozzle with clean drinking water that doesn’t make you sick in your house, like that, um, between those two stages. Is such a profound thing you can give people and it’s such a tangible difference for them.” [Jesse, LPub, EPS]

Because of his deep level of interest, he has sought and found work in a developing country.

Interests also influenced choices to change originally chosen paths; when participants were no longer interested in the work they were doing, they sought change. As an undergraduate, Justin had a goal of starting a company to pursue his interests in biotechnology. Justin did co-found a company, but:

“After about a year realized that neither one of us was exceptionally excited about it anymore and just kind of moved on.” [Justin, LPub, EPS]

Justin did not desire to stay with his company when he was no longer interested in the work. Not all participants who lost interest in their jobs were successful in moving on by the time of the EPS interview, but they all did report looking for other opportunities or actively applying for other positions.

Contextual Influences- Economy

One of the largest contextual influences faced by the participants was the economic downturn that occurred in the United States as participants were finishing their bachelor’s degrees. Although some participants were unaffected, 25 participants described impacts to their careers, or career choices, due to the economy. Eleven participants reported negative impacts, including 1) staying in a less desirable position, 2) involuntary job changes, 3) lack of advancements or benefit cuts, and 4) accepting a less desirable position. Some participants experienced multiple negative impacts. The other 14 participants broadened their job searches, sometimes pursuing graduate work, and were happy with their new career paths.

Two participants reported staying in a position they did not like because of the economy. Will, for example, was working in a specialty that he did not enjoy. He thought about changing jobs:

“One of the reasons that I didn’t run away... [was that] the economy [had] not been in that great of shape.” [Will, TPub, EPS]

Thus, Will stayed in his job because of the tight economy limiting his other options

Another four participants attributed lack of advancement or benefit cuts to the economic downturn. One participant was given a “promotion” that came with a pay cut, where she was expected to take on increased duties but with a lower salary. Another participant had her pay frozen. Emily expressed considerable frustration that both her hours and benefits were cut while her managers seemed unwilling to listen to her ideas for bringing in more work.

Due to a lack of available jobs, four participants accepted positions that, in retrospect, they believed were a mistake. For example, Lisa had a very difficult time with her employer and reflected that:

“I should have ...never [accepted that job] and just searched for a company that I actually would have liked and enjoyed working with.” [Lisa, TPub, EPS]

Had the economy been better, Lisa believed that she could have found a more interesting job with a positive work environment. Participants also bemoaned a lack of negotiating power in their job searches due to tight economic conditions.

Four participants were laid off from a position at some point during the economic downturn. While these layoffs were negative impacts the time, all laid off participants reported eventually transitioning into something that they liked better. Leah described her job search after being let go from her first job:

“It took about, it took a few months, but, yea, it wasn’t too difficult, I think our school has some very good networks. It wasn’t difficult. It was stressful [laughter].” [Leah, TPub, EPS]

Although not something she has planned or wanted, Leah did not feel that her job search after being let go from her initial job was particularly difficult. The job change allowed her to change

industries and relocate to her home state, both of which she stated that she had actually wanted to do.

In contrast to the negative economic impacts, fourteen participants acknowledged that their plans were changed by the economy but seemed relatively happy with the changes. Commonly reported changes included deciding to pursue graduate degrees and accepting alternative jobs.

Five of the 11 participants who initially pursued graduate degrees did so because the jobs available when they were awarded their bachelor's degrees were not interesting to them. During his senior year, Joe did not intend to pursue a graduate degree. However, Joe was not interested in the jobs available with his bachelor's degree. He explained in his EPS interview:

"I guess getting the position that I'm in now was very fortuitous because the company had just released a hiring freeze [when he finished his master's degree] that they had instituted so I was very lucky to get in." [Joe, TPub, EPS]

While Joe enrolled in graduate school because of a tight economy, he was able to find a much better job after earning his master's degree when his company was back in a hiring mode.

Seven participants were happy with a position that they perhaps would not have considered in a healthier economy. Oscar, for example, *"diversified [his] application pool" [Oscar, SPri, EPS]* by applying for more jobs in broader industries in response to the economic downturn before finding a good position. Similarly, Laura accepted a job outside her first choice of field and reported that *"it's treated [her] very well" [Laura, TPub, EPS]*, thereby showing that she had been able to adapt and was fairly happy with her work.

Contextual Influences- Family

Six of 14 women and 12 of 16 men reported on their EPS Pre-Questionnaire that a significant other impacted their career choices. More than half of the participants with significant others moved or were concerned about moving due to their partner's employment status or geographic preferences. For example, David, Laura, Max, and Nate all changed their plans due to their spouse's graduate education, limiting their job searches to small geographic boundaries around their spouse's schools. Significant others also provided moral support for participants. In one

case, David's wife encouraged him to quit his unfulfilling and uninteresting job, and eventually to enroll in a graduate program in line with his goals.

At the time of the EPS interviews, only men discussed being parents. Will and Nate each had one young child, and Joe and Josh were expectant first-time fathers. Two women and two other men talked about wanting to have children and trying to determine how to balance their future families with their careers. In all cases, parenthood influenced career actions through concerns with being able to both financially provide for and also have enough time to spend with the child. For example, Will would like to change jobs but had not yet, saying:

"We just had a baby. That's another thing that's influencing me to play it safe with my career choices. I want to make sure that I can provide for my family, and I can make sure my daughter has healthcare coverage." [Will, TPub, EPS]

Will limited his actions towards his goals because of his desire to provide for his child. The other prospective parents expressed similar concerns.

The participants' parents and extended family influenced the participants. In particular, parents and extended family provided broad views of available career paths. Nate, a PhD student, had several family members with PhDs, so he has seen a wide variety of options for when he finishes school:

"You see all these different sort of like paths of where people can go and what they do um, I don't know that I'll pursue any of the paths that I'm seeing family and friends do, but we'll see." [Nate, SPri, EPS]

Several other participants talked about their parents' continuing examples and guidance along their career paths, and their increased willingness to pursue various actions due to parental support. Conversely, one participant faced disapproval from her family when changing careers. Lisa's parents were "so happy" when she earned a scholarship to TPub and "so happy" when she took a job with a major corporation, "and then not happy at all about [pursuing a therapeutic health profession]" [Lisa, TPub, EPS]. Lisa did not limit her actions to following her parents' wishes and chose to follow her goals anyway.

Several participants also sought to be relatively near their parents and extended family, though these geographic restrictions were not as tight as those associated with significant others.

Beth and Kara were the exception; they were both worried about caring for their elderly grandparents. Beth explained:

“My grandmother had some health problems and I now live with her. For this reason I looked for only local employment that allowed for a flexible work schedule.” [Beth, TPub, PreQ]

Beth’s desire to care for her grandmother limited her job search much more so than other participants were limited by their relatives.

4.2.5 Summary of Findings

Nineteen participants were employed full-time and 11 went to graduate school after completing their bachelor’s degrees. Many participants associated graduate school with helping them achieve their goals. About a third of the participants also actively sought out mentors or participated in networking to advance their careers. Actions were influenced heavily by participants’ outcome expectations and limited by economic conditions and family commitments.

4.3 Future Plans

The third sub-question addresses participants’ goals and plans for the future. In both the EPS pre-questionnaire and interview, participants were explicitly asked what their plans were for the next five to ten years. In the interview, they were also asked how confident they were in their ability to achieve those plans, which revealed many of the influences impacting their goals and actions. Goals included advancement in their current jobs, additional education, and changing jobs. Participants who were less certain about their original career paths still discussed their interests in changing jobs or seeking further education. Many of the same influences that impacted past choices were still important for future goals.

4.3.1 Job Promotions

After a few years of experience, participants were generally able to identify the next step for their careers. Six participants had a goal of advancing within their current company. Laura wrote in her Pre-Questionnaire:

“I see lots of room for development, advancement, and challenging positions at [company]. I feel [company] is a great company to work for and I live in a fantastic area.” [Laura, TPub, PreQ]

Laura was planning on working towards a promotion within her current firm. Similarly, Josh had been working with his company for four years, and had determined that he wanted to advance along the specialist track:

“The way [company] does it is they try to move you either on a general track, where you have a lot of different experiences in different, parts of the world, and then you move into a manager role, so that's your general track. And there's a specialist track, you kind of stay in one area of expertise for a long time, you start writing technical papers, and you really just learn what you apply every day, and then you share that knowledge. I just was a little bit, maybe reluctant to go from place to place 'cause to take the general track you really gotta be in a new town every couple of years or whatever, so to just get a wide area of expertise. So, I think, you know I really like the area, my wife and I are just happy here with our church, and our house and, our friends that are based down here, and the company's good so I think I'd like to move into the specialist's role, just so that I could learn kind of one area of expertise and then share that knowledge with other members in the company.” [Josh, TPub, EPS]

After gaining experience, Josh knew the steps that he needs to take to advance his career within his company. He also identified many factors as influencing this goal. Such factors are discussed in subsequent sections.

4.3.2 Job Mastery

Many of the participants who changed jobs since earning their bachelor's degrees or who had earned master's degrees had been in their current job only a short duration at the time of the EPS

interview. As a result, six participants emphasized mastery of their current roles before moving on when asked about their goals. For example, Joe earned a master's degree and had only recently started his job:

“Oh, right now, I’d say basically since I’ve only been in my position for a fairly short amount of time I’m just trying to get uh, broader base of experience there before trying to move out anywhere else.” [Joe, TPub, EPS]

Joe felt that his immediate goal was to master his current position instead of seeking immediate advancement. Like the other participants seeking mastery, his main career actions were to learn how to best perform his job function.

4.3.3 Finish School

Of the 10 participants in graduate school at the time of the EPS interview, all had the goal to finish in the next year or two. Those seeking master's degrees planned to continue in or return to industry. The five PhD students were split between desires to work in industry and academia. The ability to teach and impact students in academia was appealing, but PhD students were concerned about the demands of an academic career. Common actions towards achieving their goals included discussions with advisors and networking, particularly at conferences, as well as trying to ensure they were producing high-quality work. Michael explained his efforts to build his skills:

“I’ve been trying to just, I guess figure out how I can use my skills, sort of my classroom based knowledge and extend it a little further so that I can be not just someone who can perform research but someone who can come up with his own ideas and uh, sort of develop them on his own rather than under an advisor.” [Michael, LPub, EPS]

Michael was working on establishing himself as a researcher so that he would be able to work on his own after finishing his PhD.

4.3.4 Return to School

Thirteen of the 20 participants who were not currently in school at the time of the EPS interview were considering further education, some more seriously than others. Beth, who already had a master's degree, is an example of those casually considering school at some point:

"I don't know it's just kind of another thing I always thought I could do and would have fun with. So ya know sometime in the future I might decide to go back to school and get a PhD and maybe ya know try to go into teaching." [Beth, TPub, EPS]

Beth's goal of earning a PhD was fairly loose and she had no plan to act on it soon. Other participants had much more concrete plans. For example, Max had already identified his program and expected start date:

"I want to go to a program that [school] offers... where it's an MS instead of an MBA, it's an MS in global energy management. And it's basically all the MBA classes with a focus on energy and then you get an MS instead ... I need to try to apply to it this year, to tell you the truth, that's my plan, to apply this year." [Max, TPub, EPS]

Max had a very clear plan of action. Similarly, Jesse had consulted with a mentor that told him an engineering master's degree would be far more distinguishing than other graduate programs in desired career path, and so Jesse had already taken the GRE with plans to enroll in an engineering master's degree program for Fall 2013.

4.3.5 Changing Jobs

Half of the participants, 15 of 30, had a definite goal or were at least considering changing jobs. At one end of the spectrum, Vince and Beth were happy in their current roles but wanted to keep their long-term options open; they did not want to be tied down to the same job for their whole careers. Other participants reported feeling stuck in jobs that were not ideal, but were hesitant to leave until they have secured other work. For instance, Lauren would prefer a different job, but said:

"That [uncertain economy] makes me sort of want to stay in consulting for the time being because it, even though we're always looking for a project to project or going from project to project in a sense we work for ourselves and you don't have to, I guess, don't

have to depend on the employer as much, so I guess it's just learning to take the skills and being dependent on yourself most, instead of depending on the employer and saying is my job going to be here tomorrow and that sort of thing.” [Lauren, LPub, EPS]

Lauren was hesitant to walk away from her consulting job in an uncertain economy. Most of these participants who were interested in changing jobs cited an uncertain economy and a need to provide for their families as keeping them from finding other work.

4.3.6 Why Do Early Career Engineering Graduates Have Those Future Goals?

Future goals and plans were based on learning experiences, interests, and contextual influences. All participants mentioned multiple factors influencing their careers, and many influences spanned categories. These factors are discussed here in the order they are shown in the SCCT model, moving from left to right.

Learning Experiences

Again, learning experiences were inseparable from the performance domains and attainments of previous actions and therefore combined in this section. The most common, and seemingly most important, experiences shaping participants' future were workplace experiences. Seventeen participants talked about the impact of their work environments on their careers. Otis has ignored recruiters because he loves his workplace:

“I really like working at [Company], I've ignored other recruiters who have tried to get me to go to other companies, um, just because I think [Company] is so great.” [Otis, SPri, EPS]

The positive work environment has contributed to Otis' loyalty and led him to turn down other opportunities. Negative work environments, however, contributed to some participants' decisions to change goals. The most striking case was Lisa, who chose to leave engineering altogether because of a negative work environment:

“I didn't like the politics in the office, there's a lot more like, if you suck up the best then you get the best jobs and I was helping people do their jobs that should not have these jobs at all, I was not qualified to be doing what I was doing but I was more qualified than

they were, and they were the ones that were supposed to be doing it, so that made me really, kind of aggravated and frustrated that it wasn't who you were and how smart you were it was just who you knew. And so that really turned me off from engineering.” [Lisa, TPub, EPS]

Because of the negative office environment, Lisa decided to pursue a career outside of engineering. Lisa's case again illustrates the difficulty of separating performance domains and attainment from learning experiences. She had a negative performance experience, in which her performance was devalued against those of more experienced, but less qualified coworkers, and that incident served as a key experience for learning about engineering as a profession.

Self-Efficacy

While self-efficacy was rarely discussed as a factor in prior career choices, participants did talk about their self-efficacy influencing their future careers. It is important to note that direct conversations about self-efficacy influencing career choices might be attributed to the interview structure. Participants were particularly likely to refer to their self-efficacy when asked to rate their confidence in their ability to achieve their future plans. Self-efficacy was a factor in decision making for 22 of the participants, both negative and positive. Austin and Beth are examples of those that feel confident they will be able to achieve their goals:

“Yea I think for the most part though, I have the skills and a reasonably solid resume, so, it should all work out I hope, that's my hope.” [Austin, LPub, EPS]

“I mean it's hard to be entirely like ya I'd say I'm pretty confident but I don't want to be overly confident but you have to be kind of realistic about it. You might not always achieve everything that you set out for and that's okay. You reevaluate, you make a different plan, and then you go forward.” [Beth, TPub, EPS]

Both expressed pragmatically positive outlooks on their ability to achieve their goals. Other participants, however, had adapted their goals based on having low self-efficacy towards the original goals. For example, Vicki was nearing the end of PhD studies and unsure about what to do next:

“I wonder if I actually have good enough ideas to have a real impact in academia.... I don't know if I'm good enough to be a professor at a top school, I do think that I could be

a professor at a smaller school but I not sure if I would want to do that, if I'm at a school that doesn't have as much research going on, or not as good students I may just prefer to go into industry where they are doing a lot of cutting edge stuff." [Vicki, SPri, EPS]

Vicki was backing away from her initial goal of being a professor because she was not sure of her ability to perform in a competitive academic environment. In industry, Will's self-efficacy had suffered from his inability to find a job that he liked, leading him to think his goals might not be achievable:

"And since I'm in my current job I'm worried that those skills that I learned in school are just becoming more and more stale, that the longer I stay here the harder it is to find a job in the career I want, actually something that'll match my current salary so that we can keep our house and everything." [Will, TPub, EPS]

Will was worried that he will not have sufficient technical competency to obtain the job that he wants.

Outcome Expectations

Coupled with learning experiences and self-efficacy, outcome expectations helped shape participants' goals. For example, Will's negative self-efficacy beliefs about his technical competence fed into an outcome expectation that he would not be able to move into his desired field. Outcome expectations can also shape goals through participants' observations. For example, Otis' observations of the career paths of other engineers influenced his goal of moving into technical management:

"I think, in general, as engineers age, the job prospects tend to decrease- a lot of the engineers that I've seen, they're either absolute geniuses when they're older, and they're, you know, lead architects, senior architects, and a lot of others go into entrepreneurship or technical management. I enjoy coding, but I think it would be an interesting challenge to actually, I also enjoy sort of conceptualizing answers to problems, not necessarily just like, straight out coding them as well. Um, and I think doing that combined with some sort of management or operations role when it comes to a company, would be interesting." [Otis, SPri, EPS]

Otis' observations of more advanced engineers shaped his expectations of future career paths, leading him to have a goal of moving into operations or management.

Outcome expectations can also shape a participant's choices not to pursue a certain path. Karen originally contemplated earning a master's degree but put her plans for higher education on hold, saying:

"If I'm able to move into a management position without going back for any additional education I would, you know, I probably would just do that." [Karen, TPub, EPS]

Since Karen did not expect a benefit to pursuing a graduate degree, she decided not to return to school. This decision is shown in Figure 4-4.

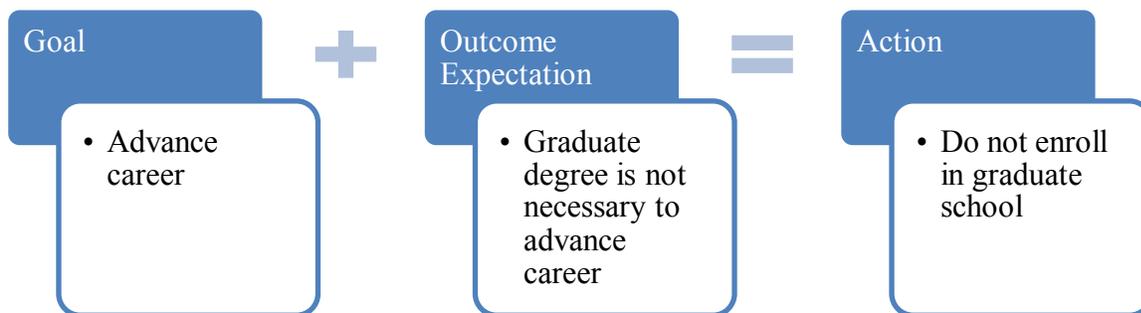


Figure 4-4. Not Choosing Graduate School

Interests

Interests played highly in participants' decisions to stay or leave their jobs. If a participant's interests were compatible with his or her current career trajectory, then the participant generally had goals to advance within the field and acted consistent with that goal. In the example from the previous section, Otis was interested in:

"Conceptualizing answers to problems, not necessarily just like, straight out coding them" [Otis, SPri, EPS]

Otis had a goal of moving into a role that would allow him to do more conceptual work. He could see a way for his interests to be met.

Some participants did not find their current work interesting; their main goals were to find interesting work. Will wanted to move into hardware work rather than software development and was actively applying for other jobs. Three other participants, however, were not certain where their interests lay:

“I’m just worried I’m not going to be able to figure out what I do want to do if I, if it’s not engineering, you know?” [Emily, LPub, EPS]

“I’m just still trying to sort through what kind of jobs are available and that I can use my degree in and also at the same time keep me captivated enough to stay and want to do the job.” [Leah, TPub, EPS]

“It’s hard for me to know right now what I really want to, what subject I really want to focus the rest of my career on, it’s really scary that I’m graduating now and have to think about those things, and it’s easy to say I know it’s a post doc and I’ll find an academic job but I have a lot more uncertainty than that.” [Vicki, SPri, EPS]

All three of these participants were uncertain about their interests and so were uncertain about what actions to take. Emily and Leah intended to stay in their current jobs until they could figure out what they wanted to do. Vicki was completing her PhD and was worried about the upcoming deadline forcing her to make a decision.

Contextual Influences

Similar to their past experiences, contextual influences on future plans included economic conditions or financial concerns, family relationships, and other personal relationships. Financial incentives kept participants in their current jobs, even when they would prefer to do something else. Emily told the interviewer that her only motivation for staying in her current job was money:

“Right now it’s basically, literally the finances. Yea, I’m not super happy when I wake up in the morning to go my job right now.” [Emily, LPub, EPS]

Emily was unable to pursue her goal of finding a fulfilling career because she needed the income from her job. Similarly, finances influenced Paul’s decision to stay at his job for a while:

“I actually just signed an employment contract for the next few years because they offered me a lot of money and I need to save to go back to school.” [Paul, TPub, EPS].

Because of the lucrative contract offered to him by his employer, Paul decided to remain in the workforce longer, postponing his education goals.

Financial concerns also overlapped with family concerns. David told the interviewer that money was becoming more important to him as he made his career choices going forward:

“I have a wife now and I’m interested in eventually starting a family, so, again, money does factor in as much as I hate to admit it.” [David, TPub, EPS]

Money had not been a major concern for most participants when they started their careers, but, like with David, it became a more important factor as participants took on dependents and mortgages. Family concerns were also addressed in worries about juggling spouses’ careers. Kara and her fiancé are both PhD students:

“My fiancé is getting a doctorate in [field] and um, he’s a lot more committed to the academic route, and you know, there are a lot of things that can make me happy in a position and so, you know, I’d like to see what opportunities are available when I’m ready to make that transition... I mean it will involve compromise at some point on, on one of our parts. So, and we’ve talked about, [he] lives and breathes math, so it’s his hobby even when he’s not working. We’ve talked about like needing time for other parts of our life, being involved our church and someday starting a family. And those are both, those are important goals to both of us, and we’re committed to making career choices that allow us to do those things.” [Kara, LPub, EPS]

Kara’s future career decisions were heavily influenced by her fiancé’s career choices as well as their desires to start a family. Like other partnered participants, Kara acknowledged that future career choices will involve compromises.

Other people also influenced participants’ career choices, largely in the workplace setting. Positive relationships led participants to plan to stay in their current jobs longer. For example, John had a great relationship with his boss:

“I’ve got a great boss, and, it’s really not a choice, I like it so much I couldn’t really want to leave....I’m just looking forward to doing this for as long as [Company] will let me or until my boss retires and then re-think it.” [John, TPub, EPS]

John’s positive relationship with his boss influenced his short-term plans of staying in his current job. Other participants similarly cited relationships with bosses and coworkers as impacting their goals to stay or leave their companies.

4.3.7 Summary of Findings

Participants who were happy or satisfied with their work were seeking job promotions with more responsibility in the next five to 10 years, as well as focusing on doing good work and ensuring they have both the qualifications and credentials for promotions. Those who were not happy had the primary goal of changing employment to something that better matched their interests and were applying for other jobs. Influences included financial concerns, spouse and children, and workplace relationships.

4.4 Tying the Past to the Future

The final sub-question asks how past goals are related to future plans. A key strength of this study is the ability to explore how future goals and associated actions or plans are related to prior career goals and actions through the SCCT model’s feedback loop from Performance Domains and Attainments to Learning Experiences (Boxes 10 and 3, respectively, on the model shown in Figure 2-1). In analyzing the interviews, the relationship seemed to overwhelmingly rely on participants’ levels of perceived success, interests, and positive or negative experiences.

4.4.1 Perceptions of Success

Participants who felt successful in achieving their initial goals had future goals that continue somewhat along the same career path; this included about half of the participants. It is important to note that success does not mean that participants are doing what they said that they would be doing. Instead, perceptions of success seem to be related to participants’ enjoyment of their work and even feelings of autonomy about their career path. For example, Emily wanted to work as a

structural engineer and worked for the same firm since graduation; she was doing what she said she would be doing but she was deeply unhappy and felt unsuccessful. In contrast, Max intended to work for three years in one place and then enroll in graduate school. Instead, he transferred within the company to another state after two years to support his wife's education and intended to enroll in graduate school in 2012, after five years of work. He felt very successful despite changing his plans.

Two participants took major detours yet still felt successful. Jesse and David were working towards the same goals they had as seniors, though in the intervening years their actions did not reflect those goals. They took engineering jobs that were not in line with their original goals and then were laid off. Due to the poor economy, both ended up working in service positions for a while. At the time of the EPS interview, Jesse was working on a master's degree to pursue his goal of working with alternative energy, and David was fulfilling his goal of humanitarian outreach as an engineer in a third-world country. Both reported that their goals as early career engineers were consistent with the goals they had as undergraduates. Even though their paths were not direct, they expressed satisfaction with their career paths.

4.4.2 Major Changes in Career Goals and Actions

Major changes in career goals and actions were usually tied to a negative experience. As described in a previous section, Emily felt she did not have enough work due to the economic downturn, was unsupported by management, and that her work did not matter. She was thinking of leaving engineering, a major change in career goals, but was concerned about money. Lisa had a terrible experience at her engineering firm, citing severe ethics violations that were downplayed by the company, and consequently left to enroll in training for a therapeutic health profession. Both women experienced major changes in their career goals tied to negative experiences.

4.4.3 How Does SCCT Explain Relationships Between Prior and Future Goals?

SCCT, as a longitudinal model, includes an important feedback loop. Performance Domains and Attainments, or the consequences of actions, lead back into Learning Experiences and the model runs again. This feedback loop explains the relationship between past goals and future goals. If

the participants had experienced success, the positive feedback loop would have encouraged them to continue. This was the case for Max, who was very successful in his career, and Samantha who was prospering in her PhD program. If participants had been unsuccessful in meeting their goals or had negative consequences to their actions, then their self-efficacy and outcome expectations would suffer and they would attempt to change their goals. Lisa left engineering after negative experiences led her expect more positive outcomes in another field. Will was seeking to change jobs, but his self-efficacy was suffering as his attempt to transfer within his company was unsuccessful.

4.4.4 Summary of Findings

Perception of success is the primary factor relating past goals to future goals. Those who felt successful persisted along the same general path, while those that felt unsuccessful changed their goals. This is consistent with the feedback loop proposed by SCCT, where attainments become learning experiences that influence the model over time.

4.5 Answering the Over-Arching Research Question

Answering the sub questions leads back to the overarching question: What factors influence early career engineering graduates' career goals near the end of their undergraduate engineering studies, career-related actions taken in the subsequent four years, and their future career plans? At the end of undergraduate studies, most participants were focused on their first job or graduate program. Goals were frequently tied to interests, but were also influenced by learning experiences such as internships. Eleven of the 30 participants chose to attend graduate school, often citing the outcome expectation that more schooling would help them find more enjoyable or interesting work.

Many participants limited their initial job searches based on geographic preferences, which usually were tied to romantic partners or family members. Job selection for some participants was also limited by decreased job availability due to the economic downturn. Fewer opportunities led some participants to accept jobs they later regretted, while others broadened their horizons and found interesting work that they had not originally considered.

Once participants settled into their jobs, they tended to evaluate what they wanted to do next and begin to proceed down that path. Participants commonly sought out mentors, such as bosses, senior coworkers, or faculty members to advise them in shaping their careers, including decisions about graduate education. Increasing family responsibilities related to spouse and children, or desires for spouses and children, led participants to factor desires for stability into their career choices.

Generally, participants who reported feeling successful or satisfied during the early career phase sought to continue developing their careers along the planned trajectory. Those who were dissatisfied with their career sought change.

5 Discussion

In this chapter I will discuss the overall fit of my data with SCCT as well as some themes and patterns that emerged during the analysis and differences among various groups. Each of these findings will also be situated in current literature. Important findings include differences in meeting expectations by sex, differences in graduate enrollment by institution, the influence of family members, and the impact of the recent economic downturn.

5.1 The Social Cognitive Career Theory Model

The purpose of using a theoretical model in this research was to provide “a broad explanation for behaviors and attitudes, and ... a ready-made series of hypotheses” (Creswell, 2009, pp. 61-62). In engineering education, drawing on theory enables researchers to “save time and effort and to ask reasonable questions informed by what is known” (Svinicki, 2010, p. 5). For my study, this means that the SCCT model provided an initial structure to explain career goals and actions, so that I had some understanding of what I was looking for before I began analyzing the data. Using this framework was also consistent with using case study methods to answer why and how questions (Yin, 2009) because the model addresses why and how career choices are made. The SCCT model itself and the general applicability of the model to this research was discussed in detail in Chapter 2. Importantly, SCCT has been used, and shown to be valid, in a variety of settings similar to my research with early career engineering graduates (Brunhaver, et al., 2010; Fouad, Fitzpatrick, & Liu, 2011; Lent, et al., 2005; Trenor, et al., 2008). These works suggest the appropriateness in adopting the SCCT framework to explain the experiences of early career engineering graduates. Because frameworks offer theories about relationships among data, it is

both necessary and important to discuss how my data and findings match or fail to match the model. The model from Figure 2-1 is shown again below as Figure 5-1.

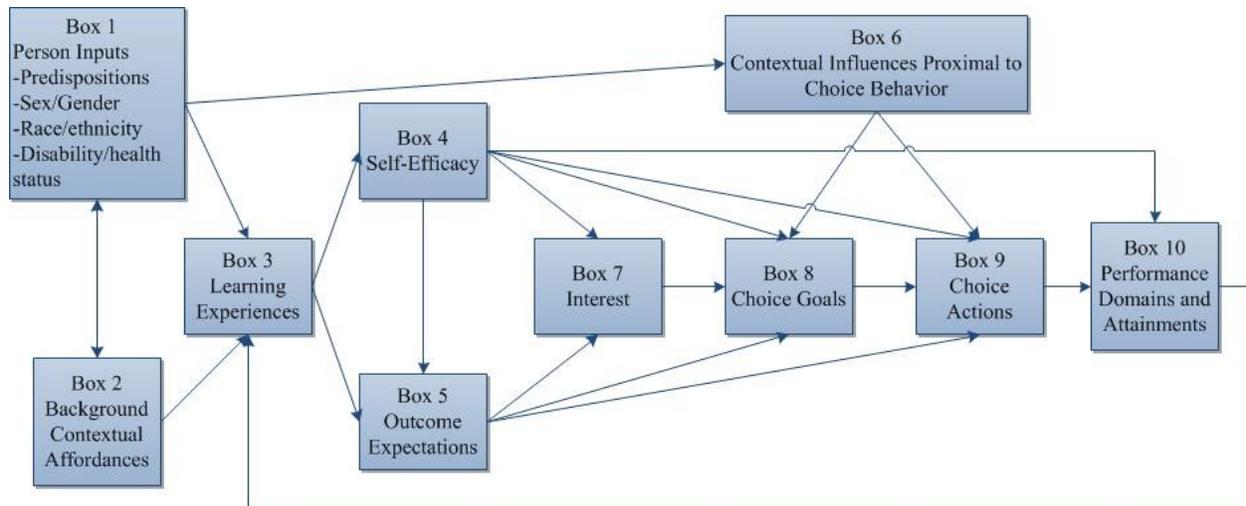


Figure 5-1. Social Cognitive Career Theory (Lent, et al., 1994).

Overall, my analysis shows that the model fits the data from my study well. For example, no participant mentioned Person Inputs or Background Contextual Affordances directly impacting their current career choices. This is consistent with the model showing these inputs as moderated by other variable such as Learning Experiences and Contextual Influences, as well as consistent with literature finding Person Inputs and Background Contextual Affordances were not as important in impacting Goals as Self-Efficacy and Interests were (Lent, et al., 2005; Lent, Schmidt, et al., 2003).

Person inputs include individual predispositions, sex or gender, race or ethnicity, and disability or health status. In the undergraduate interviews all participants were asked directly how their sex and race influenced their college experiences. Many reported no impact, but some discussed challenges faced by minority groups even when the participant was not a member of a minority. Participants were not asked about their sex or race in the EPS interviews, and no participant volunteered information about how race or sex was an advantage or disadvantage to him or her. Therefore, there are no data to suggest that Person Inputs were directly influencing participants' career choices during the study period. However, extensive literature has described differences that women and minority engineers face both as engineering students and in the

workplace (Bilimoria & Stewart, 2009; Cech & Waiszunas, 2009; Dryburgh, 1999; Faulkner, 2009a, 2009b; Jorgenson, 2002; Tang, 1999; Tonso, 2007; Trenor, et al., 2008). While it is possible that the participants truly felt that their sex or race had no bearing on their careers, it is also possible that socialization to the engineering culture led them to downplay any differences from the majority (Jorgenson, 2002; Tang, 1999; Tonso, 2007).

Similarly, Background Contextual Affordances are not discussed as important factors in the career choices participants made during the study period. Background Contextual Affordances are prior opportunities, experiences with role models, or cultural socialization that occurred in the person's past. Some Background Contextual Affordances have certainly influenced prior career choices. For example, Max frequently mentioned as an undergraduate that his mother worked in a cubical as an electrical engineer, and he very much did not want to have a career like hers. So, he chose to major in petroleum engineering. That Background Contextual Affordance of his mother's job led to a Learning Experience of learning that she worked in a cubical as an electrical engineer, which led to an Outcome Expectation that if Max went into electrical engineering, he would be working in a cubical. This expectation then interacted with Max's Interests of enjoying outdoor and hands-on work to form a Goal of not working in a cubical, to eventually result in the Action of enrolling in a petroleum engineering program. However, this entire decision-making process for Max happened before he even arrived at TPub and therefore outside of the range of this study. Like other participants, during his senior and EPS interviews he only talked about such experiences from his childhood as influencing his initial decision to enroll in an engineering major, not as impacting his career choices going forward. The cyclical and longitudinal nature of the model supports the conception of certain influences moving from Contextual Influences Proximal to Choice Behavior to Background Contextual Affordances as choices are made and acted upon as the participant's career progresses. Therefore, those Background Contextual Affordances are not salient for my analysis of career decision making during the early career phase, which agrees with the construction of the model.

Evaluations of SCCT in the literature tend to emphasize the role of self-efficacy. For example, one study proposed that Contextual Influences Proximal to Choice Behavior may be better portrayed as influencing goals and actions indirectly through self-efficacy, instead of directly (Lent, Brown, et al., 2003). In contrast, my research seems to support the direct

relationship from Contextual Influences Proximal to Choice Behavior to Goals and Actions as in the original SCCT model (Lent, et al., 1994). Another study suggested that self-efficacy only indirectly impacts goals, through outcome expectations and interests (Byars-Winston, et al., 2010). Two other studies supported the role of self-efficacy as presented in the SCCT model (Pruitt, et al., 2010; Van Vianen, 1999). In my work, participants did not discuss self-efficacy as playing an important role in past goals and actions, but several participants did discuss a direct relationship of self-efficacy to future actions, a pathway supported by the model. This is likely due to the nature of the interview questions. Specifically, participants were asked about their confidence in achieving future plans but not how their confidence played into their past goal setting and actions.

Finally, one distinct difference in my data and the SCCT pathways is found in the relationship among Learning Experiences, Goals, and Actions. Due to the longitudinal scope of this research, I could not separate Performance Domains and Attainments from Learning Experiences, and therefore combined them into a single category. The SCCT model posits that Learning Experiences influence Goals and Actions through Self-Efficacy and Outcome Expectations, not directly. My data do not refute this pathway, but many participants talked about learning experiences without clearly mentioning how those learning experiences impacted their self-efficacy or outcome expectations in the interviews. Therefore, I could only code their influences as “Learning Experiences” and found no instances appropriate to code as “Self-Efficacy” or “Outcome Expectations.” An exemplar case would be David’s description of how he changed his desired specialty while in graduate school:

“I really thought I wanted to work with wind turbines, I’m taking a wind class right now, and it’s not a great class ... and I think I might steer more towards solar.” [David, TPub, EPS]”²

So, David describes how his Learning Experiences in the course have helped develop his career path, but he does not clearly mention any perceptions of self-efficacy or outcome expectations associated with solar energy work. It is highly likely his Learning Experiences did result in changes to David’s self-efficacy and outcome expectations that influenced his decision to change

²References to data sources are presented as [Name, Institution, Data Source]. Institutions include TPub (Technical Public University), SPri (Suburban Private University) and LPub (Large Public University). Data sources are labeled as APS (senior or junior undergraduate interviews from the Academic Pathways Study), PIE (senior Persistence In Engineering surveys), PreQ (Pre-Questionnaires from the Engineering Pathways Study), or EPS (early career interviews from the Engineering Pathways Study).

his emphasis, as the SCCT model proposes. But as he, and others, do not explicitly say so, I must conclude that Learning Experiences do directly impact career pathways for the participants in this study. As discussed in Chapter 6, explicating this pathway is a suggestion for future research, as I could identify no current SCCT research that directly addresses the pathways in question.

5.2 Differences in Meeting Expectations

Beyond evaluating the model and answering the research question in Chapter 4, I noted some interesting trends in the data. One of the most surprising group differences has been in the responses to the question asking participants if, as early career engineering graduates, they are doing what they thought they would be doing when they were undergraduates. Ten of the 14 women said no, and the other four said yes. In contrast, only one man said no, three men said that they were somewhat doing what they expected, and 11 of 15³ said yes. These numbers were confirmed in a separate analysis of EPS data that included participants without engineering degrees (Carrico, Matusovich, Winters, & Brunhaver, 2012 (Forthcoming)). As a whole, participants who reported they were doing what they expected had future goals of continuing on their current career trajectories, while many of those who were not doing what they expected expressed frustration to the interviewers and were actively seeking to change employment.

It is interesting to note that participants' reports of whether they are doing what they expected do not always match up with their stated goals as undergraduates (Winters, Matusovich, & Carrico, 2012). For example, Emily wanted to work as a structural engineer, and was already working part-time for a structural engineering firm before graduating. She started full-time after graduation, and was still working there four years later. Yet, she reported that she was not doing what she expected to do. At the other end of the spectrum, Jesse and David both were laid off from engineering jobs and worked in food service positions for a time. At the time of the EPS interview, Jesse was pursuing a master's degree and David was working in a third-world country, and both reported that they were doing what they expected to be doing.

This finding that women are not doing what they expected is even more surprising when coupled with literature suggesting that women have lower career expectations than men (Gibson

³ One man was inadvertently not asked the question.

& Lawrence, 2010; Schweitzer, Ng, Lyons, & Kuron, 2011), and women college students have lower salary expectations than men college students (Schweitzer, et al., 2011; Taylor, 2007). In my study, more women than men had completed graduate degrees, and men changed employment more frequently than women did. The theory that women have lower expectations and the finding that women do not report they are doing what they expected seem inconsistent with the apparent career success of the participants.

So why might women's expectations not have been met? Research has shown that some graduating seniors were uncertain of what engineers do (Matusovich, et al., 2009). Another study found engineering graduates were surprised that engineering work involved a lot more communication and teamwork tasks, as opposed to the design tasks engineering students were promised when they first began studying engineering (Fouad & Singh, 2011; Trevelyan & Tilli, 2008). Similar discrepancies were found among my participants; Lauren, Leah, and Paige all explained that they did not understand what types of work an engineering job would entail, as they had expected more technical tasks. Emily expected her firm to have enough work for her to work full-time. But this does not explain the differences between men and women.

The other six women, and one man, who were not doing what they expected reported entering a different field or sub-specialty of their major than originally intended. I could not find literature explaining men and women engineers' differential success in working in their desired specialties and I cannot explain this difference. A significant body of literature has documented that engineering workplaces are experienced differently by men and women (Dryburgh, 1999; Faulkner, 2009a, 2009b; Fouad, et al., 2011; Jorgenson, 2002; Ranson, 2005). These differing experiences may explain part of the differences in meeting expectations, but the cause is still uncertain.

In summary, there are several possible theories to explain the differences in meeting expectations among men and women. First, it is feasible that due to the small sample size this observed difference between women and men is due to chance and not indicative of a larger trend. Another possibility is that women may have interpreted the interview question differently from men, emphasizing the differences between their expectations and experiences rather than the similarities. For example, Jesse explained how he is doing what he expected despite an indirect career path because his interests were consistent, while Emily was employed in the same job but not doing what she expected because of the workplace environment. While some women

discussed spending their work hours on non-technical tasks contrary to their expectations, men also mentioned surprising administrative duties, but the men still met their overall expectations. It is possible that the men in this study had more flexible expectations of their day-to-day job duties, though differences are not evident in the undergraduate interviews where participants briefly described their expectations of engineering practice. Further research is needed to explain this phenomenon.

5.3 Differences in Graduate Enrollment

In tracing participants' career paths, the two main opportunities each participant faced were school or work. I analyzed the data to check for patterns in graduate education by undergraduate school, sex, and race. The largest observed difference between the undergraduate schools was in patterns of graduate enrollment. SPri and TPub both had a third of participants remain for a master's degree, then leave school to go to work. In contrast, all of the LPub graduates who immediately enrolled in graduate school eventually pursued PhDs. Although a number of TPub graduates have pursued or are pursuing master's degrees, none of the TPub graduates participating in this study were pursuing PhD at the time of EPS. These numbers can be seen in Table 5-1.

Table 5-1. Graduate Enrollment by Institution

Undergraduate Institution	Degree Status at the time of EPS Interview			Total Participants with Graduate Education
	Earned MS and Joined Workforce	Pursuing Master's Degree	Pursuing PhD	
LPub (n=8)	0	2	3	5
SPri (n=10)	3	1	2	6
TPub (n=12)	4 ¹	1	0	5
Total	7	4	5	16

¹Includes the TPub graduate who earned a master's degree, went to work, and at the time of the EPS interview was pursuing training in a therapeutic health profession.

Across schools, every participant who enrolled in a master's program immediately after earning a bachelor's degree continued at their undergraduate institution, while those who immediately enrolled in PhD programs all changed schools. Participants who returned to school after working were split between changing schools and returning to their bachelor's institution.

As mentioned in Chapter 4, participants pursuing master’s degrees talked about the ease of staying on for another year or two and their existing relationships with faculty members.

My study participants enrolled in graduate school at a much higher rate than has been found in other studies. Eleven of the 30 participants, or 37 percent, began full-time graduate studies immediately after completing their bachelor’s degrees, compared to national figures of only 18 percent (Anderson-Rowland, 2008). Reasons for pursuing graduate study, such as outcome expectations, interests, relationships with faculty, and financial support, are supported by the literature (Batson, Merritt, & Williams, 1993)

Differences in graduate enrollment also exist by sex. After earning their bachelor’s degrees, half of the women and a quarter of men stayed in school. By the time of the EPS interview five men had returned to school, while none of the women that initially went to work returned to school. A breakdown of degree status by sex is shown in Table 5-2.

Table 5-2. Graduate Enrollment by Sex

Sex	Degree Status at the time of EPS Interview			Total Participants with Graduate Education
	Earned MS and Joined Workforce	Pursuing Master’s Degree	Pursuing PhD	
Female (n=14)	4 ¹	0	3	7
Male (n=16)	3	4	2	9
Total	7	4	5	16

¹Includes the TPub graduate who earned a master’s degree, went to work, and at the time of the EPS interview was pursuing training in a therapeutic health profession.

It is difficult to compare my numbers to the literature because literature reports inconsistent interpretations on the number of men and women pursuing graduate degrees. A study at McGill University found that, during their final year of undergraduate study, women were less likely than men to plan on pursuing graduate work (Baker, Tancred, & Whitesides, 2002). The National Science Foundation (NSF) reports that in 2008, 18.5 percent of bachelor’s degrees, 23.0 percent of master’s degrees, and 21.6 percent of PhDs in engineering were earned by women (National Science Foundation Division of Science Resources Statistics, 2011). Since a higher percentage of graduate than undergraduate degrees were awarded to women, this would suggest that women with bachelor’s degrees in engineering are more likely to pursue graduate degrees in engineering than are men with bachelor’s degrees in engineering. Therefore, my data

are somewhat consistent with the NSF data suggesting women engineering graduates pursue graduate engineering education at a higher rate than men.

No women who initially joined the workforce returned to school, in contrast with five men that did so. Research suggests that men are more sensitive to economic conditions, in that men more frequently change their educational aspirations to align with market conditions (Bedard & Herman, 2008). This would be true for some of the participants, such as David's decision to pursue a master's degree after his initial attempts to enter the alternative industry field were unsuccessful. However, Vince explained in his interview that his intention was to pursue an MBA after two years of employment, and that he enrolled in his MBA program despite the economic downturn.

Finally, I did not find meaningful differences in graduate school enrollment by race. Roughly half of each group pursued graduate education, which is contrary to other studies where under-represented minorities enrolled at lower rates than whites and Asian-Americans (Reichert & Absher, 1998). Samantha, who identified with multiple ethnicities, discussed graduate students at LPub influencing her decision to pursue a PhD. This is consistent with research showing institutions with larger populations of female and minority graduate students had higher persistence rates for undergraduate female and minority engineering students (Griffith, 2010).

5.4 Family Influences

Family was a surprisingly salient influence to participants' career choices. Important family members included romantic partners, children, and parents and extended family members. While the impacts of family members were mentioned in Chapter 4, I will review them here before situating family impacts in the literature.

5.4.1 Spouses and Significant Others

Six of 14 women and 12 of 16 men reported on their EPS Pre-Questionnaire that a significant other impacted their career choices, commonly citing geographic restrictions and moral support as the main impacts. While one study suggests that women are more willing to move for their partner's employment (Abraham, Auspurg, & Hinz, 2010), in my study three men and one woman reported changing their career plans due to their spouses' graduate education.

Participants did not discuss moving due to a partner's job, but rather refraining from moving due to a partner's current employment. The other impact participants reported was that their significant others provided substantial moral support in helping them pursue their goals. For example, David's wife encouraged him to quit his job that he did not like and later enroll in a graduate program in line with his goals. Literature has verified that spousal support for partners' careers leads to greater life satisfaction (Greenberger & O'Neil, 1993; Phillips-Miller, Campbell, & Morrison, 2000), and that relationship also appears to exist for early career engineering graduates.

5.4.2 Children

Notably, only men in my study discuss being parents. Participants were not asked if they had children so it may be that only men had children or that only men felt comfortable talking about having children. As Jorgenson points out, respondents' interpretations of researchers' goals may impact their responses to interview questions (Jorgenson, 2002). Research has also shown that the roles of mother and engineer are not seen as compatible (Jorgenson, 2002; Ranson, 2005). Therefore, women and men in this study may have felt that their family status was not relevant to their careers and therefore not have volunteered information to the interviewer.

In all cases where children were mentioned, parenthood influenced career choices through concerns with being able to financially provide for the child and have enough time to spend with the child. This is consistent with the literature on fatherhood. Ranson interviewed fathers with engineering careers and found that fathers sought to adjust their work demands to decrease travel commitments (Ranson, 2001), which Josh had done and Joe expressed concerns about. Ranson also found that fathers with engineering careers tended to have spouses that were ultimately responsible for caring for the children so that the fathers could focus on work demands (Ranson, 2001). Will and the expectant fathers did not discuss their childcare arrangements. Nate and his wife were both PhD students and they alternate caring for their toddler, a more equitable arrangement than found in Ranson's work. Financial concerns were commonly expressed by parents, expectant parents, and prospective parents in this study, and financial concerns are consistent with literature (Arnett, 2004). Emily was addressing these concerns by remaining in her engineering job for a few more years in order to save money before having children, even though she would prefer other work.

5.4.3 Parents and Other Family

Consistent with other young adults (Arnett, 2004), the participants' parents and extended family influenced the participants by providing broad views of available career paths. As other studies have shown, "people do not make their career decisions in a relational vacuum. Rather, family members are involved, both directly and indirectly" (Blustein, 2004, p. 605). Family members were both supportive, such as Nate's family exposing him to broad opportunities once he finished his PhD, or discouraging, such as Lisa's parents lack of understanding when she sought to change careers.

5.5 Economic Downturn

The final major area for discussion was the impact of the economic downturn on the participants' careers. This was a research interest of the EPS team, and a specific question was included in the interview protocol to determine participants' experiences. As described in Winters et al. (Winters, Matusovich, & Brunhaver, 2012), our findings indicate that economic conditions in the United States since 2007 have impacted early career engineering professionals in a variety of ways, ranging from no impact to significant changes in career plans. Impacts included negative experiences and "positive adaptation experiences" wherein an initially negative experience was later viewed positively, as discussed in Chapter 4. Several participants reported multiple impacts.

The results show that engineering is not insulated from economic decline. The economy can impact engineering careers in a variety of ways, from engineers changing expected career paths to considering graduate school. Participants like Joe originally planned on working after earning their bachelor's degrees, but pursued master's degrees due to a lack of interesting opportunities in industry. These participants' experiences are consistent with trends observed after the economic downturn that began in 2000, when graduate enrollment in engineering programs increased significantly (Bhattacharjee, 2004). This study shows that some participants were glad that the economic downturn forced them to consider careers they might not have considered in a more robust economy. Still, several participants reported not being able to achieve their career goals due to the economy.

5.6 Conclusion

In this chapter I addressed several themes that emerged during the analysis. First, the SCCT model was determined to be a valid lens for analyzing the data, though Learning Experiences impacted the participants' Goals and Actions directly. Men and women differed greatly in whether or not their career expectations were met, though meeting expectations did not align with participants' perceptions of success. Overall, participants sought graduate degrees at higher rates than expected, across demographics. Family members played important roles in participants' career choices. Romantic partners influenced geography, children influenced desires for stability and work/life balance, and extended family exposed participants to diverse career possibilities. Finally, most participants reported some impact of the economic downturn. Some participants experienced negative impacts while others changed their goals to succeed in new arenas.

6 Conclusion

In this chapter I will briefly summarize my key findings, explain my contributions to the field of engineering education, provide suggestions for application, and outline future research possibilities.

6.1 Summary of Findings

The purpose of this research was to identify and explain the career goals and actions of early career engineering graduates. To accomplish this goal, I asked “What factors influence early career engineering graduates’ career goals near the end of their undergraduate engineering studies, career-related actions taken in the subsequent four years, and their future career plans?” I framed my analysis in Social Cognitive Career Theory (SCCT), as developed by Lent et al. (Lent, et al., 1994).

Data were drawn from the Engineering Pathways Study and Academic Pathways Study. Thirty participants were interviewed and surveyed as undergraduates, then completed pre-questionnaires and an interview as early career engineering graduates. Participants were graduates from three different universities and were diverse with respect to sex, race, and undergraduate major. Data analysis followed case study methods.

My results show that at the end of undergraduate studies, most participants were focused on starting their first job or graduate program as they looked forward. Once they had been in that position for a couple of years, i.e., as early career engineering graduates, they evaluated what they wanted to do next and began to proceed down that path. If participants felt successful during the early career phase, then their future goals were an extension of their past goals. If they felt unsuccessful then they sought opportunities for change. A summary of goals, actions, highly salient factors influencing goals and actions, whether the participants are meeting their career

expectations, and future goals is shown in Table 6-1 below. This table is organized by broad categories of goal relationships, and only includes the most prominent goals and influences as expressed by the participants.

Table 6-1. Summary of Results

Sex	Primary Senior Goals	Career Path	Highly Salient Influences	Meeting Expectations	Primary Future Goals
Consistent Goals- Clear Trajectory (15)					
Female (5) Male (10)	Education (11) Job Field (9) Job Tasks (5) Money (1)	Graduate School (3) Graduate School to Work (4) Multiple Employers (1) Multiple Employers and Graduate School (1) Work (2) Work- Internal Transfer (2) Work to Graduate School (2)	Boss (1) Economy (1) Family (4) Interests (10) Learning Experiences (1) Mentor (1) Money (1) Outcome Expectations (2) Self-Efficacy (1) None Identified (1)	No (1) Somewhat (3) Yes (10) Not Asked (1)	Advancement (4) Education (5) Enter field of Interest (4) Entrepreneurship (2) Finish Degree (6) Persist (7)
Consistent Goals- Clarified Goals (5)					
Female (2) Male (3)	Education (3) Job Field (4) Work/Life Balance (1) Unsure (1)	Graduate School- Changed Programs (1) Graduate School to Work (1) Work to Graduate School (1) Work (2)	Economy (1) Family (3) Friends (1) Geography (1) Graduate Advisor (1) Interests (4) Outcome Expectations (1)	No (2) Yes (3)	Advancement (3) Education (2) Enter field of Interest (1) Finish Degree (1) Persist (2)
Detoured Goals- Back on Track (2)					
Male (2)	Education (1) Job Field (2) Entrepreneurship (2)	Multiple Employers (1) Multiple Employers to Graduate School (1)	Economy (2) Family (1) Interests (2)	Yes (2)	Education (1) Enter field of interest (1) Finish Degree (1) Persist (1)
Detoured Goals- Seeking to Return (2)					
Female (1) Male (1)	Education (1) Job Tasks (2)	Graduate School to Work (1) Multiple Employers (1)	Economy (2) Family (1) Interests (2)	No (2)	Change to interesting work (2) Determine interests (1)

Sex	Primary Senior Goals	Career Path	Highly Salient Influences	Meeting Expectations	Primary Future Goals
Changing Goals- Positive Adaptations (2)					
Female (2)	Education (1) Geography (1) Job Field (1)	Multiple Employers (1) Work (1)	Economy (1) Family (1) Geography (1) Interests (1) Outcome Expectations (1)	No (2)	Determine interests (1) Persist (1)
Changing Goals- Negative Experiences (3)					
Female (3)	Education (1) Job Tasks (1) Job Field (1)	Graduate School to Work to Other Education (1) Work (1) Work-Internal Transfer (1)	Economy (2) Interests (3) Learning Experiences (3) Family (1)	No (3)	Change to interesting work (3) Determine interests (1) Finish Program (1)
Uncertain of Goals (1)					
Female (1)	Education (1)	Multiple Employers (1)	Economy (1) Family (1)	No (1)	Determine interests (1)

These results show several interesting findings. First, interests are the major factor influencing career goals and actions, across categories of goal relationships. Nearly all participants discussed wanting interesting work. Similarly, family was important across categories. Economic conditions, however, factored into career decisions more frequently for those with changing goals than those with consistent goals. Not surprisingly, most, but not all, participants with consistent goals reported meeting expectations, as did those that had detoured their career paths but returned to their prior goals. Participants whose goals had changed did not report that they met their expectations. Strikingly, only women discussed changing goals, both due to positive adaptations and negative experiences.

Based on the data, I concluded that goals were largely influenced by interests throughout the study period. People such as family members, professors, and mentors exposed some participants to wider areas of opportunities in which to set goals. Actions towards achieving goals were tempered by outcome expectations, contextual factors such as economic conditions and family needs. Self-efficacy was also a factor for some participants in pursuing their future goals, but not commonly identified as important for past actions.

The data showed a general consistency with the pathways outlined in SCCT. However there was one notable difference: participants discussed learning experiences directly impacting their goals and actions instead of through self-efficacy and outcome expectations as posited by

SCCT (Lent, et al., 1994). I do not necessarily refute the SCCT pathway, but rather the mediating effects of self-efficacy and outcome expectations were not brought up by the participants.

My findings showed that LPub graduates were more likely to pursue PhDs, while TPub graduates pursued master's degrees. Half of the women pursued graduate degrees directly after earning their bachelor's degrees, while only a quarter of men stayed in school. Of the women who went directly into the workforce, none returned to school during the study period compared to five of the 12 men. All participants who enrolled directly in master's programs remained at their undergraduate institution. A much smaller portion of women reported that, as early career engineering graduates, they were doing what they expected. Additionally, women reported changing their goals more frequently than men. The reasons for these gender differences are unclear. With regards to the economic downturn, most participants reported some impact. Positive impacts included finding an enjoyable job in a field the participant had not previously considered. Negative impacts included periods of unemployment and not securing interesting work. Finally, the majority of participants reported a spouse or significant other impacting their career decision making, commonly discussing their partner impacting their desire to live in a certain geographic area.

6.2 Contribution to the Field

This research makes important contributions to the field of engineering education because it focuses on what happens after graduation as graduates forge pathways forward. To date, the bulk of engineering education research focuses on the undergraduate experience and little work has explored the experiences of those students after they earn their bachelor's degrees. When recent graduates are studied, the studies commonly focus on a single workplace or a small number of workplaces. My work fills this gap because:

- Participants represented a wide array of employment instead of a single or limited number of workplaces.
- Longitudinal data provided a detailed understanding of participant's goals and actions from the end of undergraduate engineering studies through their early careers.

- While not every race and engineering program were represented, participants were diverse, with the 30 participants including 14 women and 12 non-whites. Participants earned fourteen different bachelor's degrees from three institutions.

These elements of study design combined with addressing an important but understudied area ensure that my research provides a valuable new understanding of the experiences we are ultimately preparing our students to have. My findings highlight key factors influencing the career goals and actions of the study participants. I found that:

- The SCCT model is a useful framework for analyzing the experiences of early career engineering graduates.
- Early career engineering graduates want interesting work. Participants pursued interesting work through a variety of pathways, including seeking graduate degrees to improve their qualifications and being willing to leave jobs that did not prove to be interesting.
- Decisions to attend graduate school were influenced by interests in the research topic, outcome expectations of better job prospects, and relationships with faculty members. All participants that pursued master's degrees immediately after their bachelor's degrees remained at their undergraduate institutions.
- Family influences factored into career decision making. Sixty percent of participants were influenced by a spouse or significant other. Other family members, including children, siblings, parents, and grandparents were also important.
- In the workplace, a key factor for retention and satisfaction was the participant's relationship with management. Participants with supportive managers generally reported wanting to stay in their jobs, while those that felt undervalued by their managers wanted to leave.
- Engineering graduates were not immune from the recent economic downturn. Recent graduates coped with the declining availability of jobs by broadening their job searches, seeking graduate education, and staying in imperfect jobs longer than they would have in a robust economy.

These findings provide new contributions to the field of engineering education, and open up several opportunities for application and further research as discussed in the following sections.

6.3 Suggestions for Applications

Because of the broad scope and longitudinal data, this research is useful to three major audiences: engineering educators, engineering employers, and engineering students/early career engineering graduates. The following sections provide suggestions for how this work can be useful to each of these groups of stakeholders.

6.3.1 For Engineering Educators

Engineering educators can use the findings from this study to better mentor their students to enable the students to achieve their goals after graduation. Specifically by using the finding that many participants are working in fields that they did not initially consider, faculty members can encourage students to be aware of a breadth of opportunities available to them, but to fully research their job function and workplace environment before accepting a job. Engineering educators who are not familiar with the current industry climate can work with their campus career centers to learn about contemporary hiring practices and workplace environments. As demonstrated through this research, many students pursue graduate education partly due to relationships with faculty members. For example, Beth told the interviewer “*why I decided to go get my masters was really my advisor*” [Beth, TPub, EPS]. Like Beth, all the participants who immediately pursued master’s degrees stayed at their undergraduate institution, so faculty members can provide research opportunities to undergraduates to build those relationships and encourage students to pursue graduate work. Finally, engineering educators could acknowledge that career choices are not based solely on job characteristics, but family influences can be very important. While these personal influences may be difficult to discuss in a large group or classroom setting, faculty members should not shy away from appropriate discussions of family considerations with their students during individual mentoring.

Based on the experiences of the participants in this study, curricular changes may also be appropriate. Engineering programs should consider what their graduates are doing after graduation. Participants entered a wide array of career fields, including fields not traditionally tied to certain degree programs. Grace went into game development with her product design degree. Kevin leveraged his engineering background to work in investment banking. Three participants went into technology consulting, though none of them earned electrical engineering,

computer science, or information technology degrees. These choices emphasize the needs for transferrable skills, such as problem solving and communication, over deep technical knowledge. In light of the economic downturn limiting opportunities in certain sectors, engineering programs may better serve graduates by providing a broad foundational education rather than deep specialties so that graduates have a wide variety of career options. Programs should also ensure that their graduates have learned how to learn, as lifelong learning is an crucial skill as early career engineering graduates take on new roles and challenges.

6.3.2 For Engineering Employers

Engineering employers can work to make sure that their new hires understand the job duties and workplace environment before starting work. Participants in the study who left jobs cited work that did not align with their interests or negative workplace environments. Managers can also work to make their employees feel valued and respected. Even after working briefly for his own start-up company, Justin explained:

“One of the reasons that I returned to this company was because of a really strong development manager that I really liked” [Justin, LPub, EPS].

Participants reported both positive experiences with managers leading to staunch company loyalty, such as in Justin’s case, as well as poor management relationships causing the participant to look for a different job.

6.3.3 For Engineering Students and Early Career Engineering Graduates

Engineering students and early career engineering graduates can best achieve their goals by thoroughly researching their options and remaining flexible. Participants who were unhappy in their work wished they had known what the working conditions were like. Lisa lamented not being more selective in her job search:

“I should have just never done that and just searched for a company that I actually would have liked and enjoyed working with.” [Lisa, TPub, EPS]

Lisa felt she could have avoided her negative experiences at her first job had she been more selective in her search. Other participants were flexible when factors such as the economy or

their families limited their job opportunities but were still able to find enjoyable positions. Finally, early career engineering graduates who are not happy in their current work may want to consider changing jobs. Jesse decided to go back to school after an unfulfilling first job, international relocation, and a layoff, but evaluated his career progress saying: *“I’m not quite there yet, but I think I’m heading the right direction”* [Jesse, TPub, EPS]. Like Jesse, other participants also reported leaving unfulfilling jobs to pursue more interesting opportunities and were happy with their choices.

6.4 Future Work

The findings from this study also have implications for researchers. There are at least three prominent paths for expanding this work. First, the longitudinal design of this study lends itself to continuation. By following up with the same participants in another four or five years further insights could be gained in how their careers develop. For example, several participants who pursued graduate education had only recently started working when their early career interviews were collected, and all of the PhD students were still in school. Vicki, a PhD student, even mentioned the possibility of continuing the study during her interview:

“I don’t know how long you guys are going to continue the study, but I feel like I’m just still so far from being in my career you know. I’m sure that’s true of how a lot of people feel.” [Vicki, SPri, EPS]

Following up with these participants after a few more years would provide greater insights into career decision making for those with graduate degrees.

Secondly, this work could be expanded to a broader setting through surveys and additional interviews. Broadening the setting would address the limitations associated with the three institutions in my study by enabling more early career engineering graduates to participate. A survey would also address some issues of participants’ willingness to be involved in the research, as a single administration of a survey is less commitment for the participant than agreeing to a series of interviews. However, researchers would lose the richness and depth associated with the qualitative and longitudinal interviews that were used for my research. The second phase of the Engineering Pathways Study developed a quantitative survey based on interview findings, which has recently been administered to all class of 2007 engineering

graduates from the three EPS institutions and a fourth university. The survey findings could be compared to interview findings to determine if the conclusions are consistent. For example, the survey findings will show whether the same proportions of early career engineering graduates pursue various career path or graduate education as in the interview population. The EPS survey will also identify salient influences to respondents' career choices which can be compared to the interview participants. Additionally, another national survey could verify whether early career engineering graduates' learning experiences relate directly to goals and actions, or are mitigated by self-efficacy and outcome expectations as proposed by SCCT (Lent, et al., 1994). A survey could indicate what proportions of men and women are doing what they expected, while detailed interviews could help determine the sources of any differences by sex. Interviews from the national survey could also provide further details into the career decisions of early career engineering graduates across a larger segment of the population and among minorities, including those with only African American or Native American heritage, and majors not fully represented here.

Finally, a third avenue for future work would be to repeat this study with another cohort. As mentioned previously, the economic downturn significantly impacted many participants. If this study were repeated with a different cohort, different economic conditions may influence participants' career choices differently. Increased globalization and changing technology also heavily impact the engineering industry and so a younger cohort may have very different opportunities and challenges in their early careers. While my study was somewhat limited by existing data sets, the next study could better focus data collection instruments around the research questions. Graduating seniors could be asked not only what their plans were immediately after graduation, but what factors influenced their goals and actions. Researchers could also deliberately recruit minorities who were not a part of my study cohort.

6.5 Closing

My research provides valuable new insight into the experiences of early career engineering graduates, as well as a new application of Social Cognitive Career Theory. Early career engineering graduates have diverse goals and interests, but generally want to find interesting work. Relationships with faculty heavily influenced participants' decisions to pursue graduate

degrees, and family commitments geographically constrained career choices while also increasing the desire for stability. The economic downturn impacted most participants, but many participants were able to broaden their career searches to find interesting and fulfilling work. Overall, participants who exhibited an ability to adapt to changing conditions reported the greatest levels of satisfaction with their careers.

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A. Data Collection Instruments

All data collection instruments described in this study were developed by the APS and EPS research teams. Analysis can be found on the Center for the Advancement of Engineering Education (CAEE) website (<http://www.engr.washington.edu/caee/>). Additional information concerning APS and EPS can be found in the APS final report (Atman et al., 2010).

The interview protocols presented here are in the format publically available through the resources above. With one exception, these are the same protocols used in my analysis. For the APS structured interview protocol, a sample version is provided. For further details on the Spring 2006 administration (used for my analysis) please contact a member of the CAEE team through the CAEE website. Also note that the PIE survey is presented here as screen shots as participants would have viewed when completing the survey online.

A.1 APS Senior Semi-Structured Ethnographic Interview Protocol

- 1) Tell me how things are going for you?
 - a. Explore further on specifics of response, if student does not provide details: e.g., if student says, “It’s been a lot harder than I thought,” ask, “In what ways?”
Note: Follow the subject’s lead on how to handle this question. In some cases, it might be best used as an icebreaker, just to begin the conversation and move on to other questions. However, some subjects (most, based on our informal interviews at LPub this year) will have quite a lot to say, on a range of topics. In this case, don’t be too quick to move off of this question – explore all of the issues the subject seems willing to get into.
 - b. Before moving on to other questions, give subject a chance to say more, e.g., “What else is happening with you these days?”
 - c. Either here or in the context of another question ask the student the question that revisits previous years’ interviews or field work and is specific to them.
[Last year or this past Fall/when I observed you...] you were concerned about [insert student’s topic of concern/excitement...], talk about how that has gone this year.
- 2) We talked about this some last year, but I’d like to ask about it again: Can you tell me how you became interested in engineering?
 - a. Explore further, if needed, with: What were some of the experiences that were important in getting you interested in engineering?
 - b. [If they do not mention a specific person] Was there an individual who influenced or guided you to study engineering?
- 3) Thinking about yourself before you came to [School Name] – are there things that you would say prepared you to succeed in engineering?
- 4) What are you majoring in (or planning to major in)?
 - a. How did you choose (xxx)?
 - b. What other majors did you consider?
 - c. What other kinds of engineering did you consider?
 - d. Are there certain fields of engineering that you just can’t see yourself going into? Why?
- 4x) Did you have an internship during the last four years? Tell me about it. What did you do on a day-to-day basis? How has that internship related to school?
- 5) Can you take me through a typical day for you here at [School Name]?
- 6) I’d like to ask about your classes and other academic experiences you’ve had since you’ve been here.
 - a) Have you had academic experiences that you would describe as particularly bad? Can you tell me about one of those? Again, if necessary, make sure to follow up with a question like: “So what was it that made that a bad experience?”

- b) Have you had academic experiences here so far that you would describe as particularly good? Can you tell me about one of those? If necessary, make sure to follow up with a question like: “So what was it that made that a good experience?”
 - c) Tell me about your capstone/senior project?
- 7) How would you say that you changed as both a person and student since you were a freshman? How are you the same? (ask them at the same time and let them respond)
- 8) Let me ask you to think about the other engineering students you’ve come across here. Would you say that in general they are more different from you or more similar?
- a. Explore further: “How are they similar?” (or “How are they different?”)
- 9) Have you had much contact with non-engineering students? Would you say that there are things that distinguish engineering students from students in other majors?
- a. Explore further as needed to get details.
- 10) What would you say has been the most difficult thing here for you so far? [Students might mention non-academic difficulties. Make sure to explore further to get at academic difficulties.]
Note: this would be a good spot to use the placeholder noted above: [Last year/when I observed you...] you talked about [insert student’s topic of concern/excitement...], being difficult for you, talk about how that has gone this year?
- a. How did you handle (or how are you handling) that?
- 11) What’s been easy for you here so far?
- a. Explore further if subject doesn’t elaborate.
- 12) Has anything surprised you about your engineering education? Did you believe that it would be different than what you experienced?
- 13) If you were to advise me, as a freshman student, about what classes to take --- when, in what combinations, and taught by whom, what would you tell me?
- a. Besides from courses is there anything else that you would advise me as far as getting involved with the engineering community on campus?
- 14) Are there any groups that you’ve become part of since you came here to [Name of Institution]?
- a. Explore further for each group (or, if there are a lot, for what the subject would say are the “most important” ones)
 - i. Can you tell me about [group]?
 Note: This may need some prompting to establish the range of places we are interested in, both on and off campus, both social and para-professional. Explore further to see if they have answered with respect to both on and off campus groups.
 - b. Is there someone you met (professor, engineer, advisor) since you began school here who you would say has filled a mentor role for your engineering interests?

(No Question 15)

16) Knowing what you know now, as you look back on the time that you've spent here, is there anything that you would do differently?

17) One of the things that our research team is interested in is diversity in engineering and engineering education, in terms of race, ethnicity, and gender. I'd like to ask you some questions related to this.

Note: this series of questions may be another area where the placeholder will work well: [Last year/when I observed you...] you talked about [insert student's topic of concern/excitement...], talk about how that has gone this year.

- a. (This is a question that you've already answered on the survey, but your survey responses aren't available to me yet.) Can you tell me how you identify yourself racially or ethnically?
- b. Are there supports or barriers, advantages or disadvantages, for you as a [ethnic identification] engineering student?
 - i. How about for people of other racial or ethnic groups?
- c. Do you think that there are differences between the experiences of male and female engineering students?
- d. How has it been for you here, as a [male/female] engineering student?

18) I want to ask you to think about the rest of the time that you'll be spending at [School Name].

- a. What are you looking forward to during the rest of your time here?
- b. What are you concerned about?

19) This is likely the last time we'll interview you, so I'd like you to talk about what happens for you after this interview.

a) Tell us what happens next for you? This summer? This fall? Beyond?

Note: this should be another question where the placeholder may be relevant: [Last year/when I observed you...] you talked about [insert student's topic of concern/excitement...], talk about how that has gone this year. Here we are trying to get the students to frame their future on their terms. If these topics don't come up probe to steer the conversation to topics including, but not limited to:

- i) When he/she is graduating (if graduating at all)?
 - ii) Job search, how it went? Does he/she already have job?, etc.
 - iii) What about grad school?
 - iv) Options other than working in engineering? (teaching, starting a business)
 - v) What about ten years from now?
- b) What do you imagine yourself doing on a day-to-day basis?
- i) AND, if not planning on becoming an engineer: What do you imagine engineers do on a day-to-day basis?

20) Here's a more personal question. I've been asking a lot of questions so far about your academic experiences. What else do you do in your life besides being an engineering student?

(No Question 21)

22) If you could whisper in the ear of the people who set up your engineering program here at [Name of Institution], what advice would you give them about improving things?

26) (sic) You are asked to testify in front of a congressional committee that is investigating the entire institution of engineering. As a [xxx] engineer, defend your discipline.

a) Why do we need [xxx] engineers?

b) What have [xxx] engineers done to make my life better?

23) This is the last of our four interviews with you. I'd like you to comment on what you thought about this interview process. Is there anything that is relevant to this study that you think I've missed?

A.2 APS Sample Structured Interview Protocol

Q1. What is your major?

Q2. What year did you graduate from high school?

Q3. Did you participate in a Freshman Summer Bridge Program the summer after you graduated from high school?

No: Skip to Q4

Yes: Q3a. What were the most helpful aspects of that program?

Q4. Are you a member of any engineering student organizations on campus?

No: Skip to Q5

Yes: Q4a. What are those organizations?

Q4b. What are the most helpful aspects of that/those organization(s)?

Q5. In your own words, would you please define engineering?

Q6. Are there particular skills that you would say are important for an engineer to have?

No: Skip to Q7

Yes: Q6a. (IF NOT ALREADY ANSWERED) What are those skills?

Q6b. Of the skills that you mentioned, which ones do you possess?

Q6c. Please tell me about how you developed your skill(s)?

Q7. Have you had any experiences inside or outside of your classes that have enabled you to be creative?

If R asks for definition, say “Just whatever it means to you – anything *you* would call creative”

No: Skip to Q8

Yes: Q7a. (IF NOT ALREADY ANSWERED) Please describe those experiences.

Q8. Have you had any experiences inside or outside of your classes that have prevented you from being creative?

No: Skip to Q9

Yes: Q8a. (IF NOT ALREADY ANSWERED) Please describe those experiences.

Q9. Have you had any experiences inside or outside of your classes that have enabled you to solve problems?

If R asks for definition, say “Just whatever problems come to your mind”

No: Skip to Q10

Yes: Q9a. (IF NOT ALREADY ANSWERED) Please describe those experiences.

Q10. Have you had any experiences inside or outside of your classes that have prevented you from solving problems?

No: Skip to Q11

Yes: Q10a. (IF NOT ALREADY ANSWERED) Please describe those experiences.

Q11. Have you had any experiences inside or outside of your classes that have enabled you to develop general engineering knowledge?

If R asks for definition, say “Just whatever it means – anything that comes to your mind”

No: Skip to Q12

Yes: Q11a. (IF NOT ALREADY ANSWERED) Please describe those experiences.

Q12. Have you had any experiences inside or outside of your classes that have prevented you from developing general engineering knowledge?

No: Skip to Q13

Yes: Q12a. (IF NOT ALREADY ANSWERED) Please describe those experiences.

Q13. Where do you see evidence of your engineering aptitude?

If R asks what is aptitude, say “Just whatever it means to you – anything that comes to your mind”

Otherwise, after R responds go to Q14

Q14. On a scale from 0 – 10, (where 0 = not confident at all and 10 = extremely confident), how confident are you in your math ability? _____

Q14a. Describe the experiences that led you to rate yourself in this way. (REMIND THEM OF SCORE IF THEY ASK.)

Q15. On a scale from 0 – 10, (where 0 = not confident at all and 10 = extremely confident), how confident are you in your science ability? _____

Q15a. Describe the experiences that led you to rate yourself in this way. (REMIND THEM OF SCORE IF THEY ASK.)

Q16. On a scale from 0 – 10, (where 0 = not confident at all and 10 = extremely confident), how confident are you in your design ability? _____

Q16a. Describe the experiences that led you to rate yourself in this way. (REMIND THEM OF SCORE IF THEY ASK.)

Q17. Are there any aspects of engineering that you particularly like?

No: Skip to Q18

Yes: Q17a. (IF NOT ALREADY ANSWERED) What are some of those?

Q18. Are there any aspects of engineering that you particularly dislike?

No: Skip to Q19

Yes: Q18a. (IF NOT ALREADY ANSWERED) What are some of those?

Q19. In general, how do you feel about engineers?

Q19a. (IF NOT ALREADY ANSWERED) And why?

Q20. How do you believe members of other professions feel toward engineers?

Q20a. (IF NOT ALREADY ANSWERED) And why?

Q21. Are any of your family members or close acquaintances working engineers?

No: Skip to Q22

Yes: Q21a. (IF NOT ALREADY ANSWERED) Who?

Q21b. Did their experiences influence your decision to become an engineer?

No: Skip to Q22

Yes: Q21c. (IF NOT ALREADY ANSWERED) How?

Q22. How important is being an engineering student to how you feel about yourself?

Q22a. (IF NOT ALREADY ANSWERED) And why?

Q23. How committed are you to pursuing an engineering major?

Q23a. (IF NOT ALREADY ANSWERED) And why?

Q24. What do you see yourself doing after graduation?

Q25. Are there any aspects of your education at this institution that you find particularly difficult in achieving your academic goals?

No: Skip to Q26

Yes: Q25a. (IF NOT ALREADY ANSWERED) Please tell me about those difficulties.

Q25b. How do you deal with those difficulties?

Q26. Are there any aspects about being an engineering major at this institution that you find particularly difficult in achieving your academic goals?

No: Skip to Q27

Yes: Q26a. (IF NOT ALREADY ANSWERED) Please tell me about those difficulties.

Q26b. How do you deal with those difficulties?

Q27. Are there any aspects of your education at this institution that you find particularly helpful in achieving your academic goals?

No: Skip to Q28

Yes: Q27a. (IF NOT ALREADY ANSWERED) Please tell me about those helpful aspects.

Q28. Are there any aspects of being an engineering major at this institution that you find particularly helpful in achieving your academic goals?

No: Skip to SECTION II

Yes: Q28a. (IF NOT ALREADY ANSWERED) Please tell me about those helpful aspects.

...

[Performance Task]

...

DQ1. Is there any other information regarding your experience that you think would be useful for me to know?

Yes: DQ1a. (IF NOT ALREADY ANSWERED) Please share that information with me.

Again, thank you for participating. (TURN TAPE-RECORDER OFF.)

A.3 APS PIE Survey

ACADEMIC PATHWAYS STUDY SPRING'07 SURVEY

Please click the [Submit Survey] button to access the next page of the survey, and only after you have completed this page.
For best viewing results, please maximize your browser window.

1. **What is your expected year of graduation from college?**

- 2007
- 2008
- 2009
- 2010 or later

2. **Do you intend to complete a major in engineering?**

- Definitely Not
- Probably Not
- Not Sure
- Probably Yes
- Definitely Yes

3. **What do you intend to major in?**

- Aeronautical Engineering
- Chemical Engineering
- Civil and Environmental Engineering
- Computer Science
- Electrical Engineering
- Management Science and Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Other Engineering] _____
- Arts and Humanities
- Education

- Natural Science/Math
- Social Science
- Other Non-engineering | _____

4. **If you intend to DOUBLE MAJOR, what is the second major you intend to complete? (Mark N/A if you do not intend to double major.)**

- Aeronautical Engineering
- Chemical Engineering
- Civil and Environmental Engineering
- Computer Science
- Electrical Engineering
- Management Science and Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Other Engineering | _____
- Arts and Humanities
- Education
- Natural Science/Math
- Social Science
- Other Non-engineering | _____
- N/A

5. **Do you intend to practice, conduct research in, or teach engineering for at least 3 years after graduation?**

- Definitely Not
- Probably Not
- Not Sure
- Probably Yes
- Definitely Yes

6. **If you are thinking of going to graduate school in a field OTHER THAN engineering, please mark your most probable area of study. Otherwise, mark N/A.**

- Business
- Education
- Humanities and Social Sciences
- Law
- Medicine
- Natural Sciences/Math
- Public Service
- Other
- N/A

7. **We are interested in knowing why you are studying engineering now. Please indicate below the extent to which the following reasons apply to you:**

	Not a Reason	Minimal Reason	Moderate Reason	Major Reason
Technology plays an important role in solving society's problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engineers make more money than most other professionals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My parent(s) would disapprove if I chose a major other than engineering	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engineers have contributed greatly to fixing problems in the world	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engineers are well paid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My parent(s) want me to be an engineer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
An engineering degree will guarantee me a job when I graduate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A faculty member, academic advisor, teaching assistant or other university affiliated person has encouraged and/or inspired me to study engineering	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A non-university affiliated mentor has encouraged and/or inspired me to study engineering	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Please indicate how strongly you disagree or agree with each of the statements:

	Disagree Strongly	Disagree	Agree	Agree Strongly
Creative thinking is one of my strengths	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am familiar with what a practicing engineer does	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am skilled at solving problems that can have multiple solutions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. Rate yourself on each of the following traits as compared to your classmates. We want the most accurate estimate of how you see yourself. (Mark one in each row.)

	Lowest 10%	Below Average	Average	Above Average	Highest 10%
Self confidence (social)	<input type="radio"/>				
Leadership ability	<input type="radio"/>				
Public speaking ability	<input type="radio"/>				
Math ability	<input type="radio"/>				
Science ability	<input type="radio"/>				
Communication skills	<input type="radio"/>				
Ability to apply math and science principles in solving real world problems	<input type="radio"/>				
Business ability	<input type="radio"/>				
Ability to perform in teams	<input type="radio"/>				
Critical thinking skills	<input type="radio"/>				

10. How important do you think each of the following skills and abilities is to becoming a successful engineer? (Mark one in each row.)

	Not Important	Somewhat Important	Very Important	Crucial
Self confidence (social)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leadership ability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Public speaking ability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Math ability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science ability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Communication skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to apply math and science principles in solving real world problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Business ability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to perform in teams	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Please rate your satisfaction with this institution on each of the aspects of campus life listed below. If you do not have experience with this aspect, mark N/A.

	Very Dissatisfied	Dissatisfied	Satisfied	Very Satisfied	N/A
Quality of instruction by faculty	<input type="radio"/>				
Quality of advising by faculty	<input type="radio"/>				
Availability of faculty	<input type="radio"/>				
Quality of instruction by teaching assistants	<input type="radio"/>				
Quality of advising by teaching assistants	<input type="radio"/>				
Availability of teaching assistants	<input type="radio"/>				

12. Please rate your satisfaction with each of the following at this institution. If you do not use this facility, mark N/A.

	Very Dissatisfied	Dissatisfied	Satisfied	Very Satisfied	N/A
Computer facilities	<input type="radio"/>				
Libraries	<input type="radio"/>				
Classrooms	<input type="radio"/>				
Laboratories	<input type="radio"/>				

13. Think about the engineering classes you have taken during the current school year (engineering, math, and science classes). Indicate how often you: (Mark N/A if you have not taken any engineering related classes.)

	Never	Rarely	Occasionally	Frequently	N/A
Came late to engineering class	<input type="radio"/>				
Skipped engineering class	<input type="radio"/>				
Turned in engineering assignments that did not reflect your best work	<input type="radio"/>				
Turned in engineering assignments late	<input type="radio"/>				

14. Think about the liberal arts classes you have taken during the current school year (not engineering, math, and science). Indicate how often you: (Mark N/A if you have not taken any non-engineering related classes.)

	Never	Rarely	Occasionally	Frequently	N/A
Came late to liberal arts class	<input type="radio"/>				
Skipped liberal arts class	<input type="radio"/>				
Turned in liberal arts assignments that did not reflect your best work	<input type="radio"/>				
Turned in liberal arts assignments late	<input type="radio"/>				

15. **How often have you interacted with the following people during the current school year (e.g. by phone, e-mail, Instant Messenger, or in person)? (Mark one for each item.)**

	Never	1-2 times per Term	1-2 times per Month	Once per Week	2-3 times per Week	Daily
Faculty during class	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty during office hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty outside of class or office hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teaching Assistants during class	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teaching Assistants during office hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teaching Assistants outside of class or office hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. **What portion of the courses you have taken during the current school year have been taught primarily by graduate students?**

- None
- Very little
- Less than half
- About half
- More than half
- All or nearly all

17. **During the current school year, what portion of your classes have used the following teaching methods?**

	None	Very little	Less than half	About half	More than half	All or nearly all
Lectures	<input type="radio"/>					
Individual Projects	<input type="radio"/>					
Team Projects	<input type="radio"/>					
Labs	<input type="radio"/>					
Seminars	<input type="radio"/>					

18. **Some people are involved in non-engineering activities on or off campus, such as hobbies, civic or church organizations, campus publications, student government, social fraternity or sorority, sports, etc. How important is it for you to be involved in these kind of activities?**

- Not Important
- Somewhat Important
- Very Important
- Essential

19. **How often are you involved in the kinds of non-engineering activities described above?**

- Never
- Rarely
- Occasionally

Frequently

20. **Thinking about your college experience during the current school year, please indicate how much pressure you are feeling related to the following:**

	No Pressure	Reasonable Pressure	Extreme Pressure
<input type="radio"/> Course load (amount of course material being covered)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/> Course pace (the pace at which the course material is being covered)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/> Balance between social and academic life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21. **How well are you meeting the workload demands of your coursework?**

- I am meeting all of the demands easily
- I am meeting all of the demands, but it is hard work
- I am meeting most of the demands, but cannot meet some
- I can meet some of the demands, but cannot meet most
- I cannot meet any of the demands

22. **How stressed do you feel in your coursework right now?**

- No stress
- Some stress
- Reasonable stress
- Significant stress
- Extreme stress

23. **Do you have any concerns about your ability to finance your college education?**

- None (I am confident that I will have sufficient funds)
- Some (but I probably will have sufficient funds)
- Major (not sure if I will have sufficient funds to complete college)

24. **How do you meet your college expenses?**

	None	Very little	Less than half	About half	More than half	All or nearly all
<input type="radio"/> Self (income)	<input type="radio"/>					
<input type="radio"/> Self (savings)	<input type="radio"/>					
<input type="radio"/> Parents and family	<input type="radio"/>					
<input type="radio"/> Employer support	<input type="radio"/>					
<input type="radio"/> Scholarships and grants	<input type="radio"/>					
<input type="radio"/> Loans	<input type="radio"/>					

25. **How much exposure have you had to a professional engineering environment as a visitor, intern, or employee?**

- No exposure
- Limited exposure
- Moderate exposure
- Extensive exposure

26. **About how many hours do you spend in a typical 7-day week doing each of the following?**

	0	1-5	6-10	11-15	16-20	21-25	26-30	more than 30
Preparing for class (studying, reading, writing, doing homework or lab work, analyzing data, rehearsing, and other academic activities)	<input type="radio"/>							
Working for pay	<input type="radio"/>							
Participating in co-curricular activities (organizations, campus publications, student government, social fraternity or sorority, intercollegiate or intramural sports, etc.)	<input type="radio"/>							
Relaxing and socializing (watching TV, partying, exercising, etc.)	<input type="radio"/>							
Providing care for dependents living with you (parents, children, spouse, etc.)	<input type="radio"/>							
Commuting to class (driving, walking, etc.)	<input type="radio"/>							

27. **Please rate the overall quality of your collegiate experience so far:**

- Very dissatisfied
- Dissatisfied
- Satisfied
- Very satisfied

28. **Which of the following statements best describes your situation with respect to an engineering major? (Mark one.)**

I started at this institution...

- Intending to major in engineering and never doubted the decision.
- Intending to major in engineering and have/had doubts.
- Considering engineering, but was open to other majors, too.
- Intending another major, but am now considering engineering.
- Completely undecided about what my major would be.

29. **My decision to CONTINUE with an engineering major primarily came from: (Mark one.)**

- Not applicable - I am not continuing in an engineering major.
- Experiences with **PRE-ENGINEERING**-related (math, physics, etc) coursework, faculty, and/or research/internship(s)

- Experiences with **ENGINEERING**-related coursework, faculty, and/or research/internship(s)
- Experiences with **OTHER** coursework, faculty, and/or research/internship(s)

30. **My DOUBTS about continuing in an engineering major *primarily* came from: (Mark one.)**

- Not applicable - I never doubted continuing in an engineering major.
- Experiences with **PRE-ENGINEERING**-related (math, physics, etc) coursework, faculty, and/or research/internship(s)
- Experiences with **ENGINEERING**-related coursework, faculty, and/or research/internship(s)
- Experiences with **OTHER** coursework, faculty, and/or research/internship(s)

31. **Since coming to college, have you had any research experience(s)?**

- No
- Yes, in engineering related areas
- Yes, in non-engineering related areas
- Yes, in both engineering and non-engineering related areas

32. **What is your expected grade point average this academic term?**

- A or A+ (3.9-4.0)
- A- (3.5-3.8)
- B+ (3.2-3.4)
- B (2.9-3.1)
- B- (2.5-2.8)
- C+ (2.2-2.4)
- C (1.9-2.1)
- C- (1.5-1.8)
- D (less than 1.4)

33. **Your sex:**

- Male
- Female

34. **How old will you be on December 31st of this year? (Mark one.)**

- 20 or younger
- 21
- 22
- 23
- 24
- 25-29
- 30-34

- 35-39
- 40-54
- 55 or older

35. **Please indicate your ethnic background: (Mark all that apply.)**

- White/Caucasian
- African American/Black
- American Indian/Alaska Native
- Asian American/Asian
- Native Hawaiian/Pacific Islander
- Mexican American/Chicano
- Puerto Rican
- Other Latino
- Other

36. **What is your marital status?**

- Not married
- Married
- Divorced
- Separated
- Widowed

37. **How many dependents do you have?**

- None
- 1
- 2
- 3
- 4
- 5 or more

38. **Are you:**

- A U.S. Citizen
- A Permanent Resident of the U.S.
- Other

39. **Were you born in the United States?**

Yes

If no, at what age did you immigrate to the U.S.? _____

40. **Did one or more of your parents/guardians immigrate to the United States?**

Yes

No

41. **Is English your first language?**

Yes

No

42. **What is the highest level of education that your mother completed? (Mark one.)**

Did not finish high school

Graduated from high school

Attended college but did not complete degree

Completed an Associate's degree (AA, AS, etc.)

Completed a Bachelor's degree (BA, BS, etc.)

Completed a Master's degree (MA, MS, etc.)

Completed a Doctoral or Professional degree (JD, MD, PhD, etc.)

43. **What is the highest level of education that your father completed? (Mark one.)**

Did not finish high school

Graduated from high school

Attended college but did not complete degree

Completed an Associate's degree (AA, AS, etc.)

Completed a Bachelor's degree (BA, BS, etc.)

Completed a Master's degree (MA, MS, etc.)

Completed a Doctoral or Professional degree (JD, MD, PhD, etc.)

44. **What is your best estimate of your parents' total income last year? Consider income from all sources before taxes. (Mark one.)**

Less than \$10,000

\$10,000-\$14,999

\$15,000-\$19,999

\$20,000-\$24,999

\$25,000-\$29,999

\$30,000-\$39,999

\$40,000-\$49,999

\$50,000-\$59,999

\$60,000-\$74,999

- \$75,000-\$99,999
- \$100,000-\$149,999
- \$150,000-\$199,999
- \$200,000-\$249,999
- \$250,000 or more

45. **Would you describe your family as: (Mark one.)**

- Low income
- Middle income
- Upper-middle income
- High income

46. **What did you do last summer (2006) that was particularly important to you?**

47. **Did your experience last summer (2006) advance your interest in studying engineering?**

- Yes
- No

48. **Did you participate over the last summer (2006) in any of the following? (Mark all that apply.)**

- Engineering related internship/job
- Engineering related research
- Engineering related coursework
- N/A

49. **What do you plan to do after graduating from college?**

50. **Did you take the Academic Pathways of People Learning Engineering Survey (APPLES)?**

- Yes
- No
- I'm not sure

Please click the SUBMIT SURVEY button below to access the next page of the survey, and ONLY after you have completed this page. Once you click the button, you will not be able to return to this page.

[Save](#) | [Submit Survey](#)

A.4 EPS Pre-Questionnaire

1. How well do you think your undergraduate experience prepared you to learn what you needed to learn for the work you did right after graduation?
 - Poor
 - Fair
 - Well
 - Very well
 - Excellent

2. How important were the knowledge and skills from your undergraduate experience to the work you did right after graduation?
 - Not important
 - Somewhat important
 - Important
 - Very important
 - Crucial

The next three questions are similar to those you have answered as part of our previous surveys. We would like to see how your responses may have changed since you've graduated.

3. Of the 20 skills and areas of knowledge below, please put a check mark next to the FIVE you think are MOST IMPORTANT to engineering graduates.

Business knowledge

Communication

Conducting experiments

Contemporary issues

Creativity

Data analysis

Engineering analysis

Engineering tools

Ethics

Global context

Leadership

Life-long learning

Management skills

Math

Problem solving

Professionalism

Science

Societal context

Teamwork

4. Please rate your proficiency at employing the following skills and areas of knowledge:

	Not at all prepared	...	Somewhat prepared	...	Very well prepared
Business knowledge	<input type="radio"/>				
Communication	<input type="radio"/>				
Conducting experiments	<input type="radio"/>				
Contemporary issues	<input type="radio"/>				
Creativity	<input type="radio"/>				
Data analysis	<input type="radio"/>				
Design	<input type="radio"/>				
Engineering analysis	<input type="radio"/>				
Engineering tools	<input type="radio"/>				
Ethics	<input type="radio"/>				
Global context	<input type="radio"/>				
Leadership	<input type="radio"/>				
Life-long learning	<input type="radio"/>				
Management skills	<input type="radio"/>				
Math	<input type="radio"/>				
Problem solving	<input type="radio"/>				
Professionalism	<input type="radio"/>				
Science	<input type="radio"/>				
Societal context	<input type="radio"/>				
Teamwork	<input type="radio"/>				

5. Of the twenty-three design activities below, please put a check mark next to the SIX MOST IMPORTANT.

- Abstracting
- Brainstorming
- Building
- Communicating
- Decomposing
- Evaluating
- Generating alternatives
- Goal Setting
- Identifying Constraints
- Imagining
- Iterating
- Making decisions
- Making trade-offs
- Modeling
- Planning
- Prototyping
- Seeking Information
- Sketching
- Synthesizing
- Testing

Understanding the problem
 Using creativity
 Visualizing

6. How often have you had occasion to consider the following in your work?

	A lot	A little	Not at all
Economic issues			
Environmental issues			
Ethical issues			
Global context			
Health and safety			
Political issues			
Societal issues			
Sustainability			

7. Please rate your overall satisfaction with the career preparation you received during your undergraduate years.

- Very dissatisfied
- Dissatisfied
- Neutral
- Satisfied
- Very satisfied

8. Please rate your overall satisfaction with your career path since you graduated.

- Very dissatisfied
- Dissatisfied
- Neutral
- Satisfied
- Very satisfied

9. Have you done any of the following since you've graduated? Check all that apply.

- Worked in an engineering job
- Worked in a non-engineering job
- Attended graduate school for an engineering degree
- Attended graduate school for a non-engineering degree
- Other, please describe:

10. If you have worked in an engineering or non-engineering job, which of the following best describes your career path?

- Stayed in the same job
- Moved around within one employer
- Changed employers once or twice
- Changed employers three or more times

11. If you have worked in an engineering or non-engineering job, what was your first job after you graduated? Please include your job title and company.

If you have attended engineering or non-engineering graduate school, what program were you enrolled in? Please include the degree type and school.

12. Which of the following are you doing now?

- Working in an engineering job
- Working in a non-engineering job
- Attending graduate school for an engineering degree
- Attended graduate school for a non-engineering degree
- Other, please describe:

13. If you are currently working in an engineering or non-engineering job, what job do you have now? Please include your job title and company.

If you are currently attending engineering or non-engineering graduate school, what program are you enrolled in? Please include the degree type and school.

14. How important is it for you to have each of the following in your career?

	Not Important	Important	Crucial	I prefer not to answer
Opportunity for advancement				
Intellectual development				
Respect and recognition				
Helping others				
Financial and/or health benefits				
Social interaction				

15. Which of the following have had an impact on your career decisions since you've graduated? Check all that apply.

- A family member or friend
- A significant other
- A manager or supervisor
- A research or academic advisor
- A coworker
- A fellow student
- A service, religious, or civic organization
- A literary, visual, or performing arts group
- A sports club or league
- A professional or academic association

Other, please describe:

16. Are there any events that have happened since you've graduated that you think have been important to your career decision-making (e.g., getting married, having children, unexpected opportunities, etc.)?

17. Do you see yourself doing any of the following in the future? Check all that apply.

- Working in an engineering job
- Working in a non-engineering job
- Attending graduate school for an engineering degree
- Attending graduate school for a non-engineering degree
- Other, please describe:
-

18. What kinds of things do you hope to accomplish in the future?

19. What city/state/country do you currently reside in?

Thank you for participating in this questionnaire! ...If you have any questions, concerns, or complaints, please contact:

[Contact name]

[Email address]

[Phone number]

A.5 EPS Interview Protocol

2. Thank you again for completing the online questionnaire. It was very helpful to read about what you have been up to lately. You said that you are at [insert name of company/school] doing [insert participant's job/degree]. How are things going for you there? Tell me more about what you do there. i) What are your main responsibilities? ii) Who are the people you work with on a regular basis? What are their roles at work? Engineers? Non-engineers? iii) What skills and knowledge do you see as most important to doing your job? Which do you use most often?
 - A. Purpose of the question: To break the ice, to better understand the kind of work they are doing now, and to identify key skills/knowledge to ask about later.
 - B. Anticipated possible answers:
 - i. The best answers will seem like a “grand tour” of their current work/school situation, what they do, who they work with, etc.
 - ii. If the participant is giving 1-sentence answers, refer to prompts below.
 - a. Possible prompts:
 - i. Describe a typical day at your job.
 - ii. If they ask what we mean by “what kinds of people do you work with,” possible examples: “managers, engineers, grad students, etc.”
 - iii. If they ask what we mean by “skills and knowledge,” possible examples: “technical skills, people skills, etc.” Encourage them to elaborate on what *kinds* of technical skills/people skills/etc. they use.
3. Are you currently doing what you thought you'd be doing while you were an undergrad? Tell me about that. In the APS interviews, you said you wanted to do {insert from APS}. How is what you are doing now the same or different?
 - A. Purpose of the question: To see whether they stayed on the trajectory that they were on when they graduated, and to see how they define what they are doing now in relation to what they said they wanted to do before
 - B. Anticipated possible answers:
 - i. “I am doing exactly what I thought I would be doing.”
 - ii. “I am doing the complete opposite of what I thought I would be doing, and here's what I mean by that.”
 - iii. “I am doing something similar to what I thought I would be doing, but it's not exactly the same, and here's why.”
 - C. Possible prompts:
 - i. If they are confused by the first part of the question, moving on to the second part of the question should help them understand what we mean.
 - ii. If they say they are something different, but don't give details, as for examples.
4. I see from your questionnaire that you want to {insert the participant's plans for the next 5-10 years}. Tell me about that. What specific things are you doing now to realize that plan? What factors do you think might affect your plans? What are you most worried about? On a scale of 1-10, with 1 being not confident at all and 10 being very confident, how confident are you in your ability to achieve those plans?
 - A. Purpose of the question: To better understand future career goals, current career actions, perceived barriers, and to gauge their self-efficacy and outcome

expectations with regards to overcoming perceived barriers and achieving their goals

- B. Anticipated possible answers: They want to go back to school for a PhD/get an MBA/move to a management position/start a family/etc. To realize this plan, they are seeking special courses and training/seeking advice from their mentors/taking on more responsibility with work/growing their savings/etc. Things that might affect their plans or things they might be worried about include another economic decline/money/work-life balance/etc. Their confidence scores will vary.
- C. Possible prompts:
- i. If they ask what we mean by “what things are you doing now”, some examples: “training, taking courses, seeking advice, etc.”
 - ii. If they ask what we mean by “what factors might affect your plans” and “what are you most worried about”, some examples: money, family concerns, time concerns, etc.
 - iii. If they do not provide enough detail, potential follow up questions are, “can you be more specific?” “can you give an example of [whatever]?” “tell me a story about a time when [whatever]?”
5. You identified {skills/knowledge} as being important in your job/work. Can you give me an example or tell me a story about a particular time you had to use {skills/knowledge}? **How confident are you in your ability to use these {skills/knowledge}?** On your questionnaire, you said that you consider {context area} issues a lot. Can you give me an example or tell me a story about a particular time you had to use {context area}? OR On your questionnaire, you indicated that you don’t have to consider much in the way of contextual issues in order to do your job? Can you elaborate on this?
- A. Purpose of the question: To see whether or not the jobs that early career professionals take require knowledge about contextual issues, and to see how/where early career professionals are learning about contextual issues.
- B. Anticipated possible answers:
- i. “I learned about {context issues} in {course}.”
 - ii. “I learned about {context issues} when I started working.”
 - iii. “My job responsibilities are such that I don’t have to think about contextual issues.”
- C. Possible prompts:
- i. If they don't mention anything about school: Did anything in your college experience facilitate your learning these skills?
 - ii. If they do not provide enough detail, potential follow up questions are, “can you be more specific?” “can you give an example of [whatever]?” “tell me a story about a time when [whatever]?”
6. Tell me about the experiences you had during your undergraduate years that were most useful in preparing you for your engineering/non-engineering job. What was it about that experience that you think made it most useful? You say you learned a lot of {insert skill/knowledge here}. Why do you think that experience was especially effective in teaching you about {insert skill/knowledge here}?
- A. Purpose of the question: To better understand which experiences are most useful in different jobs that early career professionals end up taking.

- B. Anticipated possible answers: This could elicit a wide variety of responses, from in-the-classroom learning to outside-of-the-classroom learning such as co-op/internships, extracurricular activities, etc.
- C. Possible prompts:
- i. Tell me a story about a significant learning experience. If they ask what we mean by learning experiences, some examples: “Learning experiences either inside or outside of the classroom, such as capstone design, undergraduate research, co-ops/internships/etc.”
 - ii. If they don’t give a specific example of a learning experience: Is there a particular experience that stands out as significant in preparing you for your current work?
 - iii. If they give multiple examples: Is there one experience that stands out for you as particularly valuable? Why do you think this experience was significant, above others?
 - iv. What do you think are the qualities of this (and other learning experiences) that contributed to its being important to you?
 - v. During APS, you mentioned {insert important thing} as being important to you. Has that factored into your current or future experiences?
7. How has your idea of an engineering job changed since you graduated? What do you think has caused you to think differently about engineering work? What is it about your job that is different from what you thought engineering work would be like while you were in school? On your questionnaire, you said that your is/is not engineering work. Can you explain what you mean by that?
- A. Purpose of the question: To better understand how early career professionals’ perceptions of engineering have changed since graduation, e.g., do any graduates doing non-engineering work still see themselves as engineers?
- B. Anticipated possible answers:
- i. Expect people doing engineering work to say that their technical duties comprise engineering work and their non-technical duties (e.g., communicating with other people, etc.) comprise non-engineering work.
 - ii. Expect people doing non-engineering work to say the opposite.
- C. Possible prompts:
- i. If they don’t give specific examples: Is there a particular experience that stands out where you had to use your engineering/non-engineering skills?
8. During your undergraduate years, you talked about pursuing an engineering degree because XYZ. Does that still factor into your current career choices? How has your career motivation changed? Why do you think it changed?
- A. Purpose of the question: To better understand how early career professionals’ motivations and values have changed with regards to work.
- B. Anticipated possible answers:
- i. “Yes, I still feel the same way.”
 - ii. “No, I feel differently now, and here’s how/why.”
 - iii. “Actually, my career motivation has changed slightly, and here’s how/why.”
- C. Possible prompts:
- i. What keeps you doing your job?

- ii. How has your day-to-day motivation changed?
 - iii. If they don't elaborate on the how/why, ask them to elaborate on this.
- 9. For the work you are doing now, how did you find out what you needed to learn and how did you go about learning it? How does the way you learn now compare to the way you learned as an undergraduate?
 - A. Purpose of the question: To better understand how early college professionals learn on the job, and to serve as a scaffold for the next question.
 - B. Anticipated possible answers:
 - i. How they learned what they needed to learn: "I read/did research online/took some training courses/asked my coworkers/peers, asked my manager/advisor, etc."
 - ii. "I learn the same way as before."
 - iii. "I look things up more often now than I did before." "I ask my coworkers and managers for help now." etc.
 - C. Possible prompts:
 - i. If they can't think of specific examples, ask them how they went about learning the skills/knowledge that they identified as being important in the first question.
- 10. What supports does your organization provide to help you learn what you need to learn? What supports do you wish they provided that they don't provide now?
 - A. Purpose of the question: To better understand the supports and barriers that early career professionals perceive with regards to learning what they need to learn.
 - B. Anticipated possible answers:
 - i. Example of supports: "Orientation, training, mentors, hands-on learning, etc."
 - C. Possible prompts:
 - i. If they don't provide specific examples of supports, ask "Is there anything that your manager/advisor or coworkers/peers have done that has been particularly helpful for you?" OR "Is there anything that your work or your school has done that has been particularly helpful for you?"
 - ii. If they don't provide specific examples of missing supports, ask "Did you at any point think to yourself, wow, I really wish things were this way? Or, I really wish I had access to this or that?"
- 11. So, there has been a significant economic decline in the U.S. and globally since you graduated. {Pause for emphasis.} Do you think your experiences making career decisions were influenced by this decline? Tell me about that.
 - A. Purpose of the question: To better understand the role of the economic decline on the participants' career decision making, specifically in terms of being a barrier
 - B. Anticipated possible answers:
 - i. "Yes, and here's how/why." Answers might include, I couldn't find a job for a while, I had to take a job I didn't like, I had to take a job I wouldn't have otherwise taken and I ended up loving it, I decided to go to school, etc.
 - ii. "Not really, and here's how/why." Answers might include, I had a job before I graduated, I always intended to go to graduate school right after I finished undergrad, etc.

- C. Possible prompts:
 - i. If the participants don't mention how or why, ask them to elaborate.
- 12. In your questionnaire, you mentioned that {insert people/activities} have had an impact on your career decisions. Tell me more about that.
 - A. Purpose of the question: To better understand how people/activities have served as supports and barriers in early career professionals' career decision making.
 - B. Anticipated possible answers:
 - i. "My family/mentor encouraged me to take this job."
 - ii. "I had to take this job to support my sick relative/new family/etc."
 - iii. "Participating in this activity helped me find my true passion."
 - C. Possible prompts:
 - i. If people don't mention specific examples, ask for them.
- 13. Is there anything else that is going on currently or happened in the recent past that influenced your career choice?
 - A. Purpose of the question: To capture anything else that may have influenced their career decision making that they weren't asked about yet.
 - B. Anticipated possible answers: This will vary from person to person. Some participants might even say that, no, they said everything they wanted to say.
 - C. Possible prompts:
 - i. If they don't specifically talk about other factors that affected career choices: Has anything affected your career decision making that I didn't ask you about but should have?
- 14. How do you feel about the choices you made during college and after graduation? Knowing what you know now, is there anything you would do differently? Are there any opportunities that you wish you had taken advantage of?
 - A. Purpose of the question: To give the participant a chance to reflect on their pathway up until this point and to see how they might be thinking about their early experiences (inputs) as they relate to their current and future experiences (environment and outputs).
 - B. Anticipated possible answers: This will vary from person to person.
 - C. Possible prompts:
 - i. If they ask what we mean by choices and by things they would do differently, some examples: "choosing courses or your major, choosing how to spend your free time, making plans for your career."
- 15. I've come to the end of my question list. So, now I want to give you time to talk. You were active in APS and you now know about our current study. You have answered a bunch of questions, but is there anything else you want me to know?
 - A. Purpose of the question: To serve as a catch-all for anything else they might want to say related to their undergraduate education or career decision-making.
 - B. Anticipated possible answers: This will vary from person to person. Some participants might even say that, no, they said everything they wanted to say.
 - C. Possible prompts:
 - i. If they don't know what we mean by this, say "Is there anything else that you think is important for us to understand about your pathway?"
- 16. Thank you very much for sharing your insights and experiences with us. Would you mind if we contact you again if we have questions about your responses?

- A. Purpose of the question: To keep the channel open for following up with them in the future.
- B. Anticipated possible answers:
 - i. Mostly yes or no.
 - ii. Some participants might have questions about how we intend to use this data or how we have used the data from APS.
- C. Possible prompts:
 - i. None needed.

B. Codebook

As described in Chapter 4, the codebook was founded on Social Cognitive Career Theory and developed through multiple iterations of coding. This codebook was used and reviewed by multiple researchers to develop the structure and definitions shown below. Due to the longitudinal nature of this study, participants discussed past, present, and future actions, goals, and influences. The definitions below are not limited certain time phases and could be applicable in past, present, or future tense.

Code	Definition
Actions	These are statements of performing an act, or plans to perform an act, related to the participant's career.
Accept Job Offer	I found and accepted a job
Applying for Job	I applied for jobs
Company Rotation/ Internal Transfer	I participated in a company rotation or transferred within the same company (includes location changes)
Entrepreneurship	I started a company or non-profit.
Establishing Reputation	I am working hard to perform my job well
Exposure Activities	I am making presentations to management or outside groups.
Formal Education	I pursued formal education past my BS
Engineering Graduate School	I enrolled in or completed an MS or PhD in engineering.
Non-Engineering Graduate School	I enrolled in or completed formal education outside of engineering.
Preparing for Graduate School	I took an entrance exam, researched a program, or otherwise prepared for future enrollment.
I have/had X job	This is what I do.
Left Job	I left my job.
Networking	I participated in networking activities
New Employment	I got a new job! (does not include first position after BS)
None	I have not done anything towards achieving my career goal.
Outside Activities	I participated in hobbies tangential to my school and work assignments.
Relocated	I moved.
Stay Put	I do not intend to change employers. (inaction)

Code	Definition
Goals	“The determination to engage in a particular activity or to effect a particular future outcome” (Lent 1994) Goals are what the participants want to do or achieve, not why.
Company Loyalty	Goal to remain working for the same company
Certification/Licensure	Goal to gain professional certification, such as a PE license
Different Employment	Goal to get a different job
Formal Education	Goal to earn a degree.
Entrepreneurship	Goal to start one's own business
Family	Goal to have children, when mentioned as impacting other career choices.
Field	Goal to work in a specific field
Geography	Goal to live in a certain locale
Intellectual Stimulation	Goal to have challenging or interesting work
Job Advancement	Goal to advance to a different position
Job Mastery	Goal to succeed in current position
Job Tasks	Goal to have a job performing certain tasks
Make an Impact	Goal to make an impact
Make Money	Goal to make money (explicit)
Prestige	Goal to be respected by others
Vague	Vague goals. This is where people talk about not really knowing what they want (or wanted) to do.
Work Environment	Goals relating to the type of desired work environment
Work/Life Balance	Goals relating to time for outside activities
Influences	Influences are "why". These are not goals or actions, but factors that play into goals and actions.
Contextual Affordances	External factors that influence career decisions.
Economy	Influences of the economy or engineering markets
Changing Jobs or Fields	Changes in jobs or fields motivated by economic conditions
Fewer Job Opportunities- New Grads	For the first job, fewer jobs available than expected
Gratitude for Job	Bad economy leading participants to be grateful for a job
Lack of Advancement	Bad economy leading to lack of advancement opportunities
Layoffs and Pay or Benefit Cuts	Layoffs, pay cuts, or benefit cuts attributed to the economy
No Negotiating	Tight economy meant lack of negotiating power, generally in reference to salary or benefits
Uncertainty	Economy has led to uncertainty and lack of autonomy for participant
Geography	Geographic conditions that make living in a certain area favorable or unfavorable.

Code	Definition
Money	Money as an influence or consideration in career choices.
Professional Organizations	Professional Organizations that explicitly help the participant advance his or her career. Stating membership is not coded; only segments where the benefit of the organization to the participant's career.
Socializers	People that influence the participant's career choices.
Bosses	Supervisors in the workplace, but not graduate advisors
Classmates	Current or former classmates, including older students.
Coworkers	Present or past coworkers.
Family	Any relatives of the participant
Children	Offspring of the participant that influence career choices, even if not born yet.
Parents	Mothers and Fathers of the participant
Romantic Partners	Boyfriends and girlfriends, fiancés/fiancées, spouses
Friends (not Coworkers)	Friends of the participant that are not coworkers
Graduate Advisors	The participant's graduate advisor.
Mentors	People filling a mentoring role in guiding the participant's career choices. Mentors may also fill other roles (such as bosses, advisors, etc).
Potential Employers	Any potential employers that influence career choices, such as feedback when applying for jobs or discussions at conferences. These relationships are generally single interactions, rather than extended mentorship.
Undergraduate Professors	Participants' undergraduate professors, only when identified as influencing career choices.
University Resources	Alumni networks, department advisors, etc
Interests	Any and all interests impacting goals and actions.
Disinterests	Participants are NOT interested in certain fields, jobs, or tasks.
Enjoying School	Academic tasks or environment are interesting.
Just wanted a job	Participant reports just wanting a job, not being particular.
My work matters	Interest in meaningful work.
Not Sure What To Do	Delaying action because of lack of defined interests.
Learning Experiences	Past or present experiences that influence career decisions.
Grad School Academic Experiences	Classroom/research experiences in graduate school, to the extent that the participant identifies them as influencing his or her career choice.

Code	Definition
Internship	Internship impacting career decisions. Could be accepting a permanent position due to internship, or deciding NOT to follow a path because of internship.
Other opportunity fell through	Plan A didn't work out so now onto plan B
Past personal experience	Prior experiences influencing career choices, not academic or work. (eg Personal Illness, Athletic success)
Seeking skills before changing roles	Intending to build knowledge and skills in current role before moving on (also used past tense to justify prior career choices)
Undergrad Experience	Undergrad experiences cited as impacting career choices. These are not stories from undergrad about learning skills without mention of how that skill influenced career choices.
Workplace Experience & Culture	Experiences at work or with the workplace culture influencing career choices. Includes enjoyable office atmosphere.
Outcome Expectations	Expectations regarding consequences of actions
Advancement Opportunities	Action is desirable/undesirable because of future opportunities, usually within the same employers
Safety and Stability	Expectations of job security when following a certain path.
Self Efficacy	Beliefs about the participant's ability to perform a task or succeed in an undertaking.

C. Example Case Report

Case reports were developed for each participant. The goal of these case reports was to answer the research questions individually to ensure the participant's story was being considered. Only one exemplar case report is presented here to preserve participants' anonymity.

OTIS (SPRI)

Story: Computer science major with a love of [humanities discipline] He went to work at a start-up after graduation that he'd previously interned with, and stayed with the company until the EPS interview. He would like a [humanities discipline] PhD, but isn't certain about the market. He also has a girlfriend, and is hesitant to move away from her.

- How do graduating seniors describe their early career goals and their plans for achieving those goals?

Otis would like to work as a programmer, but is also very interested in history.

"Some sort of programming job. Right now I'm leaning towards web development"
[APS]

"I plan on working at the startup at which I interned last summer at least until IPO, and then perhaps pursue a PhD in [humanities discipline]." [PIE]

- What actions have early career professionals taken to meet the career goals they set as graduating seniors?

Otis has worked for the same company since graduation.

Goal: work as a programmer

Actions: Job is developing user interfaces

Goal: PhD in [humanities discipline]

Actions: Consulting with others lead to putting this on hold.

- How do early career professionals describe their career goals for the next phases of their careers and their plans for achieving those goals?

Otis recognizes that coders do not spend their whole career as coders, and is starting to look at management opportunities. He is working on getting a good reputation at work.

"I enjoy coding, but I think it would be an interesting challenge to actually . . . I also enjoy sort of conceptualizing answers to problems, not necessarily just like, straight out

coding them as well. Um, and I think doing that combined with some sort of management or operations role when it comes to a company, would be interesting.” [EPS]

“I still faintly entertain the idea of pursuing an advanced degree in [humanities discipline]. Otherwise, I hope to continue my profession, eventually becoming a technical manager at some point in the future.” [PreQ]

“I really like working at [Company Working For], I've ignored other recruiters who have tried to get me to go to other companies, um, just because I think [Company Working For] is so great.” [EPS]

- How are these goals and associated actions or plans related to prior career goals and actions?

Otis has set aside his goal of a PhD in [humanities discipline] and is instead focusing on his technical career. This was influenced by finances, his enjoyment of his current job, and geographic considerations including his girlfriend.

“A volatile job market and increasing financial incentives at my current job have made me less inclined to seek other opportunities.” [PreQ]

“My girlfriend. I've actually talked to her about, uh, whether or not I want to pursue a [humanities discipline] PHD, because we both live together right now, and if were, you know, and, if I had to go somewhere else like, go to New York, um, or to um, a school in southern California, I mean it would be, you know, the question would be whether she would come with me, or, we'd try the long-distance relationship or not, um. So. So that has been an influence, actually.” [EPS]

“I enjoy the thought processes that go into- into [humanities discipline], and analyzing it. Um, but, in- I mean, for just the sake of future financial stability, um, I think it's far better to stay an engineer than to try to get a- to get a [humanities discipline] PHD, and I wanna stay in this area” [EPS]