ABSTRACT

Title of Dissertation: A GENDER ANALYSIS OF ENGINEERING PHD STUDENTS' CAREER DECISION-MAKING PROCESS USING A BOUNDED AGENCY MODEL

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This qualitative research study applies a bounded agency model in investigating the career decision making process of engineering PhD students at a large, public research university in the United States. Through a gender analysis of the career decision-making of men and women PhD students in engineering, this study sheds light on the reasons why men and women choose different career trajectories in engineering, with implications for diversifying the professoriate.

This study highlights the ways in which men and women PhD students in engineering experience the university as an institution differently, and form different impressions of the academic career. The bounded agency model allows for a holistic examination of the organizational barriers, as well as the individual level dispositions and

characteristics that work to limit the range of feasible alternaives and choices for men and women as they make their career choices.

The findings provide insight into the career decision-making of men and women PhDs as an iterative process of information gathering, crystallization of values, and narrowing down of options. Gender differences are outlined at each stage in this process, providing a framework for furthering understanding of other underrepresented populations in the professoriate. Additionally, the findings have implications for graduate education in engineering, and for PhD student career development and choice, both in the United States and beyond.

keywords: agency, bounded agency, career choice, career development, engineering graduate education, gender, graduate student agency, PhD student experience, STEM

A GENDER ANALYSIS OF ENGINEERING PHD STUDENTS' CAREER DECISION-MAKING PROCESS USING A BOUNDED AGENCY MODEL

by

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Dedication

To my husband, Jiahui, because without your support and dedication to our family, this would have never been possible.

To my sweet daughter Azzurra and my dear son Zeno, thank you for helping me achieve balance in reminding me to take nights and weekends off, and for teaching me just how little sleep I can actually get by on. May you never be limited by your gender identity.

To my mother, because you always believed I would be a (medical) doctor.

To my advisor, Dr. Stromquist who has always pushed my thinking and challenged me to make this dissertation what it is today.

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CHAPTER 1: Introduction

Globally, across disciplines and fields of study, women faculty's representation in tenured and tenure-track positions lags behind that of men faculty. Research has shown that women academics are not promoted in the same proportion and rate as their male colleagues, achieve tenure at a slower rate than men, are underrepresented at the top ranks and in administrative positions, earn less than comparable men, and are more likely to leave academia in pursuit of employment in other industries (Acker, 1980; Acker & Armenti, 2004; Barrett & Barrett, 2011; Winslow, 2010).

Women are underrepresented as tenured and tenure-track faculty members across virtually all academic disciplines, particularly at the higher ranks (Xu, 2012). However this underrepresentation of women at the higher levels of academia is even more pronounced in science and engineering fields (Dworkin, Kwolek-Folland, Maurer, & Schipani, 2008; Sturm, 2006; Ward, 2008). In engineering, for example, women make up 9% of faculty overall but 34% of instructors in non-tenure-track positions; women make up just 4% of full-time professors in engineering disciplines (Ward, 2008).

Many of the factors contributing to the attrition of women in academic careers in general are even more visible and pronounced in STEM fields. These factors include a lack of female role models, gender stereotypes, a chilly climate for women in STEM, inadvertent bias against women in STEM, and an even less family-friendly atmosphere within STEM departments than in academia overall (Beede et al., 2011; Blickenstaff, 2017). In addition to these, some challenges that are specific to STEM include the problematic belief that men are biologically better cut out for scientific and rational thinking, cultural and societal pressure for women and girls to conform to more

traditionally female roles, and the ways in which the pedagogical methods and curricula employed in science classes may favor male students (Blickenstaff, 2017). Within STEM, women are horizontally segregated into the life sciences, particularly the biological sciences, while men are concentrated primarily in engineering fields (Beede et al., 2011). The absence of women in STEM is described as both progressive, meaning the further down the pipeline you go, the fewer women there are, and persistent, meaning that interventions in the past 20 years have done little to solve the problem (Blickenstaff, 2005). Many of the patterns seen in the academy overall are even more pronounced in science, technology, engineering and mathematics (STEM) disciplines.

Statement of the Problem

As an increasingly competitive, globalized economy continues to reshape higher education in the 21st century, scholars, institutions and national governments are calling for a more diverse academic workforce, particularly in STEM disciplines (Beasley & Fischer, 2012; Blickenstaff, 2017; C. Hill, Corbett, & St Rose, 2010; Ramsey, Betz, & Sekaquaptewa, 2013). This focus on expanding STEM and making it more inclusive has often centered on the recruitment, retention and advancement of women, who continue to be underrepresented in these fields (Beasley & Fischer, 2012; Blickenstaff, 2017; C. Hill et al., 2010; Whitten, Foster, & Duncombe, 2003). However, recent research has shown that efforts by institutions and policy makers have fallen short, and that the representation of women in STEM fields continues to decrease sharply as one moves up the academic career ladder (Beasley & Fischer, 2012; Beede et al., 2011; Ehrenberg, 2010; Griffith, 2010; P. W. Hill, Holmes, & McQuillan, 2014; Leslie, Cimpian, Meyer, & Freeland,

2015). This phenomenon, often termed the "leaky pipeline" for women in STEM, is described as both persistent and pervasive.

Existing research has examined several broad areas pertaining to the attrition problem for women in STEM. These include: the possibility of biological differences in scientific or mathematical aptitude between men and women (Blickenstaff, 2017; Ceci & Williams, 2010; Lubinski & Benbow, 1992); differences in the socialization of men and women into certain disciplines and career trajectories throughout their lives (Blickenstaff, 2017; Cheryan, 2012; C. Hill et al., 2010; Murphy, Steele, & Gross, 2007), and, related to this, differences in how men and women experience STEM environments (Cheryan, 2012; Good, Rattan, & Dweck, 2012; Griffith, 2010; C. Hill et al., 2010; Ramsey et al., 2013). The bulk of this research has focused on K-12 education and on college education at the bachelor's level, with fewer studies focused on the graduate and postgraduate educational experiences of PhD and postdoctoral students. Moreover, the theoretical frameworks commonly used in the literature on graduate education address the experiences of individuals throughout their graduate and postdoctoral programs in a way that emphasizes individual choice and agency. These frameworks do not adequately integrate an analysis of structural elements tied to the attributes of the university as an organization, thus omitting the role of the university itself in bounding or limiting individual agency and choice.

Purpose of the Study

The purpose of this in-depth, qualitative case study was to explore the career decision-making process of men and women PhD students in engineering disciplines. More specifically, this study sought to explore gender differences in engineering PhD

students' decisions about whether or not to pursue an academic career using a bounded agency model. This framework allowed for an acknowledgement of the role of structural conditions in limiting individuals' perceptions of their feasible alternatives, leading to a fuller understanding of the ways in which the university as an organization impacts the behaviors and choices of PhD students. This bounded agency approach called for a consideration of individual factors, as well as institutional factors that affect students' experiences and career choices.

This study employed a conceptual model that combined Kanter's (1977) framework for examining the complex connections between organizational context and individual decision-making with Rubenson & Desjardins' (2009) bounded agency model. By using a combination of these two theoretical frameworks, the conceptual model was able to better integrate an understanding of structural and organizational factors pertaining to the university as an institution with their effects on individual agency and decision-making.

The study explored individual factors influencing graduate students' decisions to pursue academic careers, including dispositional factors and individual perceptions of the academic career and its demands. Additionally, the study sought to uncover how institutional level factors and students' experiences of the university as an organization during their graduate programs influenced their decisions, highlighting the gender differences that were observed in students' institutional experiences and career decision-making process. In order to illuminate gender differences, this study involved a sample consisting of both male and female participants.

Research Questions

This study attempted to answer the following research questions:

- What personal factors influence engineering PhD students' decisions to pursue an academic career?
- How do engineering PhD students' experiences of the university during their programs influence their decisions to pursue an academic career?
- What gender differences can be observed in engineering PhD students' institutional experiences and their career decision-making process?

Research Design

This study will consisted of an in-depth, qualitative case study of engineering PhD students' career decision-making process, conducted at Mid-Atlantic University (pseudonym), referred to as MAU. The site of the study is a large, public research university on the mid-Atlantic coast. This university was chosen because it is a sizeable and well-established public research institution offering a wide variety of engineering doctoral programs. These characteristics make MAU a typical or representative case (Gerring & Cojocaru, 2015) that typifies the broader category of large, public research institutions in the United States.

In keeping with the traditions of case study research, I collected data from a variety of different sources and using a range of research methods, in order to gain a thorough understanding of the case in question (Creswell, 2013; Yin, 2018). Specifically, I used the following data collection methods: (a) semi-structured interviews with 20 engineering PhD students; (b) 2 sex-segregated focus groups, one with women and one

with men, in order to facilitate discussions and render themes regarding gendered experiences. In addition, publically available data from university websites were used to gain an in-depth understanding of the study context, including the engineering school and its departments, as well as the career-related workshops available to graduate students in general and to engineering PhD students in particular. This contextual information was helpful in making sense of how engineering PhD students perceive the career services available to them, make use of them in their job search, and rate their usefulness and applicability to the labor market that they are facing. Interviews with engineering PhD students provided insights into their underlying motivations in making career decisions, particularly decisions about whether or not to pursue academic careers. A constant comparative method of data analysis was used to construct categories or themes as they emerged from the data (Creswell, 2013; Jones, Torres, & Arminio, 2014). Several rounds of data coding were conducted, initially using an open coding approach and later developing a code book informed by the study's theoretical framework and the review of the relevant literature. As a final step in my data analysis, the results of the coding were shared with study participants, in order to obtain their feedback and reactions to the contents of this report.

In order to strengthen the robustness of my study, triangulation was employed in order to obtain data and statements on certain phenomena from a variety of different sources. For example, following careful documentation of the career services available to PhD students in engineering, student interviews allowed for a deeper understanding of how such services were used and perceived by the students themselves, who might hold their own opinions regarding the services on offer and the degree to which they were

helpful. I also sought to corroborate some of issues that came up in student interviews through communications with engineering department chair persons and professors, as well as by researching university policies regarding graduate student research assistants, since the engineering PhD students interviewed largely fall under this category. I also clarified and critically reflected on my positionality with regards to the subject of this research, acknowledging that such social research is not separate from my particular social context and elements of my personal biography and experience. Throughout the research process, I kept a thorough and transparent audit trail, recording and describing all steps taken in my research process, from its development to my reporting of findings. Finally, I looked for rival explanations that could lead to other ways of seeing or understanding the phenomena that I report herein..

Significance of the Study

This study adds to the literature in several ways. First, in investigating the career decision-making process of engineering PhD students, this study highlights how recent experiences in graduate school, as well as future career prospects, expectations, and labor market considerations all contribute to decisions regarding whether to pursue an academic career. In employing a bounded agency model, this study allowe for a consideration of how agency and choice can be constrained by organizational and structural considerations, as well as by individual level factors, such as dispositions, capabilities and consciousness (Rubenson & Desjardins, 2009). In contrast, much of the previous literature on STEM graduate students' career decisions has focused on only one of these two dimensions, making it difficult to examine interactions between structural

and individual elements, and how the balance of considerations might be different for men and women students.

Finally, this study add to the literature by employing a qualitative approach that has not been common in examining graduate career choices. Many previous studies have employed large survey questionnaires, an approach that hasn't allowed researchers to gain much in-depth understanding of the choice process, and the different factors that weigh into engineering PhD students' career choices at this transition phase. In including both men and women students in the study, the design allow for a careful look at how different factors are weighted differently by students with different gender identities.

Outline of Chapters

Chapter 2 provides an overview of the literature pertaining to academic careers, with a focus on gender differences in the academy, and the challenges to women in academia. In the first part of the chapter, I explore relations of gender in the professoriate, the nature of which may become more apparent, especially to women students, as they progress through their graduate training. I go on to examine how feminist perspectives have been employed in the study of higher education, and to describe the shifting context of academia and the academic profession, which is being restructured in ways that may make it less appealing to graduate students. Finally, I examine the literature on graduate student career choices and describe my conceptual framework and related literature.

Chapter 3 focuses on my research design. I start by introducing my research questions and describing qualitative case study in general. I then discuss the aspects of the in-depth qualitative case study and outline the criteria for my case selection, describe

the case, and outline my strategies for recruitment, data collection and data analysis. I also share my positionality as researcher.

Chapter 4 begins with an introduction of the study context and the study participants. The study context includes information about the institutional context at MAU, the engineering discipline and specific engineering departments at the university, and institutional career resources available to students. The characteristics of the study participants are outlined, ending with a preliminary analysis of student decision-making trajectories as they progress through their graduate programs and near program completion.

Chapter 5 presents the bulk of the findings of this study, focusing on the experiences of the study participants both leading up to and during the process of their PhD education at MAU. Differences between men and women students' experiences and motivations begin to emerge with more clarity in this chapter, as they relate how their experiences during the course of their PhD programs their influences their career decision-making.

Chapter 6 presents a discussion of the study findings as they relate to the theoretical framework. In doing so, it presents an understanding of what the career decision-making process is like for engineering PhD students, relating this to the structural and individual elements that inform student choices. This chapter also examines how the career decision-making process is different for men and women students, and proposes changes to the bounded agency model that reflect a more nuanced understanding of the decision-making process that students are undertaking.

Chapter 7 presents the study conclusions, along with the policy implications of the main findings. Although there are policy initiatives that could address some of the structural barriers to women engineering students pursuing the academic careers, this study's conclusions suggest that a broader transformation of the organizational structures at play may be needed to address the attrition of women at this juncture of the academic pipeline in the engineering discipline.

CHAPTER 2: Literature Review and Theoretical Framework

In this literature review, I begin by providing a brief summary of the research literature explaining some of the challenges to women in academia. This research helps to highlight some of the norms and structures that act as barriers to the hiring, retention and promotion of women within the academic profession. While this is somewhat tangential to my research questions, the extent to which women students are exposed to, become aware of, and pick up on these relations of gender within academia can impact their decisions about whether or not to pursue an academic career. I then move on to an overview of broader feminist perspectives and theories that have informed much of the research on gender relations in higher education and STEM in particular. I then introduce some of the literature documenting the changing nature of faculty roles in higher education, since changes to the academic job market have happened within the a shifting higher education context that has impacted the work of faculty and markedly changed academic career structures.

Relations of Gender in the Professoriate

This part of the literature review serves to highlight the ways in which relations of gender affect the professoriate in its basic dimensions of research, teaching and service. Although many pages could be devoted to this topic, this brief section will just skim the surface of a few important aspects of the academic profession that have gendered dimensions. These are: like ideal worker norms, a linear career progression, work-time allocations, and inadvertent gender bias.

Ideal Worker Norms

Ideal worker norms remain pervasive in academia. Universities in general and research-intensive institutions in particular demand a high level of commitment from faculty. The demands of these "greedy institutions" mean that the preferred or ideal worker is someone who does not face competing demands from family and other responsibilities, i.e. has an unemployed partner at home who can support the family needs (Acker, 1980). This ideal worker is increasingly rare given changing social norms, the prevalence of families where both partners work full time, and the desire by men to be more actively present in their home lives (P. W. Hill et al., 2014). However, men academics are still more likely to have the attributes of the ideal worker than women. Women academics still perform more childcare responsibilities and housework than men academics do (Elliot, 2003, 2008; Sallee, 2012). For example, women in the UC system spent almost twice as many hours per week as men with their children (Mason & Goulden, 2004). Family structures in academia explain part of this phenomenon, since data from the Survey of Doctorate Recipients (SDR), demonstrated that women PhDs were more likely than men PhDs to have a spouse who worked full-time (Mason, Goulden, & Wolfinger, 2006), and, female academics were more likely than their male counterparts to have spouses with a full time job or who are also academics (Wolfinger, Mason & Goulden, 2008). These factors result in men academics being more likely to fulfill ideal worker norms in the academic workplace.

Linear Career Progression

The academic career path is a very linear one by nature, and deviations from the path, or time spent off the path, are often penalized. Research has shown that women are

more likely than men to deviate from this linear career path due to "disruptive life events" such as childbirth and primary childcare responsibilities, or the need to make accommodations for a spouse's career (B. Hill, Seeker, & Davidson, 2014). This helps to explain why women may either opt for, or be pushed toward, less prestigious careers within the academy, and why women academics are promoted and tenured at lower rates than men.

Work-Time Allocations

Given that supervisors and higher-level administrators in academic institutions are more likely to be men, it is difficult for women to create spaces in which to negotiate their positions, leading women to feel that a lot of what affects them lies outside of their control (Babcock & Laschever, 2009). The unwillingness or inability of women to negotiate their positions in the workplace may result from socialization processes external to the work environment, socialization within the workplace's organizational culture, and also individuals' constructions and negotiations of their gender identities (Lester, 2008).

Whatever the underlying mechanisms, women in academia have a harder time negotiating their positions than men do, leading to a greater mismatch between women's desired and actual work time allocation (Winslow, 2010). While women work more hours than men in academia, they tend to spend more time on teaching, grant writing and service, including 15% more time on low prestige committees (Porter, 2007). Men faculty spend on average seven and a half more hours on research each week than women, the equivalent of a full days' work (Misra, Lundquist, Holmes, & Agiomavritis, 2011). Women's inability to assert control over their work-time allocations suggests that women

are less likely to be satisfied within the faculty career and may thus be more likely to leave academia in pursuit of work in other industries (Winslow, 2010).

Exacerbating these issues is the fact that women faculty are asked to perform service duties more often than their men counterparts, and also agree to serve at higher rates. Furthermore, women faculty provide service of a more "token" nature, being approached less often than men for prestigious positions such as department chair or program director, and more often than men for positions that are time consuming but offer less prestige and career advancement, such as being director of an undergraduate program (Misra et al., 2011; Mitchell & Hesli, 2013). These patterns help to explain why, controlling for productivity and experience, women are less likely to attain higher ranks within the academy (Toutkoushian, 1999).

Inadvertent Gender Bias

Despite overt efforts to diversify faculty, gender bias continues to act in ways that disfavor the hiring, tenure and promotion of women at all points along the academic pipeline. Even before women enter academia as students, research suggests that faculty across fields and institutional types are significantly more responsive to white males than all other categories in considering requests from prospective students (Milkman, Akinola, & Chugh, 2015). Science faculty at research-intensive institutions have also been shown to rate male applicants as more competent and hirable than identical female applicants (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012), suggesting a gender bias that disfavors female PhD applicants.

In the process of faculty hiring, female candidates suffer a series of cumulative disadvantages. Their letters of recommendation tend to be shorter, weaker, and of lesser

quality than those written for male candidates (Madera, Hebl, & Martin, 2009; Schmader, Whitehead, & Wysocki, 2007; Trix & Psenka, 2003), and while agentic women are penalized for not being nice enough as applicants (Rudman & Glick, 2001), the communal characteristics most likely to be found on female applicants' letters of recommendation have a negative relationship with hiring decisions in academia (Madera et al., 2009).

Finally, within the academic profession, research suggests that women are penalized for cooperative work (Sarsons, 2015), may not receive comparable credit to men when working in teams (Heilman & Haynes, 2005), and have their papers evaluated as being of lesser scientific quality than those authored by men (Knobloch-Westerwick, Glynn, & Huge, 2013). Lastly, there is research evidence to suggest that students rate male instructors significantly higher than female instructors in their course evaluations, with implications for the tenure and promotion process for women (MacNell, Driscoll, & Hunt, 2015).

Changing Academic Working Profiles

Universities have changed immensely over the course of the past two centuries, and these changes have in turn changed the roles that faculty are expected to perform. Funding cuts, growing criticism of the tenure system, increasing undergraduate enrollments, and a neoliberal emphasis on efficiency have all had enormous impacts on universities. Institutions are responding to budget cuts and a growing emphasis on efficiency by hiring contingent faculty that receive lower pay and fewer benefits, and can easily be terminated (Bland, Center, Finstad, Risbey, & Staples, 2006; A. J. Jaeger & Eagan, 2011). Women are more likely than men to be hired into these low-prestige and

low-pay contingent and part-time positions that offer little job security (AAUP, 2006). Depending on engineering PhD students' degree of awareness, these shifts in the academic profession may act as deterents to pursuing academic careers, and may impact men and women differently by introducing a higher degree of uncertainty into the profession.

When taken together, this body of literature demonstrates that women face a cumulative disadvantage at all stages of the academic pipeline. The repeated experience of these biases in the form of disrespectful exchanges, microaggressions and a feeling of being essentialized ends up creating what many researchers have described as a chilly climate for women in academia. As engineering PhD students progress through their programs, it is possible that exposure to the academic workplace would make them aware of these gendered dimensions of work-life in the university, discouraging them from pursuing an academic career path.

Career Decision-Making Process of PhDs

Career Aspirations

The career aspirations of PhD and postdoctoral students have been researched largely through the use of surveys of large numbers of students (Fuhrmann, Halme, O'Sullivan, & Lindstaedt, 2011; C. Golde & Dore, 2001; Sauermann & Roach, 2012), though qualitative focus groups were used in one of the studies reviewed (Gibbs, Jr. & Griffin, 2013). These studies have provided valuable insights into patterns concerning how students' career aspirations change over the course of the PhD process, with the consistent pattern being that interest in faculty careers decreases as students progress (Fuhrmann et al., 2011; Gibbs, Jr. & Griffin, 2013; Sauermann & Roach, 2012). These

studies also provide some insight into student perceptions of their graduate programs and the training that they receive.

The career aspirations of PhD students tends to broaden and diversify over the course of their graduate studies (Fuhrmann et al., 2011; Gibbs, Jr. & Griffin, 2013; C. Golde & Dore, 2001). Despite this trend, doctoral programs continue to prepare students for a traditional academic career path, i.e. for jobs that are no longer widely available, or that are no longer what students want (Fuhrmann et al., 2011; Golde & Dore, 2001). As a result, there is a mismatch between the aspirations of graduate students, and the training that they receive, leading students to feel unprepared for the academic jobs that *are* available, and without a clear concept of their suitability for careers outside of research (Golde & Dore, 2001).

The process of graduate student career-interest formation, particularly how it differs by race, ethnicity and gender identity, has been illuminated through mostly qualitative and mixed methods studies (Deemer, Thoman, Chase, & Smith, 2014; Gibbs, Jr. & Griffin, 2013; Haley, Jaeger, & Levin, 2014; Audrey J. Jaeger, Haley, Ampaw, & Levin, 2013; Thakore, Naffziger-Hirsch, Richardson, Williams, & Mcgee Jr., 2014). Some of these studies have applied frameworks that serve to illuminate individual level factors in the career choice process, such as different identitiy theories (Haley et al., 2014; Audrey J. Jaeger et al., 2013); others have applied frameworks that serve to illuminate contextual barriers, such as social cognitive career theory and communities of practice (Deemer et al., 2014; Thakore et al., 2014). However, there is a dearth of frameworks that examine the interplay between individual level factors and structural and contextual factors. The data from these studies do, however, provide evidence that low interest in

faculty careers among women and underrepresented minority students may result from their social identity and their values, which they do not see as aligned with faculty careers (Gibbs, Jr. & Griffin, 2013; Haley et al., 2014), as well as broader contextual factors, such as stereotype threats, particularly for women in more male-dominated scientific fields (Deemer et al., 2014). These findings suggest that career choice among graduate students can be a very complex phenomenon, and that both underlying social identities and contextual factors play a role in making certain careers more appealing than others to individuals having certain identities.

Overall, research on PhD students' career aspirations has relied heavily on quantitative methods and has largely focused on students in the sciences. There has also been a somewhat narrow focus on top-tier research institutions, though this makes sense since these universities grant the majority of science PhDs. These quantitative studies have done little to illuminate the unique experiences of women or underrepresented minority students, and cannot add much insight in terms of causality, or the nature of the experiences causing students to turn away from academic research careers. To some extent, this research has paved the path for qualitative research on the graduate school experiences of PhD students, discussed in the following section below.

Decreasing Interest in Academic Positions

Much of the research examining PhD student career choices has demonstrated that students' interest in faculty careers tends to decrease as students progress through their doctoral programs (Fuhrmann et al., 2011; Gibbs, Jr. & Griffin, 2013; Gibbs, McGready, Bennett, & Griffin, 2014; Sauermann & Roach, 2012). A drop in confidence about career choice was accompanied by a significant change in career interests between

years two and three of the doctoral program, with interest in a research career path decreasing from 80% to just under 66%; by the time they are one third of the way through their doctoral program, one third of student respondents were seriously considering non-research careers (Fuhrmann et al., 2011). Despite the trend of decreasing interest in academic careers being true for all students, however, the career preferences of women and underrepresented minority students change in manners distinct from their better-represented peers, and these groups display a larger magnitude of change in interest (Gibbs et al., 2014).

In detailing the reasons why students chose to move away from an academic career path in the course of the PhD, most students described negative perceptions of academia rather than more positive reasons for change, such as learning more about other options or discovering new skills and interests (Fuhrmann et al., 2011). Among the negative perceptions of academic careers, the most often cited by respondents to the surveys were inadequate quality of life or work-life balance, disliking tasks such as grant writing and project management, and the competition and stress inherent to succeeding in academia (Furhmann et al., 2011). In addition to these concerns, a lack of career structure and worries about job security, particularly in the early stages of an academic career, emerge in other studies (Scaffidi & Berman, 2011). For those graduate students who continued to aspire to the professoriate, concerns about faculty life, especially the perceived lack of work-life balance, emerged most commonly (Austin, 2002b).

It is very plausible that the PhD experience is giving students insights into the competitiveness and stress of the academic career, and that observations of their advisors' workloads and pressures make students doubt whether they are "cut out" for academia.

Student experiences, coupled with learning more about the state of the academic labor market and the shortage of desirable tenure track positions, may be causing students to reconsider their career options and plan for alternatives.

At the same time that the market for academic jobs has not kept pace with the growing numbers of PhD graduates, there has been a push to diversify the professoriate in order to better reflect an increasingly diverse student body (Gibbs, Jr. & Griffin, 2013). However, women and underrepresented minority (URM) students continue to leave academia at rates higher than their white and male peers. Interestingly, Furhmann et al.'s (2011) analysis showed no significant gender differences in the patterns that showed decreasing interest in academic careers over the course of a PhD program. However, female students did show a significantly lower interest in a research-intensive career in the first place, with only approximately 21% of female students demonstrating interest in a principal investigator position, compared to almost 40% of male students at the beginning of their PhD programs.

Perceived and Actual Career Prospects for PhD Graduates

In examining PhD students' career choices, there is a growing body of research focusing on students' perceived (subjective) and actual (objective) career prospects. Students' perceptions of the labor market that they are entering, and of their likelihood of securing a position within a given sector of employment, can influence the decision about whether or not to pursue a given career path. The relationship between career plans and students' subjective and objective career prospects is complex, however, and there is an interplay between preferences that reflect individual inclinations, and conditioned expectations of what students will regard as feasible based on their gender and social

identity (Fox & Stephan, 2001). In acknowledging this complexity, this area of research does allow for the interplay of individual factors and broader, structural factors in influencing students' career choices. However, the reliance on survey data in these studies does not allow for an examination of the hows and whys of the patterns observed.

Across disciplines, both men and women PhD students reported that their prospects for careers at research universities were not good, a finding that can help explain the low overall interest in academic careers among PhD students (Fox & Stephan, 2001; Waaijer, 2016). At the same time, however, PhD students reported being attracted to academic careers because they wished to pursue careers fulfilling to them, meaning intellectually challenging, granting them a degree of independence, having possibilities for personal development and enabling them to contribute meaningfully to society (Waaijer, 2016). The interplay between push and pull factors ultimately separates the students who decide to pursue academic careers from those who decide to pursue employment in other sectors.

The career choices of men and women are likely shaped by a sense of expectation related to their gender identity. This can include social expectations like the burden of family responsibilities for women, the desire to be the breadwinner for men, or other gender roles that men and women are socialized into. There is evidence to suggest, for example, that in fields where industry employment is especially lucrative, men are showing a preference for industry work, and women are pursuing academic employment in greater numbers because hard-to-fill academic positions are becoming more available to them (Fox & Stephan, 2001). Gender also plays a role in women's actual career prospects in academia. Despite the increasing proportion of female professors in many

fields, Danell and Hjerm (2013) argue that this is just a result of more women in the pipeline. The study concludes that controlling for productivity and other variables, women are still significantly less likely than men to become full professors, and that this situation is not improving over time (Danell & Hjerm, 2013). If women PhD students are aware of the barriers that they face to promotion within the academic profession, this prospect may affect their desire to pursue an academic career in the first place.

Graduate Student Agency

The idea that PhD students constrain their career choices and decisions based on the various constraints imposed by the job market, gendered expectations, job prospects, and responses to socialization processes that they undergo throughout their graduate programs is somewhat at odds with the body of literature that focuses on graduate student agency. Within the academy, scholars have defined agency as an individual's assuming of strategic perspectives, and/or taking of actions towards a goal that matters to him or her (O'Meara & Campbell, 2011). Although it is acknowledged that agency is embedded in social contexts capable of shaping the range of agency individuals may experience, the focus of this body of literature is largely on building scaffolds that support the development of greater individual agency (O'Meara, 2013). This focus yields actionable policy suggestions, such as ideas for improving advising relationships, transparency within departments, and the confronting of institutional scripts in favor of affirming multiple pathways for students throughout their graduate school years and beyond (O'Meara, 2013). Many of these suggestions are addressing some of the structural and organizational barriers that serve as possible deterents to PhD students' decisions to pursue academic careers. In a sense then, whether the approach is from an organizational

perspective or from the perspective of facilitating individual agency, it seems that many of the policy implications are similar.

Career Preparation for PhD Students

Mismatch Between PhD Education and Job Market

One trend that emerged from the research on PhD students' experiences and career choices was that of the mismatch between the PhD education and the job market that students would be graduating into. Increasingly, students enter PhD programs not only to pursue academic careers but also to seek careers in the private sector or in government (Mangematin, 2000). However, doctoral programs continue overwhelmingly to prepare students for an academic career path, despite there being fewer research-focused faculty positions available (Fuhrmann et al., 2011). The research suggests that PhD programs are not responding flexibly to changes in the academic labor market, and continue to train students in much the same way as when most students were transitioning into academic careers following their PhD training. Students reported feeling well prepared for research and publishing, but not prepared to secure funding and write grant proposals, to teach and mentor students, or to lead research teams (Austin, 2002a; Heflinger & Doykos, 2016).

Not only are graduate students not receiving the training and career preparation needed for jobs outside of academia, they also reported departmental climates hostile to students considering employment outside of the academy. Across scientific fields, for example, students reported that their advisors and departments strongly encouraged academic research careers and were discouraging and unsupportive of career paths outside of academia, despite the fact that this might exacerbate labor market imbalances

(Nerad, 2004; Sauermann & Roach, 2012). University career centers referred to non-academic careers as "alternative," or "other" careers, reproducing the idea that academia is the norm (Nerad, 2004). This is happening even as students are recognizing that the PhD has value outside of academia, and increasingly want to learn about these opportunities (Scaffidi & Berman, 2011). For both PhD and postdoctoral students, the training and career support received was reported to be generally unstructured and *ad hoc* in nature, and generally geared towards academic or research only careers (Åkerlind, 2005). Regardless of gender, a majority of students reported that they lacked structured career development opportunities in their programs and described the very demanding workload and stresses of faculty life as factors that turned them off from the academic career (Gibbs, Jr. & Griffin, 2013). However, women reported instances of sexual harassment and discrimination, as well as questioning of their abilities and capability due to their gender, something that men students did not experience (Gibbs, Jr. & Griffin, 2013).

The research results suggest that PhD programs have been somewhat inflexible in terms of adapting the training and preparation of students for jobs beyond academia (Mangematin, 2000; Nerad, 2004). This has led to criticisms of PhD training, with graduates said to be too narrowly trained and lacking in professional skills such as teamwork, organizational skills and project management skills (Mangematin, 2000; Nerad, 2004). Although recruitment criteria for industry jobs are very different from those for academic careers, PhD programs remain focused on preparing students for careers in academia. Interestingly, the academy itself has become increasingly critical of PhD training because the nature of the academic positions that institutions are looking to

fill has changed. For example, one major criticism of PhD graduates coming from the academy itself is that PhD graduates are not well prepared to teach undergraduates (Nerad, 2004). This suggests that the training focus within PhD programs is still in preparing students for research-intensive academic positions, even though the academy has shifted such that many of the new positions opening up are more teaching intensive.

Finally, another noteworthy trend is that doctoral students are taking a long time to transition into stable employment following degree completion (Nerad, 2004; Scaffidi & Berman, 2011). In English, political science, and mathematics, students take an average of four years to find a tenure-track position (Nerad, 2004). Similarly, 80% of life sciences PhD graduates spent an average of 4 years in postdoctoral positions before finding stable employment (Nerad, 2004). Today, postdocs are usually employed on fixed-term, grant funded positions before securing an ongoing or tenure track position (Scaffidi & Berman, 2011). Ultimately, this has added quite a few years to the length of training that many PhD graduates can expect to go through before securing a stable academic job, and might be yet another reason why increasing numbers of PhD students are looking for options outside of research intensive, academic careers. It would be pertinent to examine the extent to which the desire for stable and secure employment following PhD training might affect students of different genders, ethnicities or socio-economic backgrounds differently. These are important issues to consider, particularly at a time when the academy has placed an emphasis on diversifying faculty. However, at this time of writing, the review of the literature did not turn up articles attempting to investigate these issues.

Graduate School as Socialization for Faculty Roles

One key area of research regarding the career choices of PhD and postdoctoral students has been the socialization to faculty roles that occurs in doctoral and postdoctoral education. This research seems to follow from quantitative studies on the changing career aspirations of PhD students over the course of their programs. In this research, graduate education is posited as a socialization process for faculty roles (Austin & McDaniels, 2006), with doctoral students developing as aspiring faculty throughout the process (Austin, 2002b; Wulff, Austin, Nyquist, & Sprague, 2004). This research often focuses on the experiences that lead individuals to feel welcome or unwelcome in academe (S. M. Clark & Corcoran, 1986; Tierney & Bensimon, 1996; Tierney & Rhoads, 1994; Turner & Thompson, 1993), and on how successful individuals understand the profession and are able to reconcile their own values with working as academics (Antony & Taylor, 2004; E. Taylor & Antony, 2001). Research in this area oftentimes also involves highlighting background characteristics that influence students' socialization, such as education, race, ethnicity, and communities that students are a part of (Austin, 2002b; Nyquist et al., 1999).

Beyond reiterating the short-comings of graduate education in adequately preparing PhD students for the academic profession (Austin, 2002b; Austin & McDaniels, 2006), this body of research suggests that PhD students' increasing sense of dissatisfaction with the academic career as they progress through their programs stems from their difficulty adapting to the values of the academy, the ambiguity surrounding the relative value of teaching and research in the academy, and their desire for more support and direction (Wulff et al., 2004). This research lends insight into some of the reasons

why PhD students tend to turn away from the academic profession as they progress through their programs. Some studies also focus on practices that result in inequality in doctoral education, contributing to an understanding of how students go about learning the "rules" of the academic "game" that are not made explicit or codified (Gopaul, 2011, 2015; Kimberly A Griffin, Gibbs, Bennett, Staples, & Robinson, 2015). This can lend insights into how students navigate the building of different forms of Bordieuian capital as they go through their PhD programs, with implications for understanding how students of diverse backgrounds and identities succeed in different ways.

The Shortcomings of Graduate Socialization for the Academy

Another area of research related to the graduate socialization process involves studies focusing on the shortcomings of graduate education and socialization. Several authors have documented how graduate education provides limited preparation for academic work (Austin, 2002a; C. M. Golde & Dore, 2001; Nerad, 2004; Nerad, Aanerud, & Cerny, 2004; Nyquist et al., 1999; Wulff et al., 2004). For example, one study found that 37% of doctoral respondents to a survey reported receiving little guidance about entering and succeeding in an academic career (Davis & Fiske, 2000). Again, most of the studies in this area have relied on survey methods for data gathering, and quantitative analysis of results (Austin, 2002a; C. M. Golde & Dore, 2001; Nerad et al., 2004), with one exception involving qualitative methods having been reviewed (Nyquist et al., 1999). These surveys have made it possible to document trends such as the increasing numbers of PhD students interested in careers beyond academe, and student perceptions that their programs are not doing enough for their professional development. However, major gaps remain in terms of documenting in detail what exactly students expect or would hope to

obtain in terms of professional guidance in the course of their PhDs, and how the experiences of professional development of women and underrepresented minority students might differ from those of majority white, or male students.

The Labor Market for PhDs

Considerations of the labor market that they face are likely to impact engineering PhD students' career decision-making. Most of the literature on the labor market for PhDs focuses on the academic labor market, which remains the focus of this section. It is important to acknowledge, however, that not all PhD students intend to pursue academic careers. Engineering PhD students in particular have many options for research careers that fall outside of institutions of higher education. On the whole then, their awareness of the challenges inherent to the academic job market could serve as a deterrent to pursuing academic careers, but it does not tell the whole story regarding the attractions of alternative job sectors.

Economic Perspectives

Much of the research that has been done on the academic labor market in the US has been done from an economics perspective. Such studies have included an analysis of the efficiency of the labor market in allocating academics into their first jobs (Smeets, Warzynski, & Coupé, 2006), and theories of labor supply and demand in the employment of recent PhD graduates (Hargens, 2012). Interestingly, both of these studies suggest that labor market theories do not apply well to the academic labor market. For example, the academic job market in the US was not efficient in allocating top students from middle-tier PhD programs into their initial job placements, showing a bias in favor of top students that is not reflected in their productivity as scholars (Smeets et al., 2006).

Overall, the findings of the studies such as these suggest that there are many complexities beyond the simple supply and demand of PhD holders and potential academics in determining labor conditions and job outcomes for recent PhD graduates. All of these factors complicate an analysis of how PhD students navigating a job search might gauge their options and make choices. Some of the factors that emerge in the research as being of potential importance in determining job placement are things such as the prestige of the institution awarding the PhD, the amount of faculty support that individual students get from their advisors, informal networks among faculty at similar institutions, the behaviors and priorities of hiring departments at universities and the degree of confidence that individual students have in their own capacities (Smeets et al., 2006). In addition, the quantity and quality of peer-reviewed publications emerges as a very important predictor of success in the academic labor market (van Dijk, Manor, & Carey, 2014).

Other analyses reveal gender differences in the ways that male and female academics are treated in the academic labor market. Controlling for education, productivity, experience, institution type and academic discipline, women academics still earn less than men academics (Umbach, 2007). The same study found that, controlling for human capital and discipline, women faculty earn approximately 10% less than male faculty; controlling for race/ethnicity, human capital and rank, women earn approximately 8% less than men, resulting in a wage gap of approximately $5,400 for women. Overall, salaries are lower in disciplines with high proportions of female faculty, and with every percentage point increase in the percentage of women, faculty salaries reduce by 0.3% (Umbach, 2007). Gender was determined to be the third best predictor of

whether or not a scientist becomes a principal investigator, after impact factor and number of publications (van Dijk et al., 2014). Although the gender effect in this study is small, this finding helps to explain why men are overrepresented as PIs in the sciences, even after correcting for all other publication and non-publication derived features. The ways in which the academic labor market continues to display bias against female academics may result in gender differences in the ways that men and women academic perceive the academic labor market, or their chances of attaining a position that they find desirable.

Too Many PhDs?

Many analyses of the academic labor market focus on the question of whether too many PhDs are being produced, causing the demand for academic research jobs to exceed the supply of available jobs (Basil & Basil, 2006; Cyranoski, Gilbert, Ledford, Nayar, & Yahia, 2011; Larson, Ghaffarzadegan, & Xue, 2014; Sauermann & Roach, 2012; M. C. Taylor, 2011). This is a problem for science and engineering students in the US, where a 2010 survey of 30,000 science and engineering PhD students and postdocs showed that academic research is still a top career choice, but where the pace of PhD growth has meant that few graduates can actually secure tenure track positions (Cyranoski et al., 2011). Based on the simple premise that the number of tenure-track positions remains at best relatively constant, each tenured professor should produce just one PhD graduate who can take his/her place (Larson et al., 2014). However, in engineering disciplines at MIT, a conservative estimate is that professors are producing an average of almost eight PhDs in the course of their careers (Larson et al., 2014).

Although the overall trend is an excess of PhD graduates, there are important disciplinary differences to be considered. In the US and other developed nations, the problem of excess numbers of PhD graduates is most acute in the life sciences. In the US, 55% of life sciences PhD graduates were able to secure tenure track positions within six years of completing their PhDs in 1973; that number has fallen to just 15% in 2006 (Cyranoski et al., 2011). Outside of academia, there is scant research evidence to support the discourse regarding labor shortages in scientific occupations in the United States (Teitelbaum, 2014). In the technology sector, the influx of foreign workers on temporary H1B visas has led to lower employment numbers and depressed salaries for US engineers, while increasing profit margins for firms (Bound, Khanna, & Morales, 2017; Doran, Gelber, & Isen, 2016).

The research highlighting the increase in the number of PhDs produced in the US fails to highlight that the ratio of PhDs to bachelor's degrees has remained fairly constant in the last 20 years (Nerad, 2004). This implies that the mismatch between PhDs and available tenure-track faculty positions is mostly reflective of the fact that in the last 30 years, the number of tenure-track faculty positions has declined, even as the undergraduate student population has increased. Meanwhile the number of non-tenure-track faculty including lecturers, instructors and affiliates is steadily increasing, as highlighted above. University administrators are choosing to hire temporary lectures (disproportionately women and minorities) to teach undergraduates, rather than establishing new tenure-track positions (Nerad, 2004). This likely results from calls to make higher education more widely available and also more economically efficient at delivering a tertiary education to wider audiences at low cost. This has led to a decresase

in permanent positions that coincides with increased numbers of doctorate holders seeking permanent employment.

The research on the excess supply of PhDs has so far done little to address the question of causality or of appropriate institutional or policy responses. However, the trends presented do beg the question of whether the academic research enterprise that the modern university has become can be sustained without the over production of PhDs and the growing number of postdocs who will never achieve tenured positions (Larson et al., 2014). Some authors have gone so far as to describe the overproduction of PhDs as cruel, calling for reforms that would make PhD training in the US more geared towards the realities of the labor market, helping to better prepare students for jobs in industry and government (Taylor, 2011). At the very least, several authors suggest an appropriate management of career expectations before students embark on PhD programs, so that they are better prepared for the realities of their career prospects following graduation (Larson et al., 2014; Taylor, 2011).

Research on the PhD labor market tends to focus on the academic labor market, with a gap in understanding of the labor market that PhDs face when pursuing employment in other sectors of the economy. This gap is especially relevant in an age where growing numbers of PhD students are opting out of pursuing academic careers. The literature also points to the fact that women face a series of cumulative disadvanatages in the academic labor market when compared to their men peers. An awareness of these gender dynamics in the labor market could contribute to women PhD students being less likely to pursue academic careers than their men peers.

The Job Search Process

A recent review of the literature on the academic job search process revealed that this aspect of the faculty pipeline remains almost completely unstudied. The most significant contributions identified were two first-person accounts of the academic job search experience (Iac2ono, 1981; Moore, 1999) and Mason, Wolfinger and Goulden's (2013) book, *Do Babies Matter? Gender and family in the ivory tower*. This latter volume included a chapter on entry into the academic profession and highlighted some of the gendered dimensions of the academic job search, and the ways in which male and female academics might experience the job search differently. Due to the dearth of literature on this topic, this section will examine research methods that have been used to investigate the job search process and experiences of recent graduates in general, not just PhD graduates. Although the academic job search process is uniquely demanding, the methods used to examine job search processes and experiences in general may shed light on possible methodologies that could be used for investigating the academic job search. It is important to note, however, that even after opening up the literature review to include a broader search, the job search process remains one of the most understudied areas in contemporary career development research (Try, 2005). Even less research has focused on race and sex differences in the job search behaviors and outcomes of recent college graduates (Mau & Kopischke, 2001).

Experiences of the Academic Job Search

Close to nothing has been published in the research literature about PhD students' experiences of the academic job search, and the choices they face as they enter the labor market. In this current review of the research literature, only two articles were uncovered,

and both were written from the first person perspective, with the goal of sharing experiences that might help future PhD students in the academic job search process (Iacono, 1981; Moore, 1999). Although published in peer-reviewed journals, neither of these articles presents any research findings related to the academic job search and how students make decisions about whether or not to stay in academia. In addition, both articles are quite dated, with the most recent one having been written almost two decades ago. It is therefore possible that the academic job search has changed considerably since these articles were published. In addition to these articles, the book *Do Babies Matter?: Gender and family in the ivory tower* highlights some of the gendered dimensions of the academic job search, and the ways in which male and female academics might experience the job search differently (Mason, Wolfinger, & Goulden, 2013a).

Increases in the part-time academic labor market, state budgetary cuts, and an overproduction of PhDs have all made the labor market for academics more competitive (Moore, 1999). Typically, then, students procuring tenure track positions are encouraged to apply for multiple positions and to begin the process early, often before they have completed their doctoral dissertations or postdoctoral appointments (Iacono, 1981; Moore, 1999). Overall, the PhD job search process is described as extremely time intensive, expensive and emotionally draining (Iacono, 1981; Mason, Wolfinger, & Goulden, 2013b; Moore, 1999).

Some departments give very little advance notice for candidates' visits, with typical scheduling happening a week from the date of a phone call but sometimes as little as a day (Iacono, 1981; Mason et al., 2013b). This can mean travel across country for days at a time on very little notice, which presents a challenge to families and women

with young children in particular (Mason et al., 2013b). This may explain why women who are unmarried and without young children actually obtain tenure track jobs at rates slightly higher than men, while women who are married and particularly those who have young children under the age of five are much less likely than men to secure a tenure track position (Mason et al., 2013a). Maternal discrimination, as opposed to discrimination against women in general, may also be a factor that hurts job prospects for academic women with young children (Mason et al., 2013a).

Young children can present greater challenges for women on the academic job market because compared with women, academic men are more likely to have stay-at-home spouses who perform primary care-giving tasks (Mason et al., 2013a). In fact, married men are actually more likely than their unmarried counterparts to secure tenure track jobs, perhaps because their married status signals stability and responsibility to potential employers. Mason et al. (2013a) describe various instances in which women on the academic job market removed their wedding bands for the duration of academic interviews and avoided disclosing details about their families or children, whereas men did not report feeling the need to hide their marital status or the fact that they may have children. Women who were breastfeeding young children at the time of their academic interviews were in an even more difficult position, with some reporting that they brought their husband and child along but kept them hidden in the hotel, or had to take breaks during the interview to pump breast milk (Mason et al., 2013b). With visits described as intense, tiring and very heavily scheduled (Iacono, 1981), it is not surprising that having young children can make going on the job market particularly difficult for women, but oftentimes not for men.

Although the institution hosting the job candidate generally covers the cost of traveling for on-site interviews, many schools do not provide a cash advance for travel expenses, and it may take months for reimbursements to be processed (Iacono, 1981). This suggests that job candidates who have faced very low-paying employment for a number of years are expected to handle out of pocket expenses on their own, using either cash reserves, loans from family and friends, or credit card installments. The research conducted for this current literature review was unable to uncover any research addressing the ways in which financial circumstances might hinder or deter applicants in their search for academic positions. It would be important to consider the ways in which the financial burdens associated with the academic job search process differentially impact PhD or postdoctoral students of different gender, socioeconomic or racial and ethnic identities.

Finally, the academic job search process more often than not involves relocation of an individual or family to a new geographical region. For many students undergoing the job search process, this may mean finding employment not just for themselves but also for a spouse or partner. Data reveal that 52% of doctorate recipients are married, with 56% of men faculty being married to a partner who works full time compared to 89% of female faculty; female academics are also more likely to be married to male academics (18%) than vice versa (13%) (Mason et al., 2013a). Therefore, women are more likely than men to encounter what is known as the "two-body" problem in seeking academic jobs than men are. This can make what is already a difficult search process all the more difficult, given the dearth of desirable tenure track positions available. With men more likely than women to be the primary wage earners in the US, it is therefore more likely

than a female than a male academic will forsake their academic career rather than risk the job and income of their partner or spouse (Mason et al., 2013a). All of this makes the entry of women into the academy all the more complicated.

Job Search Methods

Many of the studies concerning the job search process for recent graduates have focused on examining the sob search methods and strategies employed by students seeking a job. These studies have been largely quantitative and based on survey data, oftentimes with surveys distributed a few months prior to graduation and then again a few months after graduation. These studies have attempted to highlight correlations between job search strategies and job search success.

Try (2005) examined the job search strategies employed by recent university graduates in Norway. The author used data from the Norwegian Graduate Surveys (1995-2000) to examine entry into the labor market, access to different job search strategies and implications for their use, differentiating mainly between formal and informal search strategies. The Norwegian Graduate Survey is undertaken each year and has an overall response rate of 75%, being introduced when students graduate in the spring semester before students graduate and then following up with a questionnaire six months later. Parents' educational level, students' home neighborhoods and their previous work experience were used as a proxy for social capital, which might give students greater access to informal job search strategies such as referrals from friends, family and past coworkers. This study has some interesting implications for the academic job search process, which might rely mostly on formal search strategies but

also on informal networks developed through the students' academic advisors, previous work in research teams or consultancies, conference attendances, etc.

Mau and Kopischke (2001) used data from the Baccalaureate and Beyond Longitudinal Study that surveyed a nationally representative sample of 11,152 college students in the US who completed their degree in 1992-1993 regarding their job-seeking behaviors and outcomes. Their sample included 9,245 White Americans, 663 African Americans, 587 Hispanic Americans, and 437 Asian Americans with a median age of 22. Race and sex differences among the job search strategies used, number of job interviews, number of job offers, annual salary, and job satisfaction were examined. Interestingly, the study did not find significant race or sex differences in job search outcomes, meaning women and minorities were just as likely as their white, male counterparts to have secured employment. This happened despite significant differences in job search methods, with men using resumes more often than women and women using job search ads more often than men. However, when underemployment and salary were considered, women and minority students lagged behind their white, male counterparts, having lower starting salaries and being more likely to be underemployed.

These studies raise some intriguing questions about the post-PhD job search process. For example, it would be interesting to understand the job search strategies employed by PhD students and postdocs, and whether they are different depending on whether students are seeking academic jobs or jobs outside of academia. It would also be interesting to examine whether women and minority PhD students and postdocs employ the same strategies as their white, male counterparts, or whether they tend to approach the job search differently. Finally, questions regarding the informal job search strategies

employed by PhD students and postdocs would be interesting to examine, including how relationships between advisors and students impact students' ability to tap into their advisor's networks.

While the quantitative methods used in the studies highlighted above allow for the identification of patterns across large samples, they tell us little about the reasons why students are inclined to choose certain strategies over others. Qualitative methods of inquiry could be used to gain a more nuanced understanding of the choices and decisions that students make in opting for certain job search strategies over others. If women and minority students choose to employ job search strategies that are different from those of their white, male peers, what is leading them to these choices?

Reflections on Career Decisions and the Job Search Process

Qualitative research methods have allowed researchers to investigate students' thoughts and experiences regarding their career choices and job-search process. Making use of qualitative methods has allowed researchers to gain more insights into students' choices and how they rationalize their job search decisions and experiences.

One of the studies reviewed provided perspectives on the job search expectations and job seeking strategies of recent Australian university graduates, including their perceptions of University Career Centers (UCCs), through qualitative interviews with 45 recent graduates and 5 representatives of UCCs (McKeown & Lindorff, 2011). One interesting finding was that a majority of college graduates do not use UCC services in their career search, and many are completely unaware of these services. The authors conclude that employment success among most graduates results from learning through adversity and persistence, rather than good career management.

In another study, data from focus groups was used to examine in more depth what distinguishes the career decisions of women and students from underrepresented minority groups in STEM disciplines from those of men and students from majority backgrounds (Gibbs, Jr. & Griffin, 2013). This allowed the researchers to not only assess the extent to which decision making varied by social identity group, but also to understand more deeply how students thought and felt about the issues and challenges they were dealing with in making those career choices and decisions. One interesting insight that their qualitative approach provided, for example, was that women and underrepresented minority students were more likely to feel that their values were at odds with academic careers.

Mason et al. (2013) were also able to add a significant amount of rich detail to the quantitative findings that they based on survey data from the Survey of Doctoral Recipients and a survey of over 8,000 tenure-track faculty members in the University of California system. Interviews with students in the second year of their doctoral programs and beyond helped to give the researchers insight into why some students, particularly women, were becoming disenchanted with academia over the course of their studies. Since Mason et al.'s (2013) volume is a culmination of many lessons from studies started in 2001, it is difficult to trace exactly where all the data presented are coming from, and the notes to the volume leave something to be desired in this respect. However the interview excerpts are used to illustrate some of the unique experiences of women on the academic job search, particularly the difficulties arranging for travel when they are the primary caregivers to small children, and their anxiety at keeping their marital status and children secret from the search committees that they interview with. This really helps to

highlight the ways in which the academic job search process is gendered in ways that disadvantage women.

Individual Characteristics and the Job Search

One final area that the research on the job search process of recent graduates has focused is that of individual level differences, and how these impact the ways that students approach the job search process. This literature stems mostly from the field of behavioral psychology and uses quantitative survey methods to examine how variables such as personality traits and confidence impact students' choice of job search strategy and their job search success. These studies have been able to sample large numbers of students and test hypotheses about elements of personality and disposition that impact the job search.

In one study, researchers tested a model of proactive personality and job search success with a sample of 180 graduating college students using structural equation modeling (Brown, Cober, Kane, Levy, & Shalhoop, 2006). The model included measures of proactive personality, job search self-efficacy, job search behaviors, job search effort, and job search outcomes. Job seekers were surveyed at two different points in time, once three to four months prior to graduation and once two to three months following graduation. The results suggest that having a proactive personality significantly influenced the success of the job search, with proactive students more likely to successfully find employment. This is not a surprising finding, but it is interesting that this aspect of personality was the strongest predictor of job search success in this study. Others have examined the effects of individual difference variables (such as self-esteem, job search self-efficacy, and perceived control over job search outcomes) as well as job

search behaviors on the employment status of recent university graduates at the time of graduation and four months later (Saks & Ashforth, 1999). Questionnaires were emailed to 952 students in business, computer science and engineering in the term prior to their graduation. A total of 348 respondents qualified for inclusion in the study. Multiple regression analyses revealed job search self-efficacy as predictive of job search behaviors and employment outcome. This suggests that individuals' self-confidence about the job search process can be an important factor in navigating the process successfully. This finding is pertinent to the study of women in academia since research has highlighted a confidence gap between male and female students, particularly in fields with a brilliance mindset such as STEM fields (Colbeck, Cabrera, & Terenzini, 2001; Pajares, 2005; Sax, 2008). Also, the literature on graduate socialization has suggested that students report feeling unprepared for the academic career (Austin, 2002b), which may mean that levels of job search self-efficacy are low for students entering the academic job search process.

Feminist Perspectives

Since this study presents a gender analysis and seeks to compare and illuminate differences in the career decision making process of men and women students, it is pertinent to address the feminist theories and perspectives that inform this gender analysis. This section highlights the elements of feminist theory that have been most influential in shaping the analytical framework taken in this study.

According to feminist theorists, the main pillars of patriarchy are the sexual division of labor and male control of female sexuality; both of these need to be addressed in order to change the condition of women (Walters & Manicom, 1996). The sexual division of labor allows men to maintain control over tasks that are given more prestige,

allowing men to accumulate more power and material wealth; as a result, there is a near universal subordination of women to men in public life (Epstein, 1999). This study is informed by feminist perspectives in conducting a gender analysis of the career decision-making process of engineering PhD students. This means that throughout this study, gender is assumed to be a variable central to understanding student experiences of their graduate education and of the university as an organization. In addition, it is acknowledged in this study that the university does not exist in isolation from patriarchal social forces. As a result the university is assumed to reflect and embody the elements of the patriarchy that work to forcibly push and also socialize men and women into differentiated roles. In this section I present some of the feminist conceptual frameworks that have been used in the study of higher education, and highlight those that have been most important in informing my gender analysis.

Feminist Conceptual Frameworks for the Study of Higher Education

Three main Western feminist theoretical frameworks have been applied to the study of gender and education, namely the liberal, socialist, and radical feminist frameworks (Acker, 1987). From a policy perspective, the liberal theoretical stance is the most commonly adopted as its emphasis on equal opportunity for all, regardless of sex, is one of the most acceptable to the general public. For the purposes of this study, I adopt what would largely be termed a liberal feminist approach, concerned with how socialization practices, patriarchal attitudes, and legal structures and processes within the university perpetuate gender inequality (Acker, 1987). However, I also borrow elements from socialist feminist throught, calling attention to the ways in which the university, as a public sphere and a workplace, serves to reproduce the sexual and social division of labor

(Acker, 1987). This is a pertinent approach for a study that seeks to examine gender issues in order to draw conclusions capable of informing institutional policies at institutions of higher learning. It stops short of radical feminist frameworks that argue that only the abolition of gender as an oppressive category will work to truly transform social structures that work to dominate women (Acker, 1987).

Critical theory has also been instrumental in helping higher education researchers and scholars to make visible the power structures that shape the nature of work and labor within academic institutions. Focusing on questions of gender equity in particular, critical theories have helped to both identify and explain the sources of gender gaps in higher education, addressing various domains of study such as the student body, institutional policy making and knowledge creation, to name just a few. Martínez-Alemán (2015), posits that critical approaches to the study of higher education are capable of uniting philosophical thinking with social science applications in order to provide not only a critical understanding and analysis, but also practical solutions. Institutions of higher learning are deeply embedded within the social, cultural, political and economic fabric of society, and critical theory has become an important tool for identifying and explaining the structural inequities that cause attrition rates to be higher among historically marginalized groups, including women. This study thus adopts elements of critical feminist theory in order to focus the analysis on structures of power as they shape (and are shaped by) gender relations within the academy. In doing so, my analysis in this study attempts to break with assumptions about institutional policies being gender neutral, in an attempt to move beyond simply "adding women" and towards institutional transformation of the kind embraced by Metcalfe (Metcalfe, 2015).

Finally, this study draws heavily from previous work on gendered organizations in organizational theory. This emerged in the 1970s as an acknowledgement that organizations are not gender neutral, and that structures of work (e.g. schedules, rules about time off, etc.) can affect women differently than they affect men (Acker, 1999). Kanter's work on American industry, for example, revealed that women were relegated much more often than men to positions of low visibility and status, while women's token status made it very difficult for them to negotiate their positions relative to men (Kanter, 1975), a pattern that is still seen (albeit to a lesser degree) in institutions of higher learning today. The study of gender in organizations is particularly applicable in this study because it is able to bring in bodies, sexuality and gender into the study of processes that are usually regarded as disembodied and gender neutral, revealing the ways in which gender is related to the economy and to production, whether of goods or of knowledge (Acker, 1999).

Although intersectionality is not applied as a framework in this study, it is worthy of acknowledgement in this section. Intersectionality has emerged from feminist critical theories as an interpretive frame that is at once a concept, a paradigm, a heuristic device, a methodology and a theory, and rests on the premise that social categories such as gender, race, class and age do not operate in isolation, but rather interact to construct social inequities that are more complex than the sum of their parts (Collins, 2015). Similar to other critical theories, intersectionality is concerned with relations of power and how these relations work to perpetuate social inequality (Cho, Crenshaw, & McCall, 2013; Collins, 2015).

Intersectional approaches have highlighted the differences between the experiences of white women and women of color in STEM fields, suggesting that while all women face bias, women of different racial identities face unique forms of bias that relate to assumptions and stereotypes based both on their gender and their racial identity (Williams, Phillips, & Hall, 2014). Scholars of higher education have argued that more intersectional work is needed. This would better reflect the diversity in higher education, and promote a greater understanding of how the convergence of identities shapes experiences of inequality (Museus & Griffin, 2011). Despite its merits for the study of higher education in general, and of STEM education in particular, an intersectional framework is outside the scope of this study. This has been largely due to the difficulty of recruiting a sufficient number of women (and men) of color as study participants at MAU.

Summary of Literature Review

This study set out to examine the career decision making process of PhD students in a holistic way, which includes both individual level factors and broader, structural and organizational factors that interact to inform career choices. In addition, this study included a gender analysis, as it sought to compare men and women's decision making processes. These overlapping layers of complexity resulted in the need for a very expansive literature review. This review has served to illuminate gender dimensions within the professoriate, with the assumption that a growing awareness of these gender relations over the course of a PhD education could affect women students' decisions to pursue academic careers. This review has also served to illuminate some key elements that can be influential in shaping the carer decisions of PhD students in general, and

women in STEM fields in particular. This included a summary of the literature on career decision-making, career preparation, the labor market for PhDs, and the job search process itself. Finally, this review highlighted some key areas of feminist theory and thought that have informed this study's analysis.

Overall, the literature review suggests that the career decisions of graduate students involve a complex consideration of individual, structural and societal factors. Under individual factors, traits such as self-efficacy and perseverance interact with more complex considerations such as values, aspirations and sense of fit; in addition, individuals' experiences while in graduate school can impact their perceptions of the academic career. Gendered opportunity structures within academia can also become important considerations, especially for women students, as they progress through their programs. Their awareness of how gender affects relations within the professoriate may be something that they are exposed to as they progress through graduate their graduate program, or experience differential treatment that they ascribe to their gender identity. In addition, students may become more familiar with changes in the academic labor market and in the academic profession itself as they progress through their graduate programs. Finally, societal factors such as career and family expectations and roles, the conditions of the job market, and salary expectations, all play a greater or lesser role in individuals' career decisions.

Much remains to be explored in terms of how graduate students make their career decisions. Gaps in the research literature include an underexamination of graduate students' career decisions and the process of career decision formation. In particular, much of the research on graduate student career decisions has relied on quantitiative

methods that do not allow for a more in-depth understanding of the *hows* and *whys* of the patterns observed, particularly with regard to the decreased interest in academic careers over the course of graduate programs. Finally, graduate student experiences and strategies in seeking out academic employment and navigating the job market remain very under-researched.

Theoretical Framework

The theoretical framework guiding this study draws heavily from Kanter's (1977) seminal work, *Men and Women of the Corporation*. In her work, Kanter conceptualized the fates and trajectories of men and women within an organizational context as being inextricably linked with organizational structures. In applying this framework to my study, I similarly assume the university to be an organization within which structures of opportunity and power shape the choices, dilemmas and decision-making of individual men and women. This assumption allows for an examination of the complex relationship between individuals and the university as an organization, leading to a fuller understanding of the ways in which the university impacts the behaviors and choices of people within it.

Corporate University Structure and Organization

Researchers have analyzed the structure of the university as a corporation having "a complex organizational and functional mechanism that serves educational interests" (Spivakovski, A., Alferova, L., & Alferov, 2012, p. 60). As university management strives to attain greater effectiveness and efficiency in an age of increased competitiveness, this view of the university as a corporation has been forwarded as helpful in understanding the methods, patterns and practices of corporate management

that have been put to use in university contexts. In a similar vein, organizational theorists have examined the university as an institution that shares many features with other large organizations, including corporations. For example, studies of university organization have examined both vertical and horizontal structures of power in higher education, as well as organizational decision making, learning, strategy and efficiency using frameworks applied across other organizational types as well (Bess & Dee, 2008). All of this suggests that there is a precedent for viewing universities as organizations not too dissimilar from the corporation. It therefore makes sense to draw parallels between universities and corporations, as they are both large and similarly complex entities that function as cohesive units.

Bounded Agency Model

In viewing the university as a complex organization that can apply different structures of incentives and pressures on individuals, the bounded agency approach challenges the assumption that we can understand decisions to pursue an academic career by focusing exclusively on how individuals interpret the world. Instead, it allows for the development of a framework that acknowledges the important role of structural conditions in limiting the feasible alternatives available to individuals (Rubenson & Desjardins, 2009).

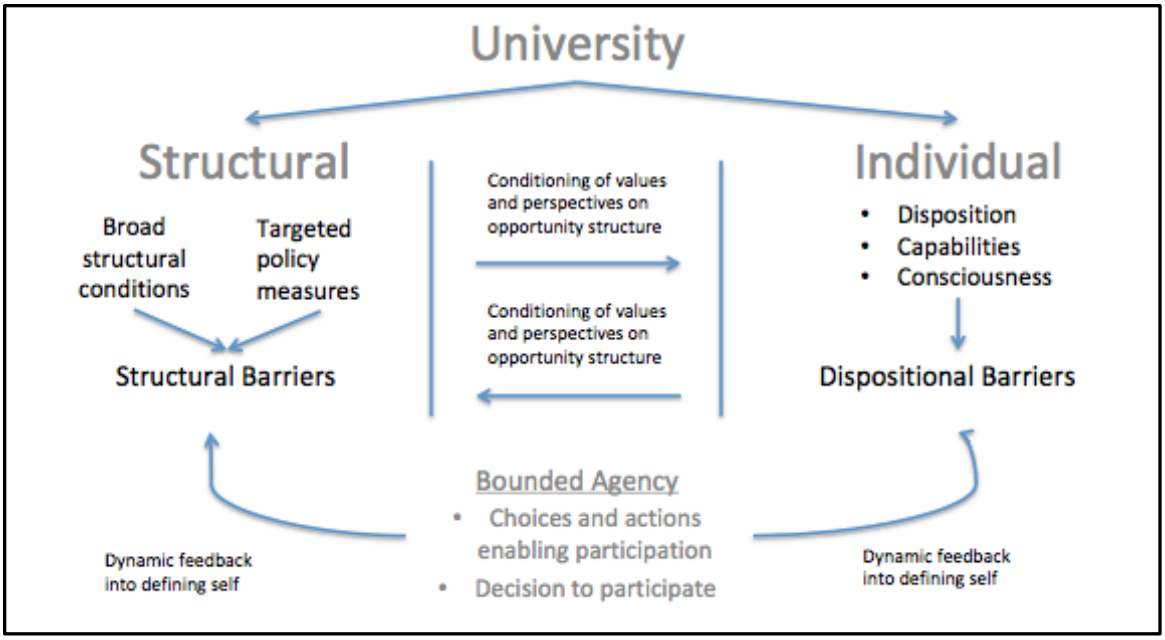

Figure 1. *Bounded agency model* (Adapted from Rubenson & Desjardins, 2009)

Structural Factors

In examining the structural attributes of the university as an organization, this study sought an "integrated structural model of human behavior in organizations" (Kanter, 1977, p. 245) in order to get at the underlying structures of academia that can impact individuals' decision to pursue an academic career. This included an examination of individuals' aspirations and future prospects as determined by their perspectives on opportunity structures within the academy. For PhD students considering options in entering the workforce, I adapted Kanter's (1977) variables in examining economic and career considerations, personal satisfaction, and sense of belonging in academia. This included inquiring about students' reasons for pursuing a PhD in their field, their experiences (positive and negative) with professors, mentors, and other gatekeepers in their academic programs, the atmosphere of their programs, and their sense of fit within their program culture. In addition, I sought to examine the formal organizational structures as well as the informal personal alliances that PhD students feel that they can

access in navigating the job search. Once again, I opted to adapt Kanter's (1977) variables in examining students' satisfaction with, and use of, formal resources for professional development, both within their immediate unit or department, and within the broader school or university; and their sense of having developed deep and meaningful relationships with mentors, advisors, professors, and peers, that they feel they can tap into in navigating the job search successfully. Finally, in examining the impact of representation, I sought to examine issues related to tokenism, stereotyping, visibility, and the ease of forming networks and alliances by asking men and women about their experiences feeling as if they are visible or on display, feeling like a part of the group, or feeling like they fit in; their experience in establishing or joining both formal and informal peer networks and alliances; their perceived ease and success in finding a mentor or sponsor who has guided them through; and their feelings of having been stereotyped or locked into specific roles based on their identity. These considerations shaped the development of the student interview protocol included in Appendix B.

Individual Level Factors: Disposition, capabilities and consciousness

The bounded agency model described by Rubenson and Desjardins (2009) added to Kanter's (1977) examination of structural and organizational factors by including three key variables related to features of the individual self that may guide and constrain choices. In this case, I drew from this framework in examining the dispositions, capabilities and consciousness that may affect individual students' choices about whether or not to pursue an academic career path. It is important to note that the qualitative approach here is especially important in providing in-depth insight into students'

subjective rationales regarding participation in, and the amount of effort and time devoted to, the academic job search process and the subsequent academic career.

Disposition

As a variable in this study, disposition refers to individual self-perceptions regarding one's suitability for the academic career path, what one has to gain (or lose) in pursuing an academic career, as well as the types of experiences (positive or negative) that one has had regarding academia throughout their schooling and training. The factors examined included things like the characteristics and traits that students perceived successful academics to posess, and whether they perceived themselves to have these same characteristics and traits; both positive and negative experiences and associations that they may have had or made regarding the academic career path during the course of their graduate training.

Capabilities

As a variable in this study, capabilities refers to individuals' abilities to navigate and overcome potential barriers to their participation in the academic career path. The factors examined related to this variable included things such as individuals' ability to seek out mentors, networks and opportunities.

Consciousness

As a variable in this study, consciousness refers to individuals' knowledge and awareness of the barriers that they face in pursuing an academic career path. Again, these barriers may be structural or personal in nature, but an individuals' awareness and acknowledgement of them, and their ability to speak to their nature will likely be correlated with their ability to seek out and develop the capabilities necessary to

successfully navigate and overcome them. Since this study is particularly interested in exploring gender differences in engineering PhD students' career decision-making process, the examination of this variable centered on issues such as students' awareness of how and where gender identity has affected their experiences, opportunities and perceptions within their programs; students' awareness of gender dimensions within the academy and academic work; and students' awarness of gendered nature of their considerations for career, family and other issues that may relate to the career decision-making process.

Summary of Theoretical Framework

My theoretical framework constitutes a bounded agency model that allowed my study to concurrently examine structural and organizational barriers, as well as individual barriers to participation in the academic career (Rubenson & Desjardin, 2009). Within my model, I drew from Kanter's (1977) work on gender dynamics within organizational structures as inspiration for my variables related to the structural barriers present within the university and within academia; I drew directly from Rubenson and Desjardin (2009) in defining the three variables that I used to examine individual and personal barriers to participation. This model for understanding bounded agency in graduate students' career choices allowed for a more holistic approach to understanding the complex considerations that inform individual students' career decision-making process.

CHAPTER 3: Research Design

This chapter provides an overview of my research design. I begin by introducing my research questions, and then provide some justification for my choice of a qualitative case study design. Next, I provide an overview of how I plan to collect and analyze my data throughout the duration of my study. Finally, I address my positionality as a researcher to clarify my interest in this topic, as well as the ways in which my epistemology, personal experiences and background might influence this study.

Purpose and Research Questions

The purpose of this in-depth, qualitative study was to explore the gendered nature of graduate education and of the university as an institution, in order to examine the structural and organizational forces guiding graduate students in their career decisions. In addition, this study explored the interaction between these structural forces and individual level factors such as disposition, capabilities and consciousness. This study employed a conceptual framework that combined Kanter's (1977) framework for examining the gendered nature of organizations with Rubenson & Desjardin's (2009) bounded agency model, which added an examination of individual level factors omitted in Kanter's (1977) study.

The research questions guiding my study were:

- What personal factors influence engineering PhD students' decisions to pursue an academic career?
- How do engineering PhD students' experiences of the university during their programs influence their decisions to pursue an academic career?

- What gender differences can be observed in engineering PhD students' institutional experiences and their career decision-making process?

My first research question allowed me to gain insights into individual level factors that affect engineering PhD students' decisions to pursue an academic career. Within this question, I explored an array of personal considerations ranging from individuals' willingness to move and dispositions towards the academic career, to external considerations such as perceptions of the job market, and career opportunities. The second research question allowed me to explore how students' stated preferences and tendencies had been shaped by their experiences while in graduate school. The research literature has documented that graduate students' interest in academic careers tends to decrease throughout the course of their graduate programs (Fuhrmann et al., 2011; Gibbs, Jr. & Griffin, 2013; Sauermann & Roach, 2012); this research question thus seeks to illuminate what sorts of experiences can deter students from decisions to pursue an academic career. Finally, my third research question brings in the gender analysis by asking whether and how the patterns and trends observed in answering questions one and two differ for men and women graduate students.

Qualitative Case Study Methodology

I employed a qualitative case study methodology in this research study. Case study research involves investigation of a clearly defined system (the case) within a contemporary, real world context, and can involve one or multiple cases (Creswell, 2013; Merriam, 1998; Yin, 2018). Case study designs are most useful when the researcher seeks to provide an in-depth understanding of a case (Creswell, 2013), when the researcher has little or no control over events, and when the variables are so embedded in

a situation as to make it difficult or impossible to fully identify them ahead of time (Merriam, 1998).

Given the particulars of my research focus, a qualitative case study was a useful approach because it allowed for the creation of a rich and holistic account of the decision-making phenomenon as it was playing out in the lives and contexts of engineering PhD students. Such case study designs are common in applied fields such as education policy because they allow researchers to study an event, activity or program, or more than one individual (Creswell, 2013). In addition, case studies allow researchers to answer "how" and "why" questions, seeking to explain rather than simply describe complex social phenomena (Yin, 2018). Case study research is able to acknowledge that experiences are rooted in complex contexts, and is therefore a useful means through which to explore PhD students' career decision-making process. These decisions are made within a present context that at once acknowledges past experiences, reflects individuals' present state of mind and disposition, and also reflects an anticipation or expectation of their future. Thus, it was difficult to identify all of the possible variables in advance and examine them outside of their appropriate context. In summary, a case study approach was preferred in this study since the relevant behaviors and attitudes related to the phenomenon at hand could not be easily identified in advance or manipulated, and there was a fluid rendition of the recent past and the present (Yin, 2018).

Several authors point out that case study methodology is often inappropriately used, or that the term is often employed as a catchall term to describe different types of qualitative studies that do not necessarily adhere to the unique characteristics of proper

case study design (Jones et al., 2014; Merriam, 1998; Yin, 2018). Therefore, care was taken in the planning and design process to ensure that this study fit the design criteria.

Study Design

In this study I used a qualitative case study design focusing on a single case, or unit of analysis, the decision-making processes of engineering PhD students. My study design fit into the criteria established for a qualitative case study in the following ways: 1) the boundaries of the case were clearly defined in that I examined advanced engineering PhD students who had all completed their qualifying exams; 2) the design of the study provided for intensive research, in which the investigator strived to provide a detailed, rich, and in-depth discussion of the case in a manner that was as complete as possible; 3) the case evolved in a specific time and place; 4) the focus of the study was on the relation of the phenomenon being studied (the career decision-making process of engineering PhD students) to the context (that of the engineering school within a large, public research institution in the United States) at hand (Flyvbjerg, 2011).

My objective was to capture the circumstances or conditions surrounding an everyday situation (the common, everyday occurrence of engineering PhD students making decisions about their careers) in order to draw lessons and insights about this social process (Yin, 2018). Therefore, the single-case design was appropriate.

My study was primarily qualitative because I was interested in exploring the career decision-making process of engineering PhD students in their real-life contexts, answering "how" and "what" questions. These allowed the analysis to be at once a descriptive and an explanatory one, examining gender differences in the experiences and

decision-making process of engineering PhD students, and also positing some reasons for these differences.

While mine was a single case design, it relied on several embedded units of analysis. This is because within my single case (the decision-making process), I also devoted attention to subunits (the individual student participants in my study), who were a part of my original case (Yin, 2018). This embedded case study design was important in maintaining my study's focus on the phenomenon at hand, rather than risking slippage into an analysis that focused exclusively on the subunit (individual) level and failed to return to my larger unit of analysis or original case (Yin, 2018).

The Context: Mid-Atlantic University

MAU is a large public research institution in the mid-Atlantic region of the United States. As a flagship university, it boasts almost 40,000 students and 9,000 staff members, an operating budget of $1.9 billion, and $560 million in external research funding. There are just over 4,000 doctoral students at MAU, and of these just under half are enrolled at the school of engineering, the school I focused on in terms of recruiting study participants.

Using MAU as the context for data collection was important in catering to my rationale for a *common* single case (Yin, 2018). MAU is typical of the large, public research institution in the US and thus engineering PhD students' decision-making process at MAU is likely to be typical of engineering PhD students' decision-making process at other similar institutions and contexts. While this study undoubtedly uncovered unique aspects of MAU as an organization, it also established that MAU falls into a series of patterns and trends that are common for other, similar institutional types,

thus contributing to the generalizability of some study findings for engineering PhD students at other large, public, research institutions in the US.

Data Collection

As typical for a case study, I collected evidence from multiple sources using a variety of methods to gain an in-depth understanding of the case (Creswell, 2013; Merriam, 1998; Yin, 2018). Specifically, I used the following data collection methods:

- Semi-structured interviews with 20 advanced engineering PhD students;
- Gender segregated student focus groups that allowed for debate and discussion of gendered themes that arose from the interview data;
- Observations of six engineering laboratories in three different disciplines, that gave insight into the work environment experienced by PhD students.
- Document analysis of materials, syllabi and workshop content, etc. for career workshops and events available to engineering PhD students.

The use of multiple data collection methods helped to develop an in-depth understanding of the key issues underlying the research questions.

Selection and Recruitment of Study Participants

In case study research, sampling occurs at two levels; the first level is that of the selection of the case, and the second is the selection of study participants within the case (Creswell, 2013; Yin, 2018). The goal for both levels of sampling in my research design was that of best illuminating the phenomenon of gender differences in the persistence of engineering PhD students into academic careers. This goal shaped my selection and recruitment strategies for study participants.

The criteria for inclusion in this study were as follows: participants had to be currently enrolled at MAU as full-time PhD students in engineering, working towards degree completion; they had to be over the age of 18 in order to consent to participate; they had to be US citizens or permanent residents in order to eliminate confounding elements such as the presense of family overseas, visa and work permit issues, and other complicating factors in the career decision-making process; they had to be employed in campus labs, in order to ensure a more uniform organizational experience; they had to be advanced doctoral students who had already completed their qualifying exams. This latter requirement meant that student participants had undergone at least two years of doctoral study prior to the study interview, guaranteeing a minimum amount of exposure to the university as an organization. This requirement also meant that students would be finished with coursework and engaged in research geared towards their PhD dissertation, thus having experience of full-time research work in a university lab setting.

To recruit student participants, I started by emailing departmental listservs. In addition, I identified PhD students in engineering through department websites, on-campus publications featuring student research, and programs and organizations geared towards graduate students in engineering. Emailing students individually helped in recruitment, whereas generic emails sent out to listservs yielded few responses. Subsequent to enrollment, some participants introduced me to other students in their programs and departments, leading to a snowball sampling. Initially, the study design relied heavily on snowball sampling. In reality, however, few students were able to introduce other eligible students to the study. This reflected the relative isolation of PhD students in engineering, many of whom did not have many friends they could approach

within their PhD cohorts. In addition, the criteria for inclusion in the study limited participation substantially, particularly the need for student participants to be US citizens or permanent residents. Several study participants reported that they were the only US citizens or permanent residents in their research lab, resulting in a dearth of eligible participants who they could introduce.

Because interviews and focus groups required engagement and time from very busy participants, I was unable to recruit a very large number of students. Time constraints involving lengthy qualitative interviews and their transcription and coding also meant that the research design had to limit the total number of individual interviews to 20. I attempted to gain maximum variation in my sample, including variation by gender, race, ethnicity, and engineering discipline. Maximum variation sampling is a technique used to gain more conceptually dense and more useful findings by grounding them in widely varying instances of a phenomenon (Merriam, 1998). Once again, however, despite my efforts to recruit a diverse sample, the majority of student participants were white. Several explained to me that most non-white students in their programs were also international students, who did not qualify for inclusion. I was, however, successful in recruiting equal numbers of men (10) and women (10) students, meaning that my sample was purposefully skewed.

Though I did not recruit any formal participants in addition to the aforementioned students, I did communicate on an informal basis with career services personnel, engineering professors, and engineering deparment chairs, both in person and over email. This on-going search for new sources of information is sometimes used in qualitative research designs to help confirm or build on initial findings (Merriam, 1998).

Interviews

Interviews with student participants were the primary method of data collection for this case study. Interviewing is a means of gaining insights into the behaviors, feelings and interpretations of individuals that are not easily grasped by simply observing (Merriam, 1998). In this study, I used interviews to learn about three main areas:

- Personal factors influencing STEM graduate students' decisions on whether or not to pursue an academic career at the end of their programs;
- STEM graduate students' experiences of the university during their programs, and how these experiences have influenced their decisions on whether or not to pursue an academic career;
- STEM graduate students' perceptions of any gender differences that they have observed or experienced throughout their graduate programs, and how these have influenced their career decisions.

I used a semi-structured interview format for all interviews. Semi-structured interviews involve a loose interview protocol with broad, open-ended questions and pre-established probes (Jones et al., 2014). This loose structure allows the researcher to collect similar information from all participants, while also responding to the unique information shared by individual participants and probing them to learn more about their experiences and views (Merriam, 1998). This interview format is common in qualitative research based on a constructivist worldview (Jones et al., 2014; Merriam, 1998). Interviewed were 60-90 minutes long, with follow-up questions happening over email in a number of cases.

With permission from my study participants, I audio recorded all interviews using a digital recorder. I transcribed all interviews myself, to establish familiarity and closeness with the data, and sent the transcripts to my participants for review and verification. Interviewees thus had the opportunity to clarify or revise any points made during the interview, constituting a form of member checking (Creswell, 2013). I engaged in this form of member checking to strengthen the trustworthiness of my data and ensure that I adequately represented each of my participants' views.

Focus Groups

In addition to interviews, I held two 90-minute focus groups with students. These focus groups were gender segregated so that participants felt at ease to share their experiences revolving around gender and gender identity, as well as their perceptions of academia, the academic labor market, and how gender dynamics play out in these areas. I conducted the focus groups once I had completed all but one of my interviews and analyzed and coded much of my interview data. This meant that I had garnered and identified some of the key gender issues that emerged for individual students, and was thus better able to facilitate a discussion of some of these emerging themes. At the same time, the focus groups provided a form of triangulation whereby a group of individuals were able to share their experiences and thoughts on the interview data I collected, and whether my initial analysis resonated with them.

Focus groups are an effective method of data collection in cases where the interaction of individuals can yield the best information (Creswell, 2013). Given that oftentimes, individuals are unaware of the gendered nature of their experiences, discussion in groups where other discussants point to patterns, interactions and challenges

specific to their gender identities brought about recognition and understanding that led other individuals to become more aware of their own experiences of gender. Students were thus able to build off each other's answers and confirm and challenge each other's views, insights and beliefs.

I took notes during the focus groups and scheduled time right after each one to memo about the experiences and what I had learned. With permission from the participants, I will also audio recorded focus groups with a digital recorder. I can later transcribed them and revisited the transcripts to further elaborate on, confirm or modify some of the themes that emerged from my interview analysis.

Observations

Observations were conducted at six laboratories in order to get a sense of student participants' work environments. Participants were asked in advance of interviews if they would be willing to show me their lab and workspace, in cases were the interviews were conducted in the lab. This gave me access to four laboratories, two in aerospace and two in mechanical engineering. Once it became evident that bioengineering was the most common engineering discipline among my study participants, I decided to include two bioengineering labs in my observations. This also provided insight into the work environment in a department that provides a very positive experience for graduate students according to my study participants, and also added a discipline in which female representation is higher.

Document Analysis: Graduate Career and Gender Resources at MAU

I analyzed documents and websites related to the central focus of my investigation, namely graduate career preparation in general, and career preparation for engineering

PhD students in particular. This gave me insights into the MAU policies, and the extent to which the university is recognizing challenges in these areas for its graduate students, responding to those challenges, and providing support. I examined both the university career services website and the engineering school's career services website, along with external links and other resources provided in each one. The topics of career services workshops were also examined, along with some of the materials distributed during the workshops. Special career development programs and opportunities were identified.

Summary

Data collection for this study included interviews with graduate students in STEM as well as informal communications with career services personnel, and engineering professors and department chairs; focus groups with men and women engineering PhD students; and document analysis of career workshop materials and websites..

Data Analysis

In qualitative case study research, the data analysis usually occurs at the same time as the data collection, allowing the two processes to inform one another and strengthening the clarity and trustworthiness of the findings (Merriam, 1998). I thus started analyzing data as soon as I began the data collection process. Throughout the time spent collecting and analyzing data, I engaged in intensive memoing, allowing me to keep track of research activities and note my initial thoughts and reactions.

Description of the Case

A case study report should include an extensive and detailed description of the case (Creswell, 2013; Merriam, 1998). To develop this description, I used publicly available information about graduate programs in STEM at MAU, as well as the

information I could put together from the various data collected. Upon realizing that more information was needed in order to thoroughly describe the case, I identified additional sources of information such as engineering professors and department chairs, who could triangulate some of the insights gleaned from interviews and confirm some of the observations of interview participants.

Qualitative Data Analysis

I engaged in a constant comparative method of data analysis to construct categories or themes, an approach consistent with qualitative case study methodology (Creswell, 2013; Jones et al., 2014; Merriam, 1998). This meant that I first coded my data for text relevant to my research concerns, and then compared these units of data to identify similarities and develop further themes or categories (Jones et al., 2014; Merriam, 1998). While what I describe here reads like a linear process, in practice I moved back and forth between the different steps throughout the data analysis process.

In the initial rounds of data coding, I reviewed my data multiple times and read closely all of my interview and focus group transcripts, notes, and memos. In another round of coding, I compared previously coded data to the bounded agency framework selected. This helped me to map out how some of the themes and categories I began to identify through the coding process fit under the structural and individual level factors affecting the career choices of engineering PhD students. In a third round of coding, I looked line by line at previously coded instances that either promoted or hindered students' decisions to pursue an academic career at the end of their graduate programs. I used an open coding approach for this round of coding in order to fully immerse myself

in the data and explore the ideas without limiting my analysis to a prior set of codes or themes.

My understanding of the literature and my choice of theoretical framework influenced my analysis, even if the open coding approach helped open me up to possibilities I did not foresee in my study design. I did my best to highlight instances that reflected the assumptions and principles that my theoretical framework and background contributed to the analysis. At the same time, I remained open to new ideas and focused on codes as they emergeed from the data itself, rather than restricting myself to themes I expected to find.

Having completed line-by-line coding of sufficient transcripts, notes and other data sources, I developed a codebook containing the names and descriptions for each code. I then compared this codebook to the theoretical framework to see where and how the data fit,, and where new concepts emerged from the data. This preliminary coding scheme was then applied as I moved forward with the coding of additional data. Once a significant portion of my data had been thus coded, I moved forward in constructing categories or themes based on the codes.

The construction of categories or themes occured as I grouped codes together under broader, descriptive concepts (Jones et al., 2014). In this phase, I continued to move back and forth between initial categories put forth by the theoretical framework, and new categories that emerged from the data in order to further revise and refine my categories. During this step I will also searched for disconfirming data or rival explanations that may affect students' career choices and decisions, but that do not fall under the bounded agency model. Examples of these included factors external to the

university, such as the non-academic job market and opportunities in industry and government.

In order to increase the validity of my findings, I shared the initial themes I identified through my data analysis with students in my focus groups. Their feedback and reactions, as well as their experiences related to the themes, questions they raised and alternative interpretations they put forward helped me in the process of reviewing my codes. Based on their feedback, I clarified my understanding of certain patterns.

Data analysis came to an end once I had exhausted my data sources and reached a saturation of research categories (Merriam, 1998). Once all transcripts, notes and other data sources had been read multiple times and analyzed, and no further themes could be identified, I considered my data sources to be exhausted.

Positionality of the Researcher

In this section, I discuss my positionality as researcher. Understanding my personal experiences with the research topic at hand and my epistemological beliefs is important to understanding the influences behind my research approach in this study.

When I first heard the statistics about the problem of STEM attrition and the dearth of women in STEM, I was in disbelief – it did not seem to reflect my experiences as an undergraduate biology major during my first two years of college. I knew, and had seen, plenty of women in my science classes; I could not recall an instance of overt discrimination; and while I ended up majoring in a social science, I know of many talented women who majored in STEM disciplines. However, when I consider how many of those women continued in STEM beyond their undergraduate years, the problem makes more sense to me. While many of my core undergraduate STEM classes had

gender ratios that were close to fifty-fifty, my women friends who remained in STEM described that in the higher-level courses, especially in math, physics and engineering, they were often the only women in their classes. Of the five talented women who I am close to who did stick it out and graduate in STEM fields, three are lawyers now and the other two are pediatricians. So while women are entering STEM in numbers that approximate those of men at the beginning of their undergraduate studies, they are dropping out at every level.

Given my personal experience with the phenomenon of STEM attrition, as well as my own experiences pursuing a PhD in the social sciences, I had an insider's perspective that helped me to build rapport with my study participants. On the other hand, I had to be careful to truly listen to their experiences and the ways in which they are making meaning of these experiences, rather than projecting or jumping to conclusions based on my own experiences. In making a concerted effort to remain open to my study findings, even in cases where they may contradict or be at odds with my personal experiences, I worked to set my biases aside and use member checks and other processes of triangulation to ensure that I was adequately representing the data as it emerged from this case study.

At the same time that I enjoyed an insider's perspective, I will also had an outsider status because I am not enrolled as a doctoral student in engineering. My status as an outsider made it all the more important to establish trusting relationships with the student participants, so that they felt comfortable sharing their stories and decision making processes with me. In order to establish trust, I clearly and fully explained the purpose of my research study to students and asked low-risk questions at the beginning of

our interactions, in order to build trust and rapport. Throughout the duration of the study, I engaged in memoing and in reflection, so that I remained aware of the ways in which my outsider status influenced my relationships with participants.

My Epistemological Beliefs

Epistemological beliefs are those relating to one's beliefs about knowledge and what constitutes knowledge; thus my beliefs about the nature of knowledge and how knowledge is created had an impact on my research approach. I view the world through a constructivist lens, meaning that I do not believe in one single or universal truth, but rather that meaning is socially constructed. Constructivist researchers tend to make use of qualitative research methods because these better allow for a focus on lived experience, getting at how people create meaning and make sense of their world (Merriam, 1998).

I have shared my personal experiences in the interest of transparency, allowing consumers of my research to gain a better understanding of the choices I have made in my research design. Throughout the course of my study, I bore in mind the ways in which my personal experiences and epistemological beliefs influenced my approach and the conclusions I drew from my data. I engaged in reflective memoing on such topics on a regular basis throughout the research process.

Conclusion

In this chapter I have described my research design—a single, qualitative case study to gain an in-depth understanding of STEM graduate students' decisions to remain or not in academia at the end of their programs. I have provided a brief description of my case, though I will present later a detailed description along with my findings. I have also detailed my approaches to data collection and analysis, including observations, interviews,

focus groups and document analysis. Overall, the design of my study provided a detailed research plan while simultaneously allowing for some degree of flexibility in responding to emergent findings and new sources of data.

CHAPTER 4: University Practices and Student Decision-Making Trajectories

In order to better understand the doctoral students' experiences in this study, it is first necessary to understand the context in which it is situated. The context includes not only the institution, but the discipline of engineering and the specific departmental cultures, as well as institutional supports for graduate student career development. In addition, the context for each of the study participant's career decision-making includes their proximity to program completion. For example, it is only natural to assume that participants who are closer to graduation will tend to prioritize career decision-making and will be making preparations to either enter the job market in ways that students for whom program completion is still more distant into the future will not. The cultural aspects of the students' context are important to better understand the organizational structures they experience, and how those influence their individual decisions regarding their future careers. Understanding where students are situated in terms of their proximity to degree completion is helpful in establishing the logistical and practical implications of the choices they were experiencing at the time of the interviews.

The information presented in this chapter is based on public information accessible through online documents and websites about the institution, the engineering college and its departments, and university career services. In addition, this chapter presents some research on organizational structures in general and disciplinary organizations in particular, and my interpretations of these contexts based on the interviews conducted, and informal observations made. This chapter provides

foundational elements that contextualize the data that follow in subsequent chapters, and it helps to situate the organizational experiences of students in the study.

Following the presentation of the institutional context for the study, this chapter briefly introduces the study participants. In doing so, relevant information such as each student's gender, their department, expected graduation date, and their expected age at graduation are also mentioned. This helps to situate each individual participant, presenting information that is relevant to understanding their current thoughts regarding their careers. Finally, this chapter presents a preliminary analysis of the ways in which proximity to program completion changes the considerations at the forefront of the study participants' career decision-making, highlighting some of the key differences between participants at different stages in their PhD programs. The chapter ends with a more in-depth examination of the cases of six students who are "mid-point" to "close" in terms of program completion, and who are interested in pursuing academic careers.

The University

A university located on the mid-Atlantic coast of the United States serves as the institutional context in this study. I have used the pseudonym "Mid-Atlantic University" and will hereafter refer to it simply as MAU. The Carnegie Foundation classifies the university as an R1 institution with the "highest research activity," indicating that it awards more than 50 doctoral degrees per year in at least 15 disciplines. With total student enrollment of almost 40,000 students, this institution is able to support substantial graduate programs throughout the curriculum. Total graduate enrollment is over 10,000 students, or nearly one third of total enrollment (MAU website, 2018).

The university declares itself to be a preeminent public research university in the United States (MAU website, 2018) and is ranked in nine programs and over ten specialties by the *US News and World Report 2019* rankings of the top graduate schools in the country, being among the top 30 engineering schools (U.S. News and World Report, 2018). Furthermore, MAU is the state's flagship university.

MAU is located in a suburban setting with easy access to a major city. Its location and size likely make an impact on students' decisions to attend, and many graduate students in the study commented on these factors during interviews, particularly the proximity to many industry and government employers. The student demographics at MAU are diverse, with almost 40% of all students being from ethnic minority backgrounds and approximately 47% of students being female (MAU Website, 2018).

Structure and Importance of Engineering Education

The school of engineering at MAU is a major priority for the institution, as evidenced by the recent construction of a $50 million engineering building that opened in 2017 to house the relatively new bioengineering department. Other signs of the prominence given to science programs and research in general include a discourse that emphasizes innovation. This word is used frequently on university websites designed to attract prospective students, and the engineering school is frequently linked in these pages. The engineering facilities take up prominent spaces on the large campus, with classrooms, labs and research facilities spread across 14 buildings. Changes in leadership and direction at the school of engineering in the past decade have resulted in an emphasis on four key challenge areas for development that are outlined in the 2020 strategic plan: Energy, Environment, Security, and Human Health. With undergraduate student

enrollment at over 4,000 and graduate student enrollment over 2,000, the school of engineering is home to 15% of all students at MAU, and 20% of the institution's graduate students.

The school of engineering offers PhD programs in seven different engineering disciplines, organized by department. The structure of the PhD programs is relatively standard across engineering departments: full-time students are expected to complete an average of two years of coursework before taking their qualifying exams; upon passing the qualifying exams, students defend a dissertation proposal, complete their dissertation research, and defend their dissertations in an average of three to four years. Thus the total length of the PhD program is usually five to six years. In my interviews, the qualifying exams came up often as a grueling and stressful experience that engineering PhD programs are notorious for. Students reported that these qualifying exams often serve as a culling mechanism, and that students who fail to pass them usually drop out of the PhD program at the two- or three-year mark.

Despite these similarities in the overall structure of the PhD programs and the overall timing of the major benchmarks for degree completion, one thing that stood out in the interviews was the great variability and diversity in PhD students' experiences working on their dissertation research. Students work on their dissertation research under the supervision and guidance of their academic advisor, who is also the principal investigator (PI) in the lab that they work in. Through interviews with PhD students it became clear that the overall size and scope of their dissertation research, the role of the research within their PI's lab, the degree of collaboration with other students and lab research staff, and even the degree and nature of the guidance received from their advisor

varied greatly. Therefore, the PhD research experience is characterized by a very high degree of heterogeneity, even within the same engineering discipline. This is a topic that will be discussed in more depth in subsequent chapters, along with the implications of this for understanding students' career decisions following PhD completion.

The Engineering Disciplines

A brief description of the disciplinary context and environment of engineering is helpful in understanding student experiences within their respective departments. Biglan's (1973) work on disciplinary differences and categorizations is pertinent here, because engineering encompasses multiple sub-disciplines that reflect the variability seen across the sciences. Within Biglan's (1973) framework, it is possible to see that engineering sub-disciplines share the characteristic of being highly applied, as opposed to the "pure" sciences, which can be highly theoretical; engineering sub-disciplines are also for the most part, characterized as paradigmatic or "hard," sharing a higher degree of consensus surrounding content and methods than "softer" social sciences or humanities disciplines; on the other hand, engineering disciplines vary considerably in their degree of "concern with life systems," with sub-disciplines such as bio- or chemical engineering being distinct from computer or nuclear engineering (Biglan, 1973). Engineering fields are thus generally "hard" and "applied," but vary in their degree connectedness to living systems.

The differences between engineering disciplines have implications for departmental cultures within engineering (B. R. Clark, 1987; Lovitts, 2001). Of particular interest in this study are the differences in the degree of male dominance in different engineering sub-disciplines. Some engineering disciplines continue to resist

feminization much more strongly than others, and this has implications for the epistemic practices and identities, group organization, norms and culture, structures, daily practices and the forms of governance that dominate within different engineering departments (Gilbert, 2009). These can all affect student experiences at different engineering departments, and their views of the academic profession.

Engineering as a field is unique within the university due to the tensions that exists between applied research in industry and government, and the more theoretical or "pure" pursuit of knowledge within insitutions of higher learning. As a very applied field, there is opportunity to pursue engineering research outside of the academy, and such opportunities are oftentimes better paid and more prestigious than work within universities. This may set up the PhD experience within the discipline to be at odds with that of the PhD experience in other STEM fields, where oftentimes the most desirable and steady employment for those interested in research is within institutions of higher learning. This has implications for this study since university professors are often encouraging of academic careers and pursuits, but within engineering at least, students may aspire to very different careers.

Tables 1 and 2, below, were compiled from publically available institutional data at MAU, and summarize the gender breakdown of faculty members of different ranks as well as PhD students in the different engineering departments. Although the latest data were from the Fall 2017 semester, one year before data collection began for this study, it is unlikely that numbers would vary very much from year to year. The faculty numbers in Table 1 illustrate expected trends, such as low female representation overall, but with stark differences between more feminized fields, such as bioengineering, (with 45%

female faculty), and fields that continue to more strongly resist feminization, such as electrical engineering (with 9% female faculty). Also, female representation tends to decrease steadily as one climbs up the faculty ranks.

The size of engineering departments also varies widely at MAU, with potential implications for departmental culture. Smaller departments such as chemical and biomolecular engineering, with just 30 faculty members, may have a tighter, more cohesive feel than larger departments such as civil and environmental, or mechanical engineering, with upwards of 100 faculty members.

Table 1
MAU School of Engineering Faculty Breakdown by Department and Gender, Fall 2017

Department	Assistant Professor		Associate Professor		Instructors and Lecturers		Other Faculty		Professor		Total	
Gender	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
Aerospace	1	2	7	2	6	0	23	2	9	2	46	9
Chemical & Biomolecular	1	2	4	1	0	1	11	2	8	0	24	6
Civil & Environmental	2	3	3	2	12	4	58	24	15	1	90	34
Electrical & Computer	6	1	6	0	10	1	27	2	38	4	87	8
Bioengineering	3	2	6	1	3	2	13	8	4	0	29	13
Materials Science & Engineering	1	1	3	2	2	1	47	10	9	1	62	15
Mechanical	6	2	8	1	13	4	46	7	21	4	94	18

Note. Table compiled from publically available data available on MAU's Office of Institutional Research, Planning, and Assessment (IRPA) website.
M = Male, F = Female

When it comes to the percentage of PhD degrees granted to men and women students in the different departments, the small program sizes call for an examination of trends over the past five years, since the fluctuation from year to year can be significant. As Table 2 illustrates, the percentage of PhD degrees awarded to men is consistent with

the overall feminization of the different engineering disciplines, with disciplines like mechanical, electrical and computer engineering and aerospace engineering quite consistent in awarding upwards of 80% of degrees to male students in the past five years. In contrast, fields such as bioengineering and materials science and engineering show a much more even distribution of PhD degrees by gender, with male degree recipients fluctuating between roughly 50-70% of total degrees. These data are consistent with the statistical profile of doctorate recipients in engineering according to the 2017 NSF survey of doctoral recipients (NSF, 2017). This implies that the gender breakdown of PhD students across the different departments at MAU is fairly typical of institutions granting doctorates in engineering.

Table 2
MAU School of Engineering Percentage of PhD Degrees Granted to Male Recipients Breakdown by Department and Year

Department	2013	2014	2015	2016	2017
Aerospace	61.5	84.6	85.7	83.3	85.7
Chemical & Biomolecular	42.9	70.0	80.0	75.0	33.3
Civil & Environmental	73.7	68.8	56.5	81.8	55.6
Electrical & Computer	86.7	86.3	82.1	81.6	88.6
Bioengineering	57.1	60.0	50.0	46.2	54.5
Materials Science & Engineering	66.7	62.5	66.7	72.7	87.5
Mechanical	82.2	91.2	93.3	91.2	92.3

Note. Table compiled from publically available data available on MAU's Office of Institutional Research, Planning, and Assessment (IRPA) website.

The institutional setting for this study is typical of large, public research institutions in the United States. The school of engineering at MAU is a very prominent school on the university's campus, home to a fifth of the institution's graduate students, and features prominently in the institution's webpages and in its discourse emphasizing the importance of research and innovation. Within the school of engineering as a whole, the statistical profile of PhD students in different engineering disciplines mostly reflects

that of typical engineering doctoral recipients on a national level, with the exception of age and marital status for men versus women. As a result of purposeful sampling, the participant sample for this study is skewed to include a disproportionate number of women, and of students interested in pursuing an academic career track.

University Career Resources

MAU boasts a large online career services platform on which all enrolled students can create a profile, upload their resumes, and be visible to corporate recruiters and employers who are registered on the platform. This online career center contains links to resources for career planning, writing resumes and cover letters, evaluating offers, interviewing, and networking. In addition, there are in-person workshops and events covering themes such as job and internship searches, salary negotiations, and careers in specific industries.

These university-wide services cater mostly to the undergraduate population; however, there are career and professional development services geared specifically towards graduate students and postdocs through the MAU graduate school. Although they share many of the same online resources through the university-wide career center, the graduate school boasts a dedicated career counseling professional to advise its PhD students and postdocs, as well as career events and workshops dedicated to this campus population. Workshop themes specific to the graduate student population include navigating career choices after the PhD, and learning about careers paths in different fields, including academia, private industry, nonprofit organizations, and the federal government. In informal conversations with career services personnel at the graduate school, it became evident that the center for graduate students is relatively new, and that

it was an institutional response in recognition of a shifting career landscape for PhD and postdoctoral students. The university as an institution recognizes that the majority of PhDs are no longer destined for permanent academic positions, and that there is a mismatch between the number of PhDs produced and the number of tenure-track positions available.

In addition to these services, engineering students have access to a dedicated career services office that is housed within the school of engineering. This career center offers engineering students their own online platform for uploading their resumes, CVs and other documents, connecting them to recruiters and companies that are recruiting specifically for engineering careers. It also offers resume writing tips and job search tips that are specific to engineers. However, according to my interview participants, this career center's staff has expertise pertaining mostly to undergraduates and master's students in engineering, and the services that they offer have less relevance to PhD students. In addition the job listings and the recruiters who go through this online platform to reach engineers graduating from MAU focus largely on the undergraduate and master's population. These campus recruiters do not generally have the expertise to recruit for the highly technical research positions that engineering PhD students vie for.

Given the landscape of available career resources, engineering PhD students at MAU find themselves in a somewhat awkward position; they are not catered to effectively either by the graduate school's career center, or by the engineering school's career center. Participants reported in interviews they navigate on their own, through their personal networks, much of their job search and career preparation. In some instances, engineering departments at MAU host their own career development

workshops and events, and interview participants reported finding these departmental events more focused on their needs, and more helpful to them.

Faculty Preparation Program (FPP)

Beyond the general career resources, the school of engineering at MAU has a program devoted to PhD students in engineering who are interested in pursuing faculty careers. This program is open to all doctoral students at the school of engineering who have either advanced to candidacy or completed their coursework and qualifying examinations, and who have at least three semesters left before graduation. Application to the program consists of a CV, a personal statement, and two letters of recommendation, one from the student's PI and one from another faculty member. The FPP consists of a sequence of three one-credit training seminars, a teaching practicum, and a research mentoring practicum, and typically takes three to five semesters to complete, depending on whether students do one or both practicums in parallel with the final seminar, or do the practicums in sequence after completing all the training seminars.

Student participants who enrolled in this program described it as extremely helpful in understanding and preparing for the demands of a faculty career. The first training seminar focuses on technical writing and developing effective presentation skills, with discussions on topics ranging from research diversification to networking, ethics and professionalism. The second seminar focuses on teaching, imparting effective teaching techniques and principles of education and learning, as well as guidance on how to develop a course, design exams and assignments, and communicate effectively with students. The third training seminar is an introduction to developing a successful faculty research program, with an emphasis on writing grant proposals, mentoring students, and

maintaining a research group. In this final seminar, enrolled students also learn about the application process for faculty positions, and receive help preparing their research and teaching statements.

Of the 20 study participants, eight were enrolled in the faculty preparation program (FPP) at MAU. Of these, six were women and two were men, and they all had good things to say about the insights that the program lends to the faculty career, and the supports that it provides for students who wish to pursue it. However, two of the students who initially enrolled in the program described that the program actually ended up putting them off from pursuing an academic career. Students described that the program offered an honest glimpse of the demands on faculty, and the challenging path to a tenured position at a research institution. For some students who were initially drawn enough to the academic career to apply for the program, the better understanding of everything that the academic career entails ironically ended up turning them away from pursuing this career. Overall, however, the program received a lot of praise from students, and provided a much-needed opportunity for those interested in pursuing faculty careers to gain teaching experience.

Study Participants

Participants in this study represent all seven engineering disciplines that confer PhD degrees at MAU. For simplicity, disciplines that have two names are henceforth referred to with only their first name. There were 20 participants in total, 10 women and 10 men, stemming from the following disciplines: aerospace engineering (two women and two men), chemical engineering (one woman and one man), civil engineering (two women), electrical engineering (one woman and one man), bioengineering (three women

and two men), materials engineering (one woman and two men), and mechanical engineering (two men).

Participants were all US citizens (18) or permanent residents (2); international students were not recruited due to confounding variables that limit their career options in the United States. All participants had completed their coursework and passed their qualifying exams at the time when interviews were conducted, and were thus advanced doctoral students focusing on their dissertation research. However, their expected time to degree completion varied, with three of the most advanced students being in their final semester at MAU, with an expected graduation date of December 2018, and the two least advanced students having an expected graduation date of May 2021. Despite my efforts to recruit an ethnically diverse set of participants, 15 students were of European descent, identifying as white, and the remaining five included two permanent residents from Iran and South Korea, and three American students of middle-Eastern and central Asian descent. Table 3 below provides the pseudonym used for each participant in this study, as well as their gender, engineering discipline, and expected graduation date.

Table 3
Summary of Study Participants

Pseudonym	Gender	Program	Expected Graduation Date	Proximity to Program Completion
Blaine	F	Aerospace	December 2018	Close
Amelia*	F	Aerospace	December 2018	Close
Hyun-Gi	M	Mechanical	December 2018	Close
Amin	M	Mechanical	May 2019	Close
Ashton	M	Materials	May 2019	Close
Olive*	F	Bioengineering	May 2019	Close
Jonathan*	M	Bioengineering	May 2019	Close
Dabir*	M	Electrical	August 2019	Close
Aisha	F	Materials	December 2019	Mid-Point
Charles	M	Materials	December 2019	Mid-Point
Robert	M	Aerospace	May 2020	Mid-Point
Sylvia	F	Bioengineering	May 2020	Mid-Point
Holly*	F	Bioengineering	May 2020	Mid-Point
Tara*	F	Civil	May 2020	Mid-Point
Ubon*	F	Civil	May 2020	Mid-Point
Conrad	M	Bioengineering	August 2020	Mid-Point
Merritt	M	Chemical	December 2020	Distant
Violet	F	Electrical	May 2021	Distant
Scott	M	Aerospace	May 2021	Distant
Willa*	F	Chemical	May 2021	Distant

Note. Table compiled from author's own interview data and communications with participants.
M = Male, F = Female
* = Participants enrolled in the Faculty Preparation Program at the time of interview.

As can be seen from Table 3, participants varied somewhat in terms of the amount of time they had left in their programs before their expected graduation date. This suggests that some participants have been in graduate school longer, and may have gained more experiences pertaining to the academic profession and of the university as an institution and a workplace than other students. A total of eight students expected to graduate within the academic year 2018-2019 or the summer immediately following. For these students, graduation is closest and career considerations and planning are most immediate. For the purposes of this study, these participants are described as being "close" in terms of proximity to program completion and thus the process of career

decision-making. Another eight students expected to graduate sometime in the following academic year, 2019-2020 or the summer immediately following. They are somewhat more distant from making immediate career choices, but are perhaps starting to more seriously consider their options and to plan for the future. They are described as being "mid-point" in terms of distance to degree completion. Finally, four students were still two academic years away from their expected graduation and thus career planning and decision making is a bit more of a remote thought for them. While these students may be aware of certain preferences, they may not have begun to fully consider the practical implications of certain career choices, or begun to envision themselves pursuing those specific roles. They are described as being "distant" to program completion.

It is possible that a participant deemed "distant" from program completion and the career decision-making that comes along with it is incidentally an exceptional long-term planner, and already very aware of pursuing a specific career direction and making choices in graduate school that pertain to some long-term ambitions. However, given the demanding nature of PhD study and research in engineering, it should be acknowledged that students tend to defer or suspend career decisions and planning until the immediate need to focus on these activities arises later on in their programs. Indeed, this pattern of delaying career planning and decision-making became evident in interviews with all the engineering PhD students.

Women participants were expected to be, on average, 33 years old at the time of their graduation, whereas the men were on average, expected to be 29 years at their expected graduation. On average, the women came with more years of work experience prior to entering the PhD than the men, and were also more likely to be married or

engaged at the time of the interview. Six of the ten women reported being married or engaged at the time of the interviews, and just two of the men reported being married or engaged. Several other participants were in committed relationships, however, and only four women and four men reported being completely unattached or single at the time of the interview. In these aspects, this study sample is not representative of typical doctoral recipients in engineering in the United States. According to the NSF survey of doctorate recipients, men doctoral recipients in engineering are typically older than women at the time of doctorate (30 years, versus 29.5 years for women) and are more likely to be married, with 42% of men, versus 38% of women being married (NSF, 2017). It could be that MAU engineering PhD students are not typical in this regard, but it is more likely that there was some sort of sampling bias in my study methodology. For example, recruiting participants enrolled in the FPP may have resulted in a sample with older participants for some unknown reason.

Although the overall institutional context is the same for all participants in this study, the context of each engineering department studied is integral to understanding some of the socialization experiences that may affect the career decision making of the doctoral students involved. The institutional, disciplinary, and departmental settings in which these students study thus form unique contextual and cultural influences on the student experience and their subsequent feelings pertaining to academic research, the academic profession, and their field at large. While these settings and the student experiences of them as they pertain to career decisions will be discussed in more detail later on in this study, this chapter laid the foundation for a preliminary understanding of these contexts.

Participants in this study stem from a wide spectrum of engineering disciplines, and represent all PhD granting engineering departments at MAU. The sample is balanced in terms of gender representation, which makes it a purposeful sample that is not representative of the overall gender ratio at the college of engineering. Particularly in disciplines where the representation of women in the graduate student body remains low, like aerospace, electrical and materials engineering (see Table 2), the participant sample in this study skews heavily female relative to the general PhD population. This is central to the gender analysis that this study set out to undertake. Variability in participants' age, marital status, and proximity to the career decisions and choices that are made as PhD students near program completion also add valuable elements to the analysis.

Career Decision-Making Trajectories

The interviews conducted for this study suggest that graduate student career decisions do not happen in a momentous way, but rather are the result of experiences that happen over time. These experiences serve as opportunities for information gathering about the type of work that goes on in different fields, what that work entails, and individuals' sense of fit and aptitude for that sort of work and environment. Students at different points in their PhD programs have accumulated different amounts of experiences of research in an academic setting, and have also, generally, had less time to evaluate their strengths and aptitudes in relation to their future career choices.

Throughout graduate school, PhD students are exposed daily to the university as an organization and a workplace, even though their status as both degree-seeking students and paid employees can sometimes mean that they inhabit a gray area. They are also exposed to the academic career through what they observe and learn about their advisors'

responsibilities and tasks. Contrasting the career thinking and planning of students who are still "distant" from program completion to that of those who are at "mid-point" or "close" to program completion provides some perspective on how engineering students' career thinking matures and develops over the course of the PhD program. In this section, I present first some insights from interviews with the four students who are "distant" from program completion. This is followed by a discussion of students who are at "mid-point" and "close" to program completion, and who have opted against pursuing academic careers. Finally, the cases of six students who are in "mid-point" and "close" stages and who are pursuing careers in academia are explored in more depth, since these cases lend some insight as to the unique perspectives of this minority of engineering PhD students.

Students "Distant" from Program Completion

The four students in my sample who were "distant" from program completion were all in their third year of graduate school at the time of our interviews, with three being at the beginning of their seventh semester, and one at the beginning of his eighth semester. As can be seen in Table 3, two were men in chemical and aerospace engineering, and two were women in chemical and electrical engineering.

For students still "distant" from program completion, work experience outside of academic settings was particularly influential in shaping their perceptions of the university as a workplace. Given that their memories of previous work experiences were relatively recent, these students tended to compare their work as PhD students to their previous work in other settings. Of the four students "distant" from program completion, two had previous work experience outside of academic settings and one held a part time

job alongside his PhD. Scott, the man in aerospace engineering, had no previous or current work experiences outside of his PhD work.

For Willa, the woman in chemical engineering, four years of previous work in industry did a lot to shape her expectations of research work and of organizational structures. She referred often to her time in industry during our interview, and contrasted those experiences with her current work as a PhD student in chemical engineering. In contrast with her work in industry, she found that as a PhD she did not get a sense of the bigger picture with her research work, and had trouble understanding what government agencies were funding her lab and why they were interested in funding these areas of research. In contrast with her research supervisors in industry, she got the sense that PIs in academia "don't even know the details of the research that's going on in their labs" and have to spend their time instead "applying for grants, writing papers, peer reviewing other people's papers, developing projects and…[doing] administrative work," a prospect that was unattractive to her. She also reported working very long hours as a PhD student, often spending upwards of 12 hours each day in the lab. She stated, "there's no balance here between work and life. They're completely separate and your work is sometimes your life." In contrast, her experience in industry was that an industry job does not "consume people and define them" as much as working as a professor.

Merrit, the man in chemical engineering, held a part-time position in a government agency concurrently with his PhD in chemical engineering. The work that he did in government was in computer programming, and not directly related to his PhD research work. However, his experience of work in a government setting and his conversations with engineers working at national labs cemented his perceptions of what it

means to work in government, and the advantages of this over work in academic settings. The biggest draws of work in government were work-life balance and generous benefits. This made government work attractive despite government workers being paid less relative to industry workers.

For both Willa and Merritt, negative experiences of the chemistry department's politics at MAU served to further their negative perceptions of academia. As Merritt put it, in government he would not have to "play with the department chair's politics." Willa set up a contrast between academia and industry in stating, "there's HR in industry and you can anonymously deal with things," whereas in her current situation in the chemistry department, she did not see a clear avenue for airing her grievances. These students' experiences were very particular to their department, and to issues that they were having with the newly appointed chair. However, this serves to illustrate how work experiences outside of the academy serve as a reference point when individuals are making sense of experiences that they have as graduate students.

Violet, the woman in electrical engineering, is a unique case because her experiences outside of the academy were as an entrepreneur in her own business ventures for four years. Having started two very successful businesses before embarking on her PhD, and having experienced the high demands of working in her own start-up companies, she described graduate school as being a very relaxed and laid-back time for her. The research group she joined at MAU is forming a company with which to commercialize the IT that they had developed in the previous year, and she sees the potential to be a part of that in the future; she also considers pursuit of an MBA a possibility following graduation with a PhD. Violet's previous work experiences did not

give her a strong sense of organizational structures that she can compare with the university. In contrast to Willa and Merritt, she has gravitated towards a research group with a more commercial focus, aligned with her previous experiences as an entrepreneur and businesswoman. However, her lack of more structured work experiences leave her open to many possibilities at this "distant" stage in her PhD journey, including the possibility of pursuing academia, or work in the tech industry where companies like Google and Facebook have good opportunities for engineers with her background in machine learning.

Having had no previous work experience at all, Scott entered the PhD program straight after earning his bachelor's as a result of his interest in research and a sense of intellectual curiosity. His youth and his lack of work experience outside of academia meant that at the time of our interview, he remained very open to career possibilities, whether in government, in industry, or in academia. However, he did acknowledge that he would prefer to "have some more data points" and "see what engineering research looks like in different contexts," showing a preference for exploring work in other sectors before potentially returning to an academic career path later on.

The four students who were still "distant" from program completion at the time of our interview displayed less well-defined notions of academia and what the academic career entails compared with students who were at "mid-point" or "close" to degree completion. Student remarks at this "distant" stage also revealed that they often held contradictory views of the academic career that they likely bring into focus later on in graduate school to form a more coherent idea of what the profession entails.

Most of these students already had a sense that the academic career is highly competitive, and that their PIs' workload is very high. Willa remarked, "I admire how hard she [the lab PI] works, but I wouldn't want to do what she does." Similarly Scott stated, "the turn-off [from the academic profession] is seeing how busy my professors and advisors are. That's not really the life I envision for myself." From their remarks one can tell that at this stage in their programs, PhD students may already be somewhat discouraged from pursuing academic careers due to the sense that this profession is one with very high time demands.

Although students already have a sense of the high workload, however, they still display a somewhat naïve idea about the freedom and flexibility inherent to the profession. Violet remarked that the life of a professor must be "so cool" because professors are "able to work on anything" that they find interesting. These students also tended to place a very high emphasis on the flexibility that comes with being a PI who is solely responsible for his or her own work. Willa's remarks that "there's a lot of flexibility" and that "you don't have to report to your boss all the time" were also echoed by Violet, who stated, academia is "probably the most lenient job out there" for people with families and young children, due to the flexibility to come and go as one pleases and keep one's own hours. "No one really checks on you throughout the day . . . it's project based so you show up for meetings, keep things on track, you show results and everyone's satisfied," she explained. This suggests that students at this "distant" stage can hold somewhat contradictory views of what life in the academy entails. At this "distant" stage it also seems that a rosy picture of the academy and the flexibility the job entails can emerge, as students have not yet really begun to consider the realities of work

in an environment with no set hours and no clear directives on what one should be spending one's time on.

For the two students in chemical engineering, bad experiences within their department, and particularly with their department chair, were already beginning to shape their perceptions of the academy as a place where politics can get out of hand, and where structures of tenure and promotion can lead to toxic personalities in positions of leadership. However, this emerged mostly as a feature particular to their department, where the appointment of a new chair in the last year or so had been particularly tumultuous. Also, since both of these students had served in the graduate student society for their department, both had had interactions with the chair and experienced his leadership style in ways that a majority of students in their department would not have. In general, most graduate students reported few occasions for interacting with higher-level administrators in their respective departments.

Students "Mid-Point" and "Close" to Program Completion

By the time students are "mid-point" or "close" to program completion, they are beginning to think more concretely about next steps, and about their transitions to work. Of the students in my sample, 16 out of 20 were in "mid-point" or "close" stages. Of these, six were interested or at least open to pursuing academic careers following PhD completion, and ten had decided against pursuing academic careers. In this section, I focus on the ten students who had decided against academic careers.

Compared to students still "distant" from program completion, students who were "mid-point" or "close" to program completion had developed a more clear sense of the academic profession. Across these ten interviews, descriptions of the academic

profession and its demands were much more consistent, and students focused on several aspects that made the academic career unpalatable to them. At the same time, students had already developed a stronger sense of how they like to spend their time and what they want their on-the-job duties to entail. Blaine, a woman in aerospace engineering, summarized eloquently the feeling of many students in stating that that their advisors were not involved enough in research and were consumed instead with grant writing: "I want to do research, I don't want to look for money. I know my advisor is always looking for funding and proposal writing and whatever, and he's broke." Beyond applying for funding, students also witness their advisors spending a lot of time in administrative tasks for the department, and managerial roles for their labs. As Ashton, a man in materials science put it, "my advisor is basically administrative and he spends his days in and out of meetings, all day basically," shedding light on another element of PIs' work life that does not appeal to students.

Students also have formed the impression that the academic profession is a very demanding one, requiring a high level of commitment and energy. As Charles, a man in materials science put it, students can "see how much professors work, how they check email in the evenings and stuff" and many of them decide that this lifestyle is not for them. By this stage in their programs, students feel that they "know the sacrifices that academics make" and have come to appreciate that the "demands on faculty are huge," in the words of Aisha, a woman in materials science.

At the same time, students have come to understand that the academic career is one that entails many risks and uncertainties, for little financial reward. Tara, a woman in civil engineering commented, "It's a big struggle to get tenure here. It's a big struggle to

even get a faculty position. So those are big obstacles." This leads some students like Amin to ask themselves, "I don't know why a PhD in engineering would go and work as a professor. It must be love of academia I guess, because we can easily get a job in industry with a much higher salary and less uncertainty, less pressure." Overall, a majority of students at these later program stages do not see the advantages of an academic career outweighing its drawbacks. Compared to students who are in earlier stages of their programs and more "distant" to program completion, there is less ambiguity regarding the academic profession, less naiveté regarding the benefits of a flexible schedule and freedom, and a more consistently pessimistic view of what the profession entails.

At the same time that they have more mature perceptions of the academic career, at this stage students have developed a more clear sense of what they want from their future work, and what they wish to prioritize in seeking out a job. They have identified what they are good at, and what preferences they have in terms of the day-to-day activities they wish to engage in. Jonathan put this eloquently when he stated, "the last five years have helped me figure out what's important to me." Unsurprisingly, many of the students expressed a desire to continue engaging in hands-on research after the PhD. When asked about their plans, many offered a version of Blaine's response, oftentimes contrasting what they hoped to do professionally with what they saw their advisors doing:

> In terms of career plans, the biggest influence is just wanting to keep doing research. Wanting to do research, loving research, having a mind for research. . . . . I want to be in the research, doing the research, engaged hands-on

with the research. . . . The bulk of my advisor's time and of other academics that I see around me is more of a managerial position – a technical managerial position.

Students also demonstrated a pattern of narrowing down their options and crystalizing their choices around a set of core values that they are unwilling to compromise on. As an example, Ashton described his biggest priority on the job search as being his ability to remain in a technical role: "coming to grad school was so that I could do something technology related. I think that's something I'm not willing to compromise on." In weighing their options and choosing directions, students considered the daily tasks that would take up their time in different roles, and how these align with their own skills and preferences. For example, Aisha described why a career in consulting might be a good fit for her, saying, "I think consulting is a good mix of the things I want. The demands are fairly significant, so it's fast paced. It offers a lot of flexibility in terms of not just the structure of your day but also the variety of problems you would be able to work on."

Although it became evident during interviews that many engineering PhD students postpone their preparations for going into the job market until very late in their programs, some students who were "mid-point" or "close" to program completion had begun preparations. In general, it became evident that students felt somewhat unsupported in their career preparation, and were left to navigate on their own the job search process. For this they relied on peer networks, and also on personal networks that they developed through professional conferences, social media, and professional platforms such as LinkedIn.

Students' experiences of university career services had taught them that while there was some helpful advice to be had in terms of reviewing a resume, a lot of the

campus services were more geared towards undergraduates. For example, recruiters at campus job fairs were unprepared to assess their research qualifications, and did not often recruit PhD candidates. Ashton explained, "I've had people tell me that a lot of PhD level jobs won't even be on their website. It can be hard to find, it's more of like, you just send in your resume," suggesting that entry level PhD jobs are often not advertised in the same way that other positions are. Thus many students expressed the importance of networks and word of mouth in learning about opportunities. Seeking out opportunities for informational interviews and reaching out to people during conferences were mentioned often as strategies for learning about industry openings and getting a "foot in the door." For example, Aisha related that she was "starting to tap into my network on LinkedIn, and when I go to professional conferences I'm asking people to give you know, 30 minutes of their time to tell me more about their experience and their advice."

Students' approaches to entering the job market could be a bit haphazard, and varied in their intensity. For example, Blaine, who was just weeks away from defending her dissertation at the time of our interview, described a very laid back approach to her job hunt. She had, however, already been offered a position by recruiters at a government lab where she had sent in her resume. She described that her "approach to the job search was pretty laissez-faire. Kind of changing my status on LinkedIn to "actively searching." Sending my resume out a couple places." It seemed as though she had been lucky and benefitted from an uptick in the job market for aerospace engineers, because one other student in mechanical engineering, Hyun-Gi, had been applying to many positions in industry and government, as well as postdocs, and had not received any call-backs. Students in different engineering specialties may face very different job

markets, and even within the same fields, the highly specific nature of their research and the lab techniques they have mastered, the machinery and equipment that they have learned how to operate, etc. may result in very different job prospects as their programs draw to a close.

Students Interested in Pursuing Academic Careers

In investigating the career decision-making processes of participants who are "close" or "mid-point" in terms of their distance to degree completion, the cases of students who remained interested in, or open to, pursuing academic career paths is of particular interest because they provide insight into the perspectives of students for whom graduate school experiences have not served to deter pursuit of an academic career. The six students who share these characteristics are a minority in the study sample, and a small subset within the group of 16 students who are close or mid-point in terms of their proximity to program completion. Yet even within this group of six participants, attitudes toward the pursuit of an academic career varied widely. For example, some of these six students had been very strategic in planning out a trajectory throughout their graduate program that would best prepare them to prepare for and place well into the academic job search. On the other end of the spectrum, at least one of the six students demonstrated a more incidental or opportunistic approach to his career planning, and was engaged in a job search that included both postdoctoral positions in academia, as well as industry and government positions. In his case, he had not actively planned to pursue a competitive academic career path; however his decision to apply to a wide range of available jobs could end up keeping the academic career doors open to him, particularly

because postdoctoral positions are less competitive than industry and government positions.

In this section, I present the six cases of engineering PhD students who were interested in pursuing academic careers within "mid-point" and "close" proximity to program completion. These cases serve to highlight the unique attributes and perspectives of these students regarding the university as an institution. These cases lend insight into their perceptions of the university as a workplace and of the structural barriers to pursuing academe both within MAU and in institutions of higher education more broadly. Furthermore, these cases lend insight into the individual characteristics and dispositions of students who feel a stronger affinity for the academic career path.

Of the six cases presented here, four are women and two are men. This is somewhat surprising given broader gender trends in engineering PhDs' pursuit of academic positions, but it is likely that this is a result of sampling bias. For example, women interested in academic careers may have been more interested in taking part in my study. In addition, at least two of these female cases were a result of snowball sampling, where a previous interview participant introduced me to someone who they knew had an interest in pursuing an academic career because of the special and unique interest that these cases hold for my study. Of the four women, one is in aerospace, two are in bioengineering, and one is in civil engineering. Two are "close" and two are "mid-point" in terms of their proximity to degree completion. All four of them took advantage of the faculty preparation program available to engineering students at MAU. The two men are in mechanical and aerospace engineering, and are "close" and "mid-point" in terms of their proximity to degree completion, respectively. Neither one of the men has

yet participated in the faculty preparation program. In this chapter I present these six cases beginning with the three who are "mid-point" before moving on to the three who are "close" to program completion.

Students at "Mid-Point"

Case 1: Holly

Holly is a woman in bioengineering who plans to graduate in August 2020. Prior to entering the PhD program at MAU, Holly held internships at an academic lab and also a start-up pharmaceutical company. Her work experiences helped her realize her affinity for research, and also that a PhD would be necessary in order to hold higher-level positions. She chose the program at MAU due to her recruitment visit, where she learned about the rotation program offered by the bioengineering department. She valued the opportunity to learn about a lab's culture and the PI's management style prior to committing because, in her words, "the PhD is a long time to work with someone you don't like."

Holly decided quite early on in her graduate program that she was interested in pursuing an academic career. At the same time, she desires to secure a job in the New England area (being willing to move as far south as New York) in order to be close to her and her fiancé's families, who are in the Boston area. Knowing that her mobility restrictions put her at a disadvantage in the competitive academic job market, Holly has approached her PhD with a very high degree of focus and a keen eye to building her resume in the right ways. She enrolled in the faculty preparation program, and has worked very hard, saying that this desire to be in Boston is "part of the reason I'm willing to go absolutely nuts and work 20 hour days when I have to – I want to be able to get

ahead so that when I do go up for faculty positions, hopefully I'll have multiple offers within the New England area."

Speaking about the mentorship she has received from her advisor, Holly remarks that he is an "exceptional PI" who has been a great research mentor. She attributes his hands on mentorship to the fact that he was still an untenured assistant professor when she entered the program, and needed to drive his students to produce. As a first year graduate student, Holly found this beneficial since she was able to "hit the ground running" with her research, and publish earlier on than most other graduate students in her department.

Another benefit of working under her current advisor has been his willingness to foster mentorships between graduate students and undergraduate students in his lab. This has given Holly the opportunity to work closely with undergraduate students in a mentorship capacity, elaborating research projects for them to undertake under her supervision. This opportunity has given her a taste of what it is like to work as a PI, formulating research projects and supervising others in accomplishing the research work. Her experiences with mentoring, along with her TA experiences through the faculty preparation program, have given Holly confidence that she enjoys these aspects of being a professor, stating, "I love mentoring students; I love pushing forward the next generation of scientists, and I kind of like the teaching aspect too."

While her PI has been an excellent research mentor, however, he has not been an adequate role model in terms of demonstrating how to pursue a good balance between work and family life, or how to handle starting a family while on the tenure track. Like other women I spoke with, Holly was acutely aware of the hours her advisor keeps, and

of his lack of competing obligations outside of work. This makes it difficult for her to envision herself filling and succeeding in a similar role. She stated:

> He's willing to put 110% into it all the time because he can. But for someone who has kids, or has outside competing priorities – I don't know what that looks like. What it's like when you can only put in 70% because you still need to have extra for your kids. I don't know.

Like other women I spoke with, Holly expressed a desire to see more young female professors at the assistant professor rank, pursuing tenure and starting families simultaneously. She was excited that her department had recently hired one such female assistant professor, enabling her to "see what her normal life looks like and how she's balanced running a lab and raising kids."

In her search for more women mentors, Holly has turned to networks for women in bioengineering and in academia more broadly, both in person and online. At a luncheon for women sponsored by the Biomedical Engineering Society, for instance, Holly recalled the importance of "sitting in a room with bioengineering women in some capacity" and how it was "helpful to see so many people also going through the same experience as me." She has also found it very helpful to follow several female PIs on Twitter, remarking, "Twitter is all the rage in academia right now" and that "Twitter has been really helpful" in getting a sense of women's experiences as PIs in academia.

One issue that has become of particular concern to Holly is that gaps taken for maternity leave end up hurting female PIs' ability to secure funding, because they're not as active during those sections of time. Holly stated women are "continuously overlooked" because they "had to take six months off a couple different times" means

that funding agencies are inadvertently penalizing women for having kids. Moving forward, the difficulty securing funding also "affects [women's] ability to go up for tenure," thus having repercussions for their careers further down the line as well. Holly posits that all of these issues, compounded with the fact that the demands of the job take up a lot of time, add up to women having a lot of hesitation about pursuing academic careers. Reflecting on all of this, Holly stated, "There are just a lot of things I have to think about because I know I'm going to be a mom. And it affects female professors much differently than it affects male professors having children." Holly's efforts to procure women's testimonials and experiences, and her in-depth consideration of the potential future challenges that a life in academia can entail for women like her suggest that for at least some women, there is a high cognitive load associated with considering an academic career.

Despite the many factors weighing down on her choice, Holly demonstrated a high degree of confidence in her ability to direct research and manage a lab well:

> I can contribute a lot scientifically because I have a lot of questions I want to answer, and I have learned to design experiments to answer the questions I have. I don't make mistakes often; I am probably too hard on myself when I do make mistakes, and I don't waste money because I don't make the same mistakes twice.

Her conviction that she has a lot to contribute scientifically and that "mentoring, and researching, and teaching, fits [sic] my personality really well" are thus strong drivers behind her desire to pursue an academic career.

Case 2: Robert

Robert is a man in aerospace engineering who plans to graduate in May 2020. Prior to enrolling in the PhD program at MAU, Robert received his bachelor's in mechanical engineering, beginning the PhD straight after undergraduate. To him, it was natural to pursue a PhD since he came to "admire the academic atmosphere" and enjoyed doing research as an undergraduate, deciding early on that he aspired to become a professor. Although he has already been at MAU for three and a half years, Robert is strategically taking his time to graduate since he has a fellowship that will continue to fund him for another two and a half years. This, he claims, will give him time to get higher quality data for his dissertation, while also allowing him time to publish as first author at least once or twice before he graduates.

Although Robert was not yet part of the faculty preparation program, he had heard of it and, at the time of our interview, planned to apply for it later that fall semester. From what he had heard, he expected that the opportunity to co-teach as a TA would be one of the most valuable aspects of the experience. Beyond some opportunities to guest lecture and to take on an undergraduate in his lab, Robert had thus far been unable to get much teaching and mentoring experience in his program. With little guidance on how to teach or mentor, it also became clear that he was not necessarily making the best use of his undergraduate's time in the lab, stating that he has him do "grunt work, because he's an undergrad" or undertake "menial chores that help speed up the process of running a test."

Reflecting on the demands of the PI position, Robert remarked on the importance of communicating science to students, and the heavy emphasis on writing, especially

proposal writing. This need to be "writing constantly" was "a little bit scary" to Robert, especially since he has not yet had the chance to work on writing proposals. However, he planned to be involved in writing future proposals with his advisor.

Asked what attracted him most to academia, Robert stated simply that he enjoys "learning and challenging myself to figure stuff out," also mentioning the pride that he takes in the research work and his faith that he can "solve any of these problems that get put in front of me." He also mentioned the value of working on "foundational problems" in a "collegiate atmosphere." When asked if there were any aspects of the academic career that he found off-putting, he stated that he had never thought of any, but that one challenge he foresaw in searching for academic positions would be issues of mobility, since he is married to a woman who values her career in an environmental non-profit and would thus be unwilling to move to certain locations.

When asked whether he thought academia might be at odds with his plans to start a family or have children, Robert did not think that an academic career poses challenges to parenting, stating, "I don't think that would be much of a problem." His own advisor had had a child a bit over a year before we spoke, and Robert recalled that the flexibility to write from home meant that his advisor could stay home and take care of his child while he wrote proposals.

Case 3: Tara

Tara is a woman in civil engineering who entered the PhD program at MAU with two master's degrees and three years of industry experience under her belt. She decided to pursue a PhD with the intent of making a career change and pursuing academia due to her love of "learning, teaching, and empowering others."

Although she is working with a good advisor, the lack of funding in her lab means that Tara has only a half time teaching assistantship rather than a full research assistantship. This means that not all her tuition is covered. Luckily, her husband is able to support her through the program. In addition, she described "subpar" conditions, working "out of a basement with no windows" and with no computer – she has to bring in her own.

Thinking about what a career in academia entails, Tara emphasized the importance of self-discipline and a passion for constant learning. However, she also mentioned the all-consuming nature of the academic career, stating, "the expectation in my department is of complete focus, with no outside distractions." Although she desires to have children, she is "not sure how I would manage with kids." Being in a "male dominated field," Tara senses that she has to be able to "compete with men," and that they "don't talk about family." Thus while the climate in her department is not openly hostile to women, there is a sense that women in the department are asked to leave outside the door elements of themselves that are important in their lives.

Tara is enrolled in the faculty preparation program and considers it "important to anyone who wants a career in academia." Through it, she has learned about the ideal breakdown of time that faculty should spend on the different activities that they are tasked with while working towards tenure. She described the expectation that young faculty spend 40% of their time on research related activities as "scary" since it would mean working approximately 12 hours a day. Thinking of what this entails, particularly for women with families, Tara posits that "women might prefer a normal life," in which the demands of the job leave more time for the tasks required of them at home.

Despite her observations regarding the dynamics of work and family life in her department, Tara remarked that she had not had any negative experiences related to her gender. She did remark on the need for changes in the academy, with things such as on-site daycare, being able to bring your children, and speaking openly about family obligations being part of a cultural shift that would help recruit more women into the professoriate. She also called on universities to demonstrate an appreciation for the presence of women, and to empower the women who are already present. The implication is that while there are some women present, their presence is not appreciated, and they are not empowered.

Tara faces some personal barriers in terms of pursuing an academic career, especially when it comes to the question of mobility. Her husband is a civil engineer with a good industry job and, while he is willing to move, there are some limitations in terms of where he could continue to pursue his career. She also has some preferences in terms of temperature and climate, being from Iran originally, and prefers to be close to family on either coast or in Hawaii. She intends to pursue a postdoc following her PhD, since she sees that as a chance to "improve, develop skills, and take on projects in different areas," but she does not want to remain in a postdoc for more than one or two years. After this timeframe, if she is unable to secure a tenure-track academic position, she plans to work as a researcher.

Students "Close" to Program Completion

Case 1: Amelia

Amelia is a woman in aerospace engineering who was just weeks away from defending her dissertation when we spoke. She had already started a full-time position in

a lab hundreds of miles away from MAU, where she intends to pursue a postdoc for two years before taking up an offer for employment as assistant professor in an aerospace program at a high profile research institution. I was able to interview her in person at MAU, since she visits often.

Amelia received her undergraduate degree in aerospace engineering and worked at NASA prior to enrolling at MAU for her PhD. She knew going into the program that she wanted to someday be an independent researcher and run her own lab. She knew she wanted her work to remain technical but that she really enjoys working with people. Since academia seemed like a good career fit for her, she joined the faculty preparation program at MAU. The program helped in preparing her for the academic job search process, including preparing documents such as her research and teaching statements, and preparing for the interview process. She described that this made it easier for her to apply to academic positions.

Amelia sees her postdoctoral position as an opportunity to work in what she deems a very well run lab, and to gain more experience in managing a lab effectively and writing grant proposals. In her new lab, she described being able to participate in lab meetings she was not able to be a part of as a PhD student, and "seeing different parts of the job" while getting more of a "top view of what everything's like." This has been valuable in helping her envision herself balancing the many tasks of a PI in her own lab.

Amelia has been successful so far in navigating some of the mobility requirements that an academic career usually entails, despite having a husband who is also pursuing a very demanding career. She did, however, remark "having to balance my career with my husband's career is sort of like a burden that I have to take on as a woman

that other people wouldn't," indicating her awareness of the gender dynamics that are at play in negotiating these issues with her husband and her future employer.

Thinking ahead to her role as an assistant professor heading her own research lab, one of the tasks that Amelia finds most intimidating is that of recruiting PhD students to work for her. Although she has had opportunity to work with undergraduate and master's students, she described the prospect of attracting and mentoring graduate student talent as daunting. Observing her mentors in her PhD program and in her postdoctoral lab, she has come to realize the importance of delegating tasks, describing that her current postdoctoral advisor only does the tasks that he "absolutely has to" himself. On the whole, however, she appeared confident that she is in a good position to prepare for her PI role.

In contrast to the confidence that she displayed in preparing for her professional role, Amelia had some apprehensions about preparing for her future as a wife and mother on the tenure track. She stated her husband's desire for a family does not align with his career plans as a doctor. For example, she complained that he has chosen a specialty as surgeon that keeps him at work for long hours and has no set schedule that they can plan around. This makes it difficult to count on him doing his share of childcare and other home tasks. Echoing other engineering women interested in academic careers, she lamented that there were few role models, citing a dearth of women assistant professors in aerospace engineering who have children. Speaking of balancing career and family while on the tenure track, Amelia remarked that she still doesn't know "how it will be possible," and also that she does not want to have kids "unless I have somebody who is like, going to meet me halfway and help me take care of them." She remarked that she

knows of many women in the sciences who have "chosen not to do tenure track careers because they want to focus on their families" and who perceive that "the sacrifices don't outweigh the rewards." However, Amelia does not want kids to be her focus in life. Although she would like to have kids, she stated that this is not her "number one goal" and this attitude means that she is at least "willing to try" life on the tenure track.

Amelia displayed a unique and somewhat refreshing attitude in talking about things that act to discourage other students from pursuing academic careers. For example, in speaking about the many challenges and the overall difficulty and competitiveness of the profession, Amelia stated that she wants to be a tenure-track professor precisely *because* "it is the most challenging thing that I could do. So I am really motivated by how challenging and potentially rewarding it is." When asked about the uncertainties of the tenure process and the risks that working towards tenure entail, she brushed off concerns by stating, "I try not to make my decisions based on the fears of whether or not I will get tenure." Similarly, while other research participants described feeling overwhelmed by the many hats that professors wear, Amelia looked at the many duties and tasks that await her as opportunities to have a wide impact in her field, beyond the research and what it might yield:

> I feel that there's a lot I'd like to change in our world, in our field, and how graduate research is done, how graduate students are treated, how universities are run . . . I'm interested in modernizing or changing a lot of what departments do. . . . I'd like to see more professional development opportunities for graduate students, more health and community resources for graduate students, so I care about all these things. . . . I feel like universities are great places for people and I

feel strongly about the value you can provide to students. But I also feel really strongly about areas in which we're lacking and so all those are things I would like to do. And I would like to keep doing research too…I still want to do more on solar system science, and that's why I'm still wanting a position in research.

Amelia's attitudes and perspectives towards challenging aspects of the academic profession set her, and others interested in pursuing academic careers, apart from the majority of students in my sample. For her, the difficulties of the profession become an enticing challenge, and the risks and uncertainties, while troubling, are something that she chose to look past.

In interviewing for and securing her tenure-track assistant professorship, Amelia faced an "intimidating" search committee that was "one hundred percent white men." She described the two-day interview as "the craziest thing" that she had ever done and as very "draining," but also "fun." In the grueling 48 hours, she met her search committee chair and members of the department throughout the day for one-on-one interviews, ate lunch with a group of students on one day, and with a group of faculty members on the next day, delivered an hour-long research talk, and also presented a closed "chalk-talk" with just the department faculty regarding her planned research program. She slept for just four hours between the first and second day of interviews, and while her meetings were collegial for the most part, she described at least one faculty member as being "unpleasant" and "aggressive" towards her.

Amelia recalled being warned by her advisor and her chair not to bring up her husband during interviews, but at the same time, she found it impossible not to bring it into the discussion: "Becoming faculty is such a life-affecting decision, I think it would

be dishonest if I went through that whole interview and didn't bring up the fact that I am married. It's affected my trajectory a lot!" Thankfully, the institution where she accepted a position agreed with her. They have a dual career program in place for spouses and through it, connected her husband to another faculty spouse who is also a doctor. They also paid for him to be included in a second campus visit, once they had decided to make her an offer. This institution had the mindset that for Amelia to accept the position would be "a family decision," and she was grateful that they wanted to ensure that their campus and town were a place where both she and her husband would be comfortable living. In contrast, the one other institution where Amelia interviewed for a faculty position had no such policies in place, and reacted awkwardly when she brought up her husband, stating "oh, we can't pay for his travel!" when she suggested that he visit the campus with her, even though she had never asked them to do so. She stated that they "more seemed annoyed by the fact that I brought my husband," leading to awkward interactions that were clearly unpleasant memories for her. Her experiences revealed just how divergent recruitment policies can be at different institutions, and how some are more prepared to deal with families and dual careers than others.

Case 2: Olive

Olive is a woman in bioengineering who planned to graduate in May 2019. At the time of our interview in early Fall 2018, this was about two semesters away. Olive received her bachelor's degree in chemical engineering and worked for two years in the pharmaceutical industry prior to enrolling in the PhD program at MAU. Her work in industry helped her to realize her affinity for research and her desire to enroll in graduate school; her initial plan was to return to industry after completing her PhD. She viewed

the PhD as opening up doors in terms of her professional advancement and her ability to lead research in an industry setting.

Her experiences in the bioengineering program at MAU were not unique among the bioengineering students interviewed, but they do point to some unique and positive aspects of the bioengineering program at MAU in comparison to other engineering PhD programs at the university. For example, the bioengineering program at MAU offers a rotational program, whereby first year students are able to experience a few months of research in two to three different labs before they settle on a PI who they want to work with. This gives students some more information to work with before they lock themselves into working with an advisor who they are incompatible with for the duration of their program. Olive described this as giving her "a little bit more comfort signing on to work with them for five years."

The bioengineering department at MAU is relatively new and growing, is housed in a state-of-the-art building that just opened in 2017, and has a reputation across other engineering departments at MAU for being a very collegial and cooperative department. In addition, the department's graduate student organization is very well funded and organized, putting on regular social events, as well as research and professional development events that create a sense of community. As Olive put it, "everyone knows everyone." She also stated having "no problem knocking on any professor's door," even within a department that houses 42 faculty and 60-70 PhD students. There is a strong focus on welcoming the first year PhD students. She said:

> Coming in as a first year and thinking like, they do this barbeque and they want to get to know us. The first day of orientation they plan a happy hour so that current

> grad students come and the new students come and they kind of make an effort to meet you. . . . So it's very focused on the first year students, so it kind of fosters interaction between current students and old students. So because there are a lot of these events, I meet a lot of people.

These unique social aspects of the bioengineering program have given Olive such a positive view of the academy that she even expressed concerns that the program at MAU might have given her a skewed perception of what work at a university might be like:

> That's one thing that actually scares me. Is that if I go to another institution, if this is so unique to our department, what's it going to be like somewhere else? Is it going to be completely different, more competitive, or unsupportive and uncollaborative [sic]?

Olive is at once grateful for her very positive PhD experience, and aware that it might be unique in being so positive. This gives her some trepidation about what she might find at bioengineering departments at other institutions where she might work in the future.

As a PhD student, Olive became even more "connected" to her department than usual as elected president of the graduate student organization for two years. Her experiences with her PI and mentor have also been very positive, and she described being given enough structure to make adequate progress, and enough freedom to and autonomy to feel that she has grown as an independent researcher and is respected as a scientist in her own right. Olive described feeling "supported and not pressured," and being "grateful" to her advisor.

In describing the academic profession, Olive emphasized the importance of being able to communicate well with others on all fronts, including both orally and in writing.

This is something that she regards as her own personal strength. In contrast to most students interviewed, for whom the many hats the academic wears seem like a burden, Olive demonstrated an excitement for this multitude of roles. However, it was also evident that there was some nervousness about the need to multi-task, and the sheer volume of responsibilities that being a PI entails. Olive stated:

> In one way, I see it where it's like, you're doing the research that you want to do, you are mentoring students, you're helping them find their way. You're teaching; you have this amazing, flexible schedule. You're kind of your own boss. . . . And then the other side of it is like, well, you have to always work because it's on you. You're your own boss so it's on you to get money; it's on you to make sure everything happens; if something goes wrong, it's on you to fix it.

Even in someone excited about the challenges and variety of an academic career, one can sense a degree of unease and trepidation on Olive's part as she envisions all that an academic career would entail. She later expressed feeling that all the expectations that befall academics are "not realistic," and that she would be more confident about pursuing an academic career "if there was a way to lessen [the burden], so that it wasn't so much that you were expected to do." Even then, however, Olive displayed ambivalence about this stance, stating, "all of those things, I think, are what I find attractive about being a faculty member." In a way, the very elements that attract her towards life as an academic repel her and intimidate her.

When asked what specific experiences first excited her about the possibility of an academic career, Olive brought up her experiences as a TA through the faculty preparation program, and the importance of working with students and receiving positive

student reviews and feedback on her teaching. In addition, she recalled being approached by a professor at a conference and being told that she has "that thing," and should consider an academic career. It is noteworthy that in both examples, Olive brings up external validation and affirming experiences of being told that she has what it takes being important in cementing her resolve by giving her confidence in her ability to do the work well.

Olive has worked under a female PI who gave birth to her first child as an assistant professor on the tenure track at MAU. Although Olive acknowledged that her advisor was the perfect role model who "awesomely balances it all," she still fears that she will be unable to handle everything "as gracefully" as her advisor. Olive described her advisor being back on email days after giving birth. The thought of being a parent on the tenure track thus leads her to "fear not being able to balance family life" while at the same time excelling at her job. This apprehension regarding starting a family while on the tenure track was described as very stressful by Olive.

One of Olive's final reflections in our interview involved her perception that as a qualified woman in STEM, she feels that she owes it to herself and to other women to pursue an academic career. Given that she has an aptitude for and interest in the career, to her it would seem like a betrayal of her feminism to give up due to perceived conflicts with family life. Olive stated:

> I almost feel guilty being a female in STEM and then being like, well, I don't want to go into academia, even though I think I would really like it, because of a family. Or because I want to be a good mom and housewife. I feel like I am not feminist enough. . . . It's like I'm letting down other females.

These concerns about owing something to other women, or feeling a responsibility for advancing the movement of women into science, demonstrate that for at least some women, the decision to pursue an academic career upon PhD completion does not feel like a simple, individual choice. These women engineers feel themselves, for better or worse, part of something bigger than themselves, and like they owe something to other girls and women.

In preparation for an academic career, Olive participated in the faculty preparation program at MAU, which she described as helpful in familiarizing her with the different facets of the academic career and helping to build up experience in teaching that she would not have otherwise had through her program. She planned to begin applying to postdoctoral positions shortly, and viewed the postdoc as an opportunity to experience research in a different institutional setting, to get a few more publications under her belt, and to gain more insight into lab management.

Case 3: Hyun-Gi

Hyun-Gi is a man in mechanical engineering who was just weeks away from defending his dissertation when we spoke. As such, Hyun-Gi was actively engaged in a job search at the time of the interview, and described himself as applying widely for jobs in both academia (focusing on postdoctoral positions) and in industry. As a US permanent resident, Hyun-Gi described that certain jobs in government were closed off to him due to being a non-citizen.

Hyun-Gi faced both cultural and linguistic barriers during his time as a PhD student at MAU, and it was clear in our conversation that language barriers would continue to pose a challenge for him in entering the job market. For example, Hyun-Gi

experienced a lot of difficulty understanding and replying to my questions during the interview, which might pose a serious challenge for him during job interviews. In addition, he had not established networks through conferencing and membership in professional groups to assist him in his job search, a strategy that many of the engineering PhD students I spoke with seemed to employ. Instead, his primary job-search strategy relied on online research through commercial sites such as LinkedIn and Indeed. Finally, Hyun-Gi had not made very much use of the career preparation resources on campus. His only visit to the career services office had been a few weeks prior to our interview, and he stated that they "correct [sic] my resume and give [sic] me suggestions." He did not have plans to go back for help with job search strategies, or for interview preparation from which he may have benefitted. He also had not taken part in the faculty preparation program.

While Hyun-Gi's preference was for industry jobs due to their higher pay, he was also applying to postdoctoral positions, acknowledging that there are more of them and that they were less competitive than most industry jobs. He remained open to the possibility of an academic career whether he went the postdoc or the industry route, stating that a transition back into academia would be possible after several years in industry. Hyun-Gi remained open to the possibility of pursuing an academic career despite acknowledging, "it's difficult to be a professor" and that due to his difficulty with English, writing and publishing papers is a very slow and painstaking process for him.

Unlike the other two cases in the "close" group, Hyun-Gi was not as committed to an academic career. In contrast with the other two cases, he had also not exerted a lot of effort in making preparations for the academic career.

Conclusion

Examining the institutional supports for career preparation, a picture begins to emerge of the ways in which career planning for PhD students in engineering is loosely structured, with most students navigating on their own the preparation and job search process. The exception to this is the faculty preparation program available to PhD students at the school of engineering. The program necessitates an application, which means that only individuals with a specific disposition towards the academic career, and some degree of commitment to their career planning are likely to enter the program.

Unsurprisingly, students' distance from program completion has a bearing on their career planning and decision making, and on their perceptions of the academic career. Students who were more advanced in their programs held more consistent views of the academic career, having a more clear idea of whether or not it was for them. These students were less ambiguous in describing the challenges and demands of the academic career. In contrast, students who were more distant from program completion were inconsistent in describing the academic career, seeming at times both drawn to its perceived flexibility and freedom, and repelled by the long hours of work. These students also demonstrated a tendency to compare their work as PhD students to any previous work experiences that they had in industry or government, weighing working conditions, schedules, and organizational structures.

Students interested in pursuing academic careers at "mid-point" or "close" to program completion varied in their degree of commitment. However, for those making a serious attempt at securing a tenure track faculty position, preparation tended to begin relatively early in their programs. This set them apart from their peers interested in

industry or government careers, who tended to delay career preparation until much later on. The women interested in academic careers were particularly proactive and engaged in pursuing a course of action throughout their PhD programs that would set them up for success on the academic job market, and all of them were enrolled in the FPP. In general, students interested in the academic career were drawn by some of the very features and challenges of the career that other students found repellent, such as the opportunity to wear many hats, and to focus behind the scenes on some of the broader conceptual patterns guiding the research, rather than spending time at the actual lab bench. Thus a picture begins to emerge that potentially sheds light on some of the personal dispositions of students who choose to pursue academic careers.

Examining students' career decision-making trajectories over time begins to paint a picture of the career decision-making process. Underlying all of the different phases is a sense that students are engaging in information gathering about different career options and forming more concrete notions of what these different options entail. They go through a process of comparing different aspects of work-life that they can expect to experience in different institutional and organizational settings. The decision-making process begins to emerge as a continuous act of refinement, rather than one that occurs at a distinct point in time. At each phase, there is a similar process going on, but at later stages the process is more confined, directed, and focused within the bounds that students have created for their own choices.

As students draw closer to program completion, the need to start making concrete plans and to refine their career direction becomes more immediate. The students "close" to program completion therefore begin to engage in a more elaborate, deeper process of

decision-making than those who are at "mid-point" or still "distant" from program completion. For the majority of students, this entailed making a choice to pursue careers outside of academia, in either industry or government. As they near program completion, these students were active in drawing on peer, personal, and professional networks to gather information about opportunities available to them. However, students varied in the intensity of their approaches to entering the job market.

In contrast, as they near program completion, students who are highly interested in academic careers have, for the most part, devoted a lot of time to preparation. Most have been through the FPP and have in hands most of the documents that they need to put together application packages in advance of entering the job search process. Applying directly to faculty positions in the US requires a lot of juggling in terms of the demands on students' time during their busy final fall semester. Applying to postdoctoral positions is less demanding, and postdoc positions were described as being less competitive than industry and government jobs. Calls for applications to postdocs open up throughout the year, and the process is less involved than that for faculty applications, so there is less pressure to prepare application materials by a certain time. Some students therefore planned to delay applications to postdoctoral positions until they had submitted their dissertations.

In relating some of these preliminary findings to the study's conceptual framework, the university as an organization emerges as a site for information gathering, especially regarding the academic career. Although engineering PhDs are degree-seeking students, their paid role as research assistants, and the responsibilities that they are entrusted with in their PIs' labs mean that they experience the university as a workplace

for the majority of their time to degree. Through their direct experiences of work in a university setting, engineering PhD students absorb information about organizational structures and about faculty work-lives. Their time engaged in academic research for their dissertations is also an opportunity for students to learn about research tasks in academic institutions, and about their personal dispositions, aptitudes and preferences towards this type of work.

The next chapter engages in more depth with the interview data, presenting findings regarding how student experiences during graduate school shape their perceptions of the academic career and influence their career decisions. At the same time that students are forming impressions of what the academic career, they are also gathering information about other career options available to them. Gender differences emerge in the ways that men and women engineering students recognize organizational factors as potential barriers or deterrents to their pursuit of academic careers. In addition, gender differences in individual level dispositions, attitudes, and inclinations emerge, in light of students' increasing understanding and knowledge of the university as an organization. The lure of industry and government work is also discussed in the next chapter, presenting a more holistic picture of the factors that serve to both push and pull engineering PhD students in different directions as they are weighing their career choices.

CHAPTER 5: Experiences Informing Career Decision-Making

This chapter presents some of the experiences of the study participants both leading up to and during the progress of their PhD education at MAU. In inquiring into these experiences during interviews, the focus was on facts and events that could inform the career choices and decisions of PhD students.

Leading up to the PhD, it is relevant to understand the reasons why participants chose to undertake a PhD in engineering, and how they perceived a PhD to fit into their future career trajectories prior to embarking in the program. During the course of the PhD program itself, student experiences of the university as an organization and of scientific research in an academic setting likely shape their career decisions, especially regarding whether or not to pursue an academic career following the PhD program. This chapter also provides insight into what PhD students observe about their own advisors' and other professors' work, versus their perceptions of careers in industry and government sectors.

Although this chapter pertains most directly to how students' experiences of the university during their programs influence their decisions to pursue an academic career, it also touches tangentially on some of the personal factors influencing students' career decisions, including their personal dispositions, and external personal influences such as family. Additionally, differences between men and women students' experiences and motivations are presented here.

Leading up to the PhD

Prior Work Experiences

The women engineering PhD students in my sample were more likely than the men to have worked prior to applying to graduate school. In fact, every single one of the women I interviewed had worked at least one full-time summer internship prior to their PhD program. In contrast, only two of the men had ever worked full-time, with one of these comprising work as an intern in a lab the summer prior to commencing his PhD. Four of the women had had industry experience, one had experience in a government lab, one had experience in an academic lab, and one had been an entrepreneur in charge of her own business prior to entering the PhD.

As outlined in chapter 4, this pattern does not point to a broader trend among engineering PhD students across the United States. In a focus group discussion, women participants did confirm at least anecdotally that they noticed among their lab mates and cohort acquaintances that women at MAU may indeed have more work experience than men prior to entering their PhD programs. This bias may be a result of the MAU admissions process, it may reflect that MAU's programs do not attract the most typical engineering PhD students, or it may be a result of sampling bias for this study. Regardless of the underlying reasons for this pattern, one of the women participants suggested that for her personally, she had to experience work and see regular, working people who were PhD holders in order to realize that she too, was capable of attaining a PhD. It is possible, then, that for at least some women engineers, experiences in their undergraduate and master's programs are not affirming enough to give them confidence that they are cut out for doctoral study. It is only later, through work experiences, that

some women find the confidence and perceive the advantages of PhD study to their career progression. In contrast, the men students explained that though they may have wavered in their confidence at times, they found themselves pushing away or dismissing these feelings and opting to pursue PhDs in engineering straight after completion of their undergraduate degrees. They were able to overcome any insecurity despite reporting fewer research and work experiences than the women.

The pattern of women students in my sample having more work experience than the men merits some discussion because these differences could mean a different approach to career decision-making between the men and women participants in my sample. Having taken time to work before entering their PhD, the women in my sample were older on average than the men. For the women in my sample, the average age at their expected graduation from the PhD program was 33 years. For the men in my sample, their average age at graduation from the PhD was expected to be 28 years. The women participants were also more likely to be married or engaged than the men. Being five years older on average, having had previous work experience, and having to consider the work of a partner in a serious committed relationship could have implications for women's career decisions. Women in my sample could be more likely to seek out financial stability and a greater sense of certainty in their careers, or they could be more limited in terms of their willingness to relocate due to their partners' preferences or careers. Their previous work experience could also mean that women would have a better sense of their career fit and thus a stronger sense of direction in terms of knowing what sorts of jobs they would like to pursue following the PhD. In contrast, many of the men would be looking to enter their first full-time position, and might be more likely to

want to explore options career-wise. They might also be more willing to pursue a more uncertain and less stable career path, or display more risk-taking behaviors than the women because being younger and at an earlier stage in their professional and personal lives could mean that they feel they have more time before they need to settle down into a stable and financially rewarding professional position.

Reasons for Pursuing a PhD

Overwhelmingly, both male and female engineering PhD students expressed a passion for scientific discovery and the research process, alongside a sense of intellectual curiosity. The engineering PhD was seen was an opportunity to engage in more depth with scientific research, and to do so in a hands-on way. Many student accounts were along the lines of one student who stated, "I like learning, I like school, and I really like research, I like hands-on stuff. So I felt like graduate school would be a good fit." Despite this similarity in the affective dispositions of men and women towards prior to beginning the program, however, gender differences in prior work experience translated into a different sense of how the PhD fit into their future career aspirations.

The women, having had work experience, had a much clearer sense of what work outside of academia could entail, and about how a PhD fit into their career trajectory. Many of them spoke about their experiences in industry and government labs, about their enjoyment of the work, and about realizing at some point that they would hit a ceiling in terms of their potential for advancement if they did not have a PhD. In one example, a woman who had worked in a pharmaceutical company described how "the only people making formulation stability decisions were the people who had PhDs," and in wanting to have more research autonomy in industry, she decided to pursue a PhD. To women like

her, returning for a PhD was a way to advance in a research career where they already saw themselves as a good fit.

In contrast, many of the men entered the PhD because they had enjoyed research in their undergraduate institutions and sought to do more of it. A few of them also mentioned looking at engineering jobs towards the end of their undergraduate schooling and realizing through the application and interview process that they were not interested in entry-level positions for engineers with a bachelor's degree; they sought out a PhD in order to leap-frog over some of these less desirable positions. In one man's words, he got a PhD in order to "hop over some of those steps" and secure the job he wanted to secure. To men like him, securing a PhD meant being able to pursue more interesting research in a future job.

Experiences of Graduate Education

Relative Unimportance of Coursework

Although my interview protocol included questions about classes and coursework, participants reacted with confusion when I asked them questions regarding the impact of coursework on their PhD experiences. It became apparent that for engineering PhDs, classes are something that they must get through in order to reach the research stage, but classes were not considered an important aspect of the PhD experience. As one student put it, "coursework isn't such a big part of the graduate school experience." Students complete coursework relatively early, usually by the end of their second year in the PhD program. The bulk of their time is spent in the lab, and the majority of their technical expertise is acquired through hands-on research applications. Therefore classrooms and

learning environments outside of the lab do not feature strongly in discussions of the PhD engineering experience in this study.

Heterogeneity of the Graduate Experience

One of the underlying themes uncovered in the interviews was the heterogeneity of the engineering PhD experience. While there is a high degree of similarity in the overall structure and organization of the PhD program across engineering disciplines and departments at MAU, students ultimately spend the majority of their time in a lab that is run by their advisor or PI. This means that PhD students' experiences of academia and academic work happen in settings that are highly variable in key ways. A majority of participants used the word "unique" in describing the dynamics and atmosphere of their lab, indicating that they felt that their situation departed from some "norm;" yet no one described their research setting as "typical."

The make up of laboratory staff, the size of the lab, the degree of collaboration with others, the pace of work, expectations of hours put in, and of productivity or research output, were among elements of the day-to-day lives that students reported depending almost exclusively on the lab PI. There are no set rules or expectations from an institutional perspective, and as long as PIs are able to bring in sufficient funding to run their labs, hire students, and produce research, *how* they go about these activities is left up to their discretion. In the words of one student, the "relationships between advisor and graduate student is a very close relationship" and boundaries are often difficult to draw. A PI can be "involved in pretty much everything like your personal matters," especially if the lab or research group is small. This feeds into student perceptions that

within academic settings, one's experiences are very much subject to outsize influence stemming from the whims and personalities of those in power.

Although students have some say in determining the PI with whom they work during the PhD, it is clear that their options are limited. First, the PI must have funding available for an additional PhD student at or around the time when a student is applying to the PhD program, because as one student put it, graduate students "want financial support." Additionally, students will tend to limit their options to PIs whose research aligns with their own background, interests, and expertise. Lastly, the PI will have the final say in which individuals they choose to hire into their lab. Students also expressed that unless the department has a rotation program, it is virtually impossible to know what it will be like to work under someone until you actually begin. As one student put it, you "send in emails based on the lists on the website, you have no idea" who you might be working with in terms of their personality of working style.

One additional reason why the PhD experience is so heterogeneous is that there are no set expectations of what is required of a PI. Students do not know what is reasonable to expect or what to ask of their PIs in terms of guidance, mentoring, the frequency of one-on-one meetings, or the boundaries of their job expectations. The responsibilities and duties of PIs with regards to their students are not clearly defined and in a similar vein, the responsibilities and duties of PhD students with regards to their PIs and their labs are also not clearly defined. Therefore, students and PIs navigate on their own the process of establishing expectations and boundaries for each another. Since there is a clear power dynamic at play, students often find it awkward or difficult to have their voices heard in this process. Students who established good and comfortable

working relationships with their PIs simply deemed themselves lucky to have landed with a PI with a good management style or a reasonable personality.

The heterogeneity of the experiences of engineering PhD students is also evident in the very different laboratory settings in which each of them spends their time. As part of this study, brief observations were conducted at two aerospace labs, two bioengineering labs, and two mechanical engineering labs. The aerospace and mechanical engineering labs were convenient ones to visit because interviews were conducted either in these labs or in close proximity to them, leading to spontaneous lab visits that added to my understanding of participants' contexts. The visits to bioengineering labs were arranged in order to add this observational element in an engineering discipline where female representation is high compared with aerospace and mechanical engineering, which are traditionally more male dominated. In addition, bioengineering was the field of expertise for the highest number of my participants, so visiting these labs gave a good sense of the environment that many of my participants experience on a daily basis.

The lab visits demonstrated that even for students in the same department, the labs that they work in may be housed in different buildings and may look very different from one another, depending on the nature of the research and the nature of the facilities and space required for the experiments conducted. One of the only similarities among all the labs I visited was that they were spaces frequented and run mostly by PhD students, with the occasional presence of postdocs or other research staff. In all of the labs I visited, the PI was notable only by his or her absence.

The two aerospace labs visited were very different from one another, but shared some commonalities in terms of the overall messiness, the overwhelming male presence, and the impressive steel equipment. The first lab was housed in a large, open warehouse space shared by several labs. The student I interviewed worked in testing sonic waves that occur at very high speeds inside a long, steel cylinder capable of driving air at speeds up to Mach 5, or five times the speed of sound. The large warehouse was necessary for assembling and housing these large pieces of equipment. Desktop computers were set up on messy tables strewn with papers, pens, and notebooks right alongside the steel tunnel, so that the researchers could easily observe the experiments as they happened. Tall cylinders of pressurized air stood at one end of the tunnel, and on the other end a camera capable of capturing these very high speed events stood poised to record what happened in the tunnel. A 3D printer used to manufacture the objects used as projectiles in the tests was present, and many 3D printed objects ranging from small toy-like jets to tiny plastic spheres and bullet-like shapes were in clear plastic bags strewn around the space. Just meters away an even bigger steel tunnel was being assembled, capable of producing wind speeds up to Mach 8. Everyone visible, even in the neighboring labs, was young and male, all PhD students on that day, and the PI was nowhere to be seen. Students reported he rarely steps foot in the lab.

The second aerospace lab was a much smaller space, the size of a large room. It was a standalone lab, and was housed in an old, brick building. In this particular building, a large piece of equipment in the basement would make the entire structure rattle and shake when it was in use, and it would get so loud it would be difficult to have a

conversation. In the stairwell, photographs of men alongside aircraft and large pieces of lab equipment lined the walls on the way up.

Inside the lab itself, students worked on testing small propulsion devices in vacuum chambers resembling submarine capsules, to mimic conditions in space. The largest was about the size of a large television, and the smallest was about the size of a large cooking pot. Each of these vacuum chambers had a wooden bench set up next to it, presumably where the student in charge of the experiments on that piece of equipment would set up their computer to work. The lab was empty except for one young man, working on his laptop. Two of the workspaces were left abandoned by students who had recently graduated. The lab was in disarray with colorful wires, cans of WD-40 and assorted tools, like pliers and screwdrivers, strewn around the place. The students apologized for the mess and swore this was not the usual state of things. Their PI was on sabbatical at the time of the visit.

The two bioengineering labs visited were a lot more similar to one another in terms of layout, amenities and size. This is because the entire bioengineering program had recently moved into a brand new building that opened in 2017. All bioengineering labs are housed in this state of the art facility that is made of steel, brick and glass. The building is five stories tall, and each floor is identical save for the ground floor, where the lobby features an open space for students to gather at large wooden tables designed for collaborative work. The building is named after an alumnus who donated the funds for the new facilities, and there is a large oil portrait of him and his three sons on the first floor of the building, right under the department name. On the ground floor of the building there is a large replica of the invention that this alumnus is famous for, along

with a plaque that describes how his invention has been implanted in over 20 million people worldwide.

At each floor, one exits the elevator into a small lobby with a glass walled conference room that can comfortably seat approximately 20 people. The glass sides of the building allow for natural light to come in, brightening the environment. Moving past the conference room, there is a set of glass doors that require keycard access. These are the doors to the work areas for bioengineering faculty and graduate students, as well as the labs. The lab walls are all made of glass, allowing them to take advantage of the natural light, and also allowing visitors to easily see what is happening inside. Outside of the lab, an open office with individual cubicles houses all the graduate students who work in that lab space. Further down the hall, several identical faculty offices are lined up, followed by the next lab space with an identical arrangement of graduate student cubicles and faculty offices outside of it.

During the visit with one my interview participants, it was clear that this open floor plan fostered communication. As we walked by the labs together, several graduate students who were at work in their cubicles recognized and greeted her as we passed. To get from one side of the building to the other, one must walk by each of the faculty offices and many of the doors were open, so one can imagine that interactions may take place throughout the day. Also, when we walked by the conference room on the first floor, it was in use by a large group consisting of both faculty and graduate students. I was told that this was an event sponsored by the bioengineering graduate student society, and it was clearly well attended. In all the building spaces, there were approximately equal numbers of men and women at work. There was one interesting downside to the

open floor plan and the abundant windows, however. My participant noted that when working late nights, the absence of windows allows one to lose track of time and not feel as depressed about working late and seeing the sky grow dark. Also, in staying behind long after others have left on occasions when she worked late, she felt safer in the smaller and more enclosed space of her previous lab than in the large, open space of the new facilities.

The bioengineering labs looked a lot more like the stereotypical laboratories we envision when we think of the sciences. Those working in the labs wore white lab coats and had blue latex gloves on. Some wore protective eyewear. There were a lot more of the typical test tubes, Bunsen burners, and large fume hoods that one imagines in lab facilities. Visitors entering the lab were required to wear special gowns, and everyone wore a mask due to some experiments being conducted with harmful chemicals. There was much more of a semblance of order and cleanliness than in the aerospace labs. However the bioengineering students also stated that their PIs are rarely seen in the lab, unless a problem required their presence.

The mechanical engineering labs visited were all housed in the warehouse-like basement of an older brick building. The other floors of the building housed classrooms and department offices. The basement was used for moving in and storing large pieces of equipment, with an area that appeared built for trucks to drive in and drop off supplies. The labs themselves were walled off from the warehouse and lined the perimeter of the space. Both labs were completely windowless, and illuminated only by fluorescent lighting.

The first was a very busy lab and full of students working at different lab benches equipped with powerful looking microscopes and desktop computers. Here, while the majority of the 15 or so students were men, I also saw two women students. Although they were working on microscopes, most of the students were not in lab coats and few donned gloves. It appeared that most of the samples were pieces of materials that the students were studying. One room in the lab housed a large piece of equipment – the only electron microscope in the building. It was explained to me that students must reserve a time to work with that specific instrument. The lab manager was an older man, a full-time research staff member who looked to be in his 50s. He was present and working on a computer, the only figure of authority ranked higher than a PhD student that I encountered at any of my lab visits. Once again, I was told that the PI rarely if ever sets foot in this lab.

The second mechanical engineering lab consisted of a small office space where five desks lined three of the walls. Each desk had one working desktop computer, but there were also several unused monitors and extra chairs strewn around the room. The participant leading my visit explained that since this lab works primarily on computer models and analyses, they are at their computers almost all the time and do not conduct experiments. Given the many hours spent at their computers, they are constantly changing computer monitors in order to try to find one better on their eyes. The room was completely empty of people and I was told that students keep their own hours and these hours are often not regular. The fourth wall of the lab contained a small fridge, a microwave oven and a coffee machine, and it became apparent that the students often take their meals there, not leaving their workspace for many hours at a time. Once again,

the PI was only notable in his absence from the space. To the best of my interview participant's knowledge, the PI had never entered this space.

Isolation of Research Work

PhD work in engineering can be socially isolating. While there is some degree of interaction with other students during the coursework phase, once students begin engaging in their research work full-time, they generally have few opportunities to interact with individuals outside of their own lab. Even within lab settings, students are often consumed with tasks that they accomplish alone, and that require a lot of focus and concentration. So while there may be a sense of companionship in that there are other people around them in the lab, there is little occasion or opportunity for conversation, collaboration and interaction. Even where students' research work may pertain to the same project, they are each assigned very specific tasks and do not work together. As one student put it, "everybody is working on a specific project" and collaboration is hard to envision when each project is so distinct. It is often only in the weekly or bi-weekly lab meetings that students working in the same lab engage in longer discussions and share their progress with one another. Due to students keeping odd hours rather than a nine to five schedule, it is also true that lab mates are not always working the same hours.

The isolation of PhD students became very evident in the recruiting of participants for this study. The study design originally relied heavily on the snowball sampling of participants, under the assumption that participants would be able to introduce at least one or two other eligible participants into the study. When asked whether they might introduce new study participants, however, almost all of the students I interviewed seemed uncomfortable with the request. Many said that they were not in

touch with the other PhD students in their department, and were not comfortable approaching other PhD students in their lab. Others informed me that they did not have any friends in the program, and socialized mostly with connections they had made in off-campus settings. In the end, only three participants were recruited to the study through snowball sampling.

In addition to the isolating nature of research work, students also felt a sense of isolation stemming from their national identity, ethnicity and language. The engineering PhD programs at MAU attract a large number of international students, particularly from East Asia (namely China, but also South Korea), South Asia (especially India and Pakistan), and the Middle East. On more than one occasion, students I interviewed found themselves in situations where they were the only Caucasians, the only Americans, or the only ones who did not speak a certain foreign language. Women students also had the issue of being the only woman in the room, layering on an additional element to their sense of isolation. While none of the research participants seemed to be too concerned or bothered by these issues, they reported that cultural and language barriers, as well as a lack of shared affinities were an additional reason for not pursuing meaningful relationships with their lab mates and other members of their PhD cohort. Due to this, lab relationships were more like work relationships than friendships. Communications with others did not often extend far beyond polite small talk, and conversations pertaining to the everyday business of running the lab and completing research tasks.

The sense of isolation that PhD students described in their research work becomes relevant to their career decision-making because most students mentioned that one of the attributes that they plan to look for in their job after the PhD is the ability to work with

people. Many of the affective experiences that participants mentioned were factors in leading them to pursue engineering involved working in groups, collaborating with others, and being involved in projects that drew from the strengths of more than one person.

Informal Learning and the Importance of Networks

In interviews, it became apparent that engineering PhDs are expected to do a lot of learning on their own, outside of their required coursework. The specific research activities that students engage in call for a degree of specialization that cannot practically be addressed in the coursework common to all engineering students. Hence the importance of being versed at independent learning and "knowing how to learn" came up in several interviews as one of the keys to being a successful PhD student. As one student remarked, "you have to be willing to learn on your own." Through the interviews, it also became apparent that "knowing how to learn" involved navigating peer networks in order to identify individuals whose skills and talents one would want to acquire, and negotiate with them in order to be given the opportunity to acquire those skills from them.

Independent learning could take many forms for PhD students, from reading academic papers and textbooks pertaining to one's research, to learning lab techniques from more senior lab mates, and to seeking out people with expertise in one's area elsewhere in the department or in the university. More often than not, students had to rely on peer networks to supplement what they could not master on their own, rather than seeking out their busy advisors. While this seems to contradict the assertion that PhD research work is often isolating, it is important to understand that these cooperative instances of peer learning and problem solving did not happen often in daily interactions but rather punctuated specific points in time. For example, peer-to-peer learning was

very common when a first year PhD student first entered a new lab and had to be taught to use new pieces of equipment by more senior students in the lab. These interactions were often at the behest of the PI, who would direct a student in the lab to coach another one in a specific research task.

The need to tap into networks and locate specific talents or expertise arose when student encountered a problem new to them, specific to their research tasks and pertaining to an area in which no one in their lab had the required expertise. Sometimes, the problem might be so specific to their particular research task that even the lab PI might not be a good resource. Hence students were often left to explore the networks that they developed over time. This might entail asking others for a referral, in order to identify an individual with the specific expertise required. Once someone with the particular skillset of expertise had been identified, the student would contact that individual and negotiate some informal arrangement. This might mean setting up a time to observe them in a specific activity, or to discuss a theoretical problem. In other situations it might mean an exchange of favors, where the student might get help preparing a sample or using a specific piece of equipment and the individual who provided the assistance would be given credit in a publication or conference presentation.

Men students came across as more aware of using networks as an effective approach to informal learning. When asked about the role of informal learning and learning from peers in their PhD experience, for example, many women spoke only of the study groups that they had formed and used during the coursework portion of their PhD, in the first two years. Other women also mentioned learning from lab mates, but usually at the behest of their advisor that someone in the lab teach them a specific technique. In a

focus group discussion, women students stated that they would usually try to do things on their own as much as possible, and only turn to others for help or support if they absolutely could not figure out a problem on their own.

In contrast, men's experiences of informal learning went beyond these instances. In addition to study groups and learning under a lab mate at the PI's request, men spoke about strategies for identifying and pursuing individuals with specific pockets of expertise that interested them, or that would help to advance their research. They also spoke about the strategic exchange of favors in order to get work accomplished more efficiently.

While a mapping of networks falls outside the scope of this study, it is noteworthy that the men participants seemed more adept at navigating networks for informal learning than the women participants. It was not clear, however, whether the men had bigger and stronger networks than the women, or whether they were simply more aware of these networks and of their strategic approaches to using them. However in a focus group discussion, women participants did discuss the possibility that they feel a greater need to prove themselves and their competence as women in a space dominated by men, thus leading them to take on the burden of accomplishing independently tasks that men do not always feel the need to do on their own.

The Importance of Good Mentorship

The importance of good mentorship came up repeatedly in conversations with research participants. Ironically, but perhaps not surprisingly, those who emphasized the importance of good mentorship the most were also those with experiences of bad or toxic mentorship – currently or in the past.

One of the reasons why good mentorship is important is because the responsibilities of the PI are so loosely defined. It is really up to each individual PI to set the tone for their lab and determine the frequency of required meetings, and whether these are conducted one on one or as a group. In addition, PIs vary in the amount of direct supervision and guidance that they provide, and the degree to which they scrutinize student behavior, research progress and output. The students themselves seemed ambivalent with regards to what they expected of their PIs. Ideally, a PI who is a good mentor should be able to achieve a balance between being too "micromanagy" (in the words of one participant), and not providing enough direction and guidance. They are able to set a high bar without being unreasonable, and they are also able to adjust to each student's individual needs and personalities.

In emphasizing the importance of good mentorship, many students remarked that one of their key pieces of advice to new PhD students would be to seek out a lab with a good PI as being of foremost importance. A variation of Amelia's statement, "the personality of the advisor really affects the personality of the lab" came up in virtually every interview. Students remarked that their interest in the research being conducted in the lab would be a close second in choosing a mentor to work with, but that compatibility with the PI was most important. Students with bad previous experiences talked about doing their "due diligence" before deciding on a PI to work under, asking other students in the professor's lab about working under him or her. In addition, many students lamented most departments do not offer a rotation program like the one in the bioengineering department.

Realizing the importance of good mentorship had implications for students' approach to the job search. For students with prior bad experiences of mentorship, or bad experiences with people in positions of influence within academic settings, it was emphasized that in their job search, they seek out good superiors. These students mentioned that the personalities of the people working above them were going to be very important factors in deciding whether or not to take a position. Although not explicitly stated, this has implications for the academic job search. For example, many students described the academic job market as very competitive, and related that in seeking out an academic position, most applicants would not have a choice – most would have to accept whatever offer they received. This gives academic job applicants much less agency in selecting the colleagues that they will work with and under. This lack of agency gains even more significance in light of the perception from both male and female PhD students that academic institutions lack a good system for airing grievances and solving workplace conflicts.

No System for Airing Grievances

When students were faced with problems working under their PIs or within their lab, they described being faced with a series of less than ideal choices for handling the situation. These choices included transferring to another lab, leaving the PhD program altogether, confronting or negotiating directly with their PI, or appealing to the department and then the graduate school to step in and mediate.

The first two options mean a significant loss to the student, who would have to either give up their pursuit of a degree, or lose any time that they had already invested into their research. In addition to these practical difficulties, students intending to switch

labs would have to consider the politics of this, the impression it might cause on the department, the potential effects on the student's reputation and on their ability to remain collegiate with the professor whose lab they are leaving. In my interviews, the only student who made a switch from one lab to another was able to do so because the PI she had been working with passed away. In a focus group discussion, women students confirmed that transferring labs would be all but impossible, and would cost a student a lot of time in terms of having to recommence the research and data collection process, since the data that students collect belongs to their PI.

Confronting or negotiating directly with a PI can also be difficult, depending on the nature of the issue. Some students reported gaining the confidence with time to ask for things like more frequent meetings, or more research guidance. However, the situation was more complicated in cases where students were asked to complete work that fell outside of their responsibilities, or when the PI made unreasonable demands of students. Students described being hesitant to complain in these situations, or to refuse to do certain tasks, because they were keenly aware that their work environment and their ability to progress and graduate from the program was tied up with their personal relationship with their PI. One student described how he and his lab mates felt compelled to oblige when their PI requested help moving water-damaged "junk" out of his garage that had flooded on a weekend; another described the difficulty of getting out of an expectation that he teach a summer class for no pay, due to a mistake his PI had made with her budget.

Ultimately, students who experienced a bad situation with their advisor reported having few recourses and protections. Any action that they might take could leave them

in an awkward situation, or in fear of being retaliated against. Most students I spoke to therefore chose to put their head down and focus on the work, moving towards degree completion rather than changing a bad situation. In the case of Charles, the student who was asked to teach a course for no pay, appeals to his advisor and department chair did not resolve the situation. He ended up having to ask the office of the ombudsman to intervene on his behalf. Although the case was resolved in his favor, Charles described how the ordeal hurt his relationship with his advisor:

> I appreciated that she [the advisor] didn't try to force me to do this, or say I'm not allowed to talk to the graduate ombudsman, or just keep quiet or something. But she also didn't stand up for me or support me in the way that I expected. So the more I keep our relationship focused on the research, the better.

When asked why he thought his advisor did not step up to help him, and whether her rank might have been the issue, Charles stated that his advisor is a full professor at MAU. However, he perceived that a fear of petty retaliation could have been a factor in her not taking a firm stance. He expressed that "she probably didn't want to be stuck teaching on a Friday evening," demonstrating his awareness of interdepartmental politics and of the ways in which the department chair could potentially take reprisals. Charles also described how this ordeal hurt his relationships in the department at large:

> I don't feel like they [the department] appreciate my work very much. I don't interact with them at all – I don't have much interest to see them either; I don't know what I would say to them at this point. I don't think anything good would come of it since I've asked the graduate dean to tell them to stop bothering me. That's not conducive to positive interaction.

Overall, Charles' experiences serve to highlight how individuals who seek to resolve grievances with their superiors in academia can face very awkward situations going forward, leaving them feeling shunned or cut off for behavior that was deemed disloyal.

While Charles' case was unique in its severity, other students also experienced bad situations with their departments. Willa spoke to me of the difficulty of working with her department chair as president of the graduate student society for her department. She described him as being "adversarial, and rude, and condescending, and impossible to work with," stating that his interactions with her were "different from his interactions with others who were not female." Ultimately, she resigned as president of the graduate student society because she was frustrated with his antagonizing behavior, and because his personality made it impossible to foster a collegiate and welcoming environment in the department. Faculty would not attend any of the department social events that she tried to organize, since they wanted to avoid seeing the chair; and if faculty did not attend or encourage their students to attend, then the students did not attend either. Willa found that she had no recourse:

> There's HR in industry and you can anonymously deal with things. It doesn't always work that well, or course. But here, there's a really strong direct impact if you were to complain about somebody. So this whole issue that I had, he was being very nasty towards me and other women. There's nowhere I can take that and not be retaliated against. It's just not so straightforward what to do when you are in a situation that makes it more difficult for you to get your job done.

In realizing that she was not alone in her disdain for the chair, she also voiced her disappointment with the academic structures that allow a man with this kind of personality and misogynistic attitude to be promoted to a position of power:

> I mean tenure – this is something that I think comes down to tenure. That's something I think [sic] academia is not doing any favors for women. People can't be held accountable and they can kind of do whatever they want. In industry all of the men higher up were respectful of everybody. And whether that is liability – sure – but also, that's how you get ahead. You have to not only be successful but you have to be likeable and able to work with and manage all kinds of people. And here that's not the case. His [the chair's] group overlaps with multiple departments, one of which is heavily female – but he has no female students.

Experiences such as these leave PhD students under the impression that in academia, roles and responsibilities are very loosely defined. Furthermore, those on the lower rungs of the hierarchy are subjected to the whims and impulses of those in positions of power with little recourse; complaining may come at great personal cost, but at little or no cost to the individual who has made one's life difficult; the nature of the program trajectory makes it extremely difficult to leave your position for another one before you complete your degree, or reach the next milestone; in filing grievances, you may be subjected to petty retaliation tactics designed to make your life less enjoyable; finally, the system of rewards in academia does not prevent difficult personalities and discriminating attitudes from being promoted to positions of power, and from being protected from demotion or firing once there.

These impressions of the academy definitely color students' attitudes and impressions of what it would be like to enter academia in an entry-level, assistant professorship. While few students made the explicit connection to the academic profession, it was clear that at some level the idea that there are a lot of complicated politics and difficult personalities at work in the university setting came up often in interviews with students.

Mismatch Between PhD Education and Academic Career

Both men and women described the skills important to the work of a PI in ways that highlighted a mismatch between the PhD education they were receiving and the academic career in several key areas. The main issues concerned the lack of managerial experiences and training for PhD students, and few opportunities and experiences of proposal writing, teaching and mentoring work. This mismatch made the prospect of entering an academic career even more daunting, since PhD students reported not feeling prepared to fulfill the many different roles that the PI takes on in academia.

From participants' descriptions of their PhD programs, it became clear that the graduate education of engineers focuses almost exclusively on building their technical capacity and the ability to undertake independent research. Once coursework is completed and qualifying exams are over with, engineering PhD students are only required to focus on the research work that will culminate in their doctoral dissertation. Pursuit of other activities that can result in the learning of complementary skills such as leadership, organization, management, teaching, mentoring, and grant writing is not actively discouraged, but is left almost entirely up to students to initiate. Since these pursuits compete for time with research tasks necessary for progress to degree, few

students prioritize them. However, for students with an eye on pursuing academic careers, these experiences can be especially relevant.

Pursuing learning opportunities in the leadership, organization, and management skills central to the work of a PI in academia is difficult as a PhD student. Although some students reported that their PI gave them opportunities to take on a leadership role in the lab, this is very dependent on the PI. For example, some advanced PhD students may be tasked by their PI with keeping the lab supplied, and putting in orders for equipment and materials, while balancing the budget. However, other PIs might assign these tasks to other research staff or postdoctoral fellows, or take them on themselves. As a result, many of the students interviewed for this study reported not having had opportunities to develop the skills to effectively run and manage a lab while in graduate school.

Students with a desire to pursue academic careers described an interest in observing their PIs at work, paying attention to their delegation of tasks and to other aspects of their lab management, and noticing their time management practices in order to learn. Pursuing postdoctoral experiences following the PhD was also described as an opportunity to gain some of these experiences, and several students described the postdoc as an opportunity to learn more about lab management and to receive leadership training.

Proposal writing for grants to secure research funding was another activity that students described having little to no experience of. While some of them described having read through proposals, or contributed to writing small sections, none of the 20 students interviewed had ever been involved in fully developing and writing a proposal. In contrast with the PI's managerial and organizational tasks, proposal writing tends to

happen behind the scenes and is not easily observable. Students described it as a very involved, lengthy and intimidating process that is very high stakes for PIs, and where the success rate can be very low. The only activity that students described as being an opportunity to practice similar skills independently was the process of applying to research fellowships to secure outside funding for their PhD research. These fellowships are highly competitive and prestigious, and many have very involved applications, leading students to compare them to the proposal writing process for grants. For students intending to pursue academic careers, however, postdoctoral positions were once again seen as key opportunities for developing proposal-writing skills.

At MAU engineering PhD students are not required to undertake any teaching as part of their graduate education. The graduate assistantships that students take on are entirely devoted to research activities, so most PhD students have only informal opportunities to teach or mentor. For example, several students reported being asked to do short guest lectures in courses where their expertise was relevant, or to lead short workshops for students and faculty in their department on a specific technique they had become proficient at. Some students found opportunities for ongoing mentoring of undergraduate students through involvement in undergraduate organizations and clubs devoted to engineering. Again, these opportunities tended to compete with PhD students' research, and only few students pursued them.

In some cases, PhD students had opportunities to supervise or mentor undergraduates working in their labs, but the nature of this activity could vary widely depending on how the lab PI viewed the role of undergraduates. For example, in many labs undergraduates are brought in to do the "busy work," performing uninteresting tasks

that require little but cursory supervision on the part of graduate students. In other labs, undergraduates were brought in to work on independent research projects led by the PI. In these cases, undergraduates might turn to graduate students on an informal basis for help and guidance. In these types of arrangements, graduate students might simultaneously find the work with undergraduates interesting and rewarding, but also an annoyance or distraction from their own research tasks. Only one student out of the 20 I interviewed described working under a PI who was very deliberate in using undergraduate students in his lab as a learning experience for PhD students. In this lab, PhD students who wanted experience in mentoring and supervising research could take it upon themselves to interview and recruit undergraduate students to work on independent research projects designed and supervised by the PhD students themselves.

The only more structured way of obtaining experience as a teaching assistant (TA) was through enrollment in the faculty preparation program at MAU, a special program designed for engineering PhD students considering the pursuit of an academic career. As described in chapter 4, the FPP does require that enrolled students undergo two semesters in a TA role. This is deemed sufficient exposure to teaching and what it entails, and helps the students in the faculty preparation program to begin building a teaching portfolio for use in academic job applications.

The unimportance attributed to teaching and mentoring in the engineering PhD programs at MAU serve as a reminder to PhD students that these activities are an afterthought in the academic careers of their PIs. It is ironic that for many students, teaching and mentoring undergraduates were the highlights of their graduate experiences.

Student perceptions that professors "put teaching on a backburner" help to explain why many students do not perceive academic careers to be attractive or fulfilling.

Overall, both men and women students pointed out similar areas of concern in the mismatch between the skills and aptitudes that they were developing through their PhD education and the skills necessary for success in an academic career. However, there were some important differences in how men and women students perceived their ability to overcome these gaps in their preparation. One observation that might have implications for career decision-making, for example, is that men tended to reduce some of the challenges to pursuing a career in academia, and the gaps in their experience in ways that made them seem relatively easy to overcome through greater exposure, experience and practice. For example, in noting the importance of time management for academics to successfully juggle their many roles, men pointed out that time management workshops were available to new faculty. To men, postdoctoral experiences were a straightforward means to help them bridge gaps and "check the right boxes" in terms of publishing more papers, and gaining experience with proposal writing. In contrast, women were much more likely to compound worries in an area like time management to further worries about striking a balance between a career and family. Worries about their ability to succeed in grant writing were exacerbated by women's concerns regarding their ability to provide secure funding for future PhD students working under them. I will broach this in more detail in my discussion, along with the implications of this kind of thinking to the career decision-making processes of men and women.

Haphazard Approach to Career Preparation

Interview participants described their approaches to career preparation and for entry into the job market in ways that were inconsistent and unsystematic. For the most part, PhD students in engineering were so focused on their immediate research responsibilities that they tended to postpone thinking about their careers for as long as possible. Career planning was not prioritized because it is a time consuming endeavor that competes with more immediately pressing demands. Even students set to graduate in just a few months were yet to begin actively engaging in preparations.

Along with this tendency to delay career preparation was a tendency to not make use of university career services, despite the fact that the school of engineering boasts its own dedicated career services office. Students related that although the content of many of the workshops seemed relevant and interesting, they simply had not made the time to actively engage with the services. Two of the students who planned to graduate within two months of the interview reported that they had made use of resume review appointments with a career counselor, and had found the appointment helpful. This pattern supports the idea that for many PhD students, preparation for the job search is not a priority until entry on the job market is imminent.

There were few exceptions to the overall pattern of delaying career preparation. Scott, a man in aerospace engineering, reported making a concerted effort to "remain connected to the real world" throughout his PhD program, and not completely lose sight of the job market by cultivating his undergraduate network and remaining in touch with friends who work as engineers in industry. The other notable exceptions constituted

students in bioengineering, and students enrolled in the faculty preparation program at MAU.

Bioengineering students benefited from an active graduate student society in their department that hosts frequent career workshops and events. These department level career development events were mentioned by all six participants in bioengineering as being extremely helpful due to their high degree of specificity and relevance to bioengineering PhDs. These events were well attended because students not only enjoyed their relevance, but also enjoyed the opportunity to network with faculty and alumni from their department. These highly specific events stand in contrast to students' experiences of university level career services, and even the generic engineering career services, that are perceived as not being specialized enough.

There is a sense among students that the PhD job search is so unique and specialized that university career services events and personnel may be unequipped to adequately support them beyond the basic resume review and editing. As an example, students described the recruitment of PhDs, especially in industry, as highly specific and technical; in contrast, industry recruiters sent to university career fairs are not usually trained to identify that level of technical expertise. This acted as a deterrent to students attending future career fairs, or making more use of university career services. Also, university career counselors were described as not being specialized enough in the technical and research expertise that engineering PhDs have to offer, and thus unable to help students communicate this expertise on resumes and cover letters.

Students in the faculty preparation program at MAU benefitted from a structured program geared at preparing students interested in an academic career. Enrolled students

receive guidance and assistance in preparing the materials necessary for their application packages to faculty and postdoctoral positions.

With the exception of bioengineering students and those in the faculty preparation program who opted to pursue academic careers, then, the majority of engineering PhD students at MAU reported finding themselves unable to reliably access career preparation services that are relevant and specialized enough. As a result, they approached career preparation and the job search process in informal and unsystematic ways. Engineering PhD students reported turning to their own peer networks for career advice, rather than to their advisors, professors, or career services personnel. They reported finding it important to join professional groups and to network at professional events and conferences. Some students reported purchasing or reading books related to the PhD job search, or using online tools and questionnaires to identify possible careers.

The haphazard and informal approach to career preparation and entry into the job market has implications for career decision-making processes. Since many students who are close to PhD program completion had not yet actively embarked on the job search, and at least one student who was just weeks away from graduating was yet to secure a job interview, it stands to reason that many students may leave the program unemployed. In fact, at least one student planned to take a few months off following receipt of his degree, reporting that he had little urgency to find a job.

In stumbling onto the job market in this way, PhD students may not be setting themselves up to pursue academic positions, with most university departments recruiting for assistant professorships many months in advance of the appointment start date. The academic profession may also be less forgiving of time away from research and

publishing, making it more difficult for students who leave the job search to the last minute to be competitive applicants for academic positions.

On the other hand, it is possible that the haphazard approach to career preparation and job searching ends up making it more convenient to apply for jobs in government and industry sectors, where positions are being posted more continuously, and where the job application process is less involved. For PhD students who have not put much thought into career planning until they are very close to graduating, the academic job search is bound to seem very daunting, with jobs in other sectors thus becoming the default to which students apply.

The Lure of Industry and Government

Industry and government jobs appeal to engineering PhD students for a variety of reasons, most of which stand in contrast to students' bad experiences of academia, and their bad impressions of the academic career. The lure of careers outside the academy stems primarily from the opportunity that these sectors provide for PhD graduates to focus more exclusively on research and (especially in the case of industry) to work on products that have more practical applications. However, my participants also expressed a desire to explore what research looks like outside of academic settings, particularly if they had never had work experience outside of academia, which was the case for most of the men. Students also reported that outside of academia, things are not so reliant on a single individual which is the case for the lab PI in academic settings, making for a more collaborative, team-based working environment. These collaborative structures also mean that benefits such as paid time off and parental leave are easier to take advantage of outside of academia. In addition, the work culture outside of academia strikes PhD

students as having more defined time boundaries, operating around a more typical nine-to-five schedule. Finally, pay is typically better, the career trajectory is less uncertain, and individuals feel a greater sense of agency in determining where they will land and whom they will work with. To most of the interview participants, these advantages made careers outside of the academy a "no-brainer," and many could not fathom wanting to work in academia given the perceived advantages in these other sectors.

Opportunities to Focus on Hands-On Research

Most notably, students stated that careers in industry and government allow engineers to stay in touch with their research in more hands-on ways. Research positions in industry and government are perceived to allow engineers to focus on research, without getting sidetracked trying to secure funding, procuring and maintaining equipment, or doing other unrelated administrative or teaching work. This is how Charles, who had done a two-month internship in industry described it:

> The content of the work was similar to what I do here [at the university], but I found it to be a lot less stressful . . . because there were other people to support my work, to get samples for me, to do maintenance, keep the equipment running. . . . So all I have to focus on is the science, and doing what I do well.

Researchers in industry are perceived to be able to focus on what they are really good at and enjoy, while specialists who focus on other areas support their work, reducing the need to juggle so many competing tasks.

The engineering students interviewed also expressed the feeling that outside of academia, and particularly in industry, they could remain more connected to the practical applications of their research, and see an actual end product developed. In contrast, they

reported feeling that their work at the university lab is many steps removed from an actual end product or application, and that they might only see their science applied to actual product development many years down the line. This was of significance because many of the students interviewed were idealistic in terms of their desire to bring about positive changes, such as improving quality of life for people. They expressed a desire to do research that could help others and advance society meaningfully, and for many the products of academic work seemed too removed from the impact that they wished to have.

Exploring Research Work Outside of an Academic Setting

For some of the men participants in particular, exploring work in industry or government following the PhD felt necessary. Since none of them had previous work experience outside of academic settings beyond brief internships, they expressed not knowing enough about what research looks like outside of an academic setting. Many of the men students emphasized that this would be their first time actively seeking long-term, full-time employment, and that they might need to try more than one job in order to assess their fit and determine their career trajectory.

Interestingly, almost all of the men who were still open to the possibility of academia seemed confident that it would not be a problem to transition back into academia after some time spent working in industry or government. Several of them noted that they knew professors in their respective departments who had successfully done so, and expressed the belief that experience in industry or government could better prepare them for the managerial duties required of a PI in academia. These students mentioned that gaining experience leading research projects and managing teams would make the prospect of entering an assistant professorship less daunting. In addition, they

felt that experiences outside of academia would give them broader insight into the types of research work being done, and better prepare them to initiate and pursue new research directions when running their own labs. So to men students in particular, experiences outside of academia were deemed important in filling gaps in their PhD education and better preparing them to be academic PIs in the future.

In contrast with the men, most of the women participants had more definite career plans in mind, and only one of them mentioned the possibility of starting out in industry or government before transitioning back to academia. Most women I interviewed had already made a more firm decision to pursue either academia or careers outside of academia. This greater clarity regarding their career trajectory might have stemmed from the women participants being, on average, older than the men, and having more work experiences.

The impression on the part of some students that there is a relative ease in transitioning back to academia after time in industry or government is somewhat misguided. In informal communications with two department chairs at MAU, I learned that although a transition back into academia is possible, it is not always straightforward, particularly for engineers employed in industry. Time spent in industry rarely yields academic publications, due to the proprietary nature of the knowledge produced. In contrast, some government positions can facilitate a transition back into academia because the government does publish at least some of its research results. Engineers transitioning back from industry to academia therefore usually spend a few years in postdoctoral positions in order to produce publications that allow them to go back on the academic job market. All of the students who aspired seriously to an academic career

stated that they would be pursuing postdoctoral appointments following graduation from the PhD. It is likely that these students knew how indispensable it is to have postdoctoral experience in the current market for tenure-track professorship positions.

When students expressed the need to explore alternatives to academia before possibly returning and settling into an academic career, the students were unconsciously referencing the linear nature of the academic career. Once entering a highly competitive, tenure track position in academia, one may feel bound to progress in working towards tenure and climbing the academic career ladder without a true possibility of exploring other options. The lock-step nature of the career trajectory in academia, and the inflexibility of trying out the profession in order to assess fit may make this career trajectory less appealing to students, especially those who have never explored careers in other industries. It seems easier to students to explore career options and then possibly return to academia, than to do the reverse.

Opportunities for Collaborative Work

Aspects of the work culture in industry and government sectors appeal to engineering students in several ways. First and foremost, most engineering PhDs experience a sense of isolation in academic research work. This sense of isolation is at odds with some of the affective experiences of working on collaborative projects in design and research that were described as important hooks that first led students into the sciences and into engineering in particular. Experiences of isolation as PhD students can thus lead individuals to seek out the more collaborative research process and the opportunity to work on research teams, by pursuing careers in sectors outside of academia.

The collaborative work arrangements present in industry and government strike students as advantageous in several ways. In working in research teams, students described being able to take on leadership roles in the tasks that they are best at, and being able to step back to allow others to take on tasks that they perform better. This gives those involved the sense that if something goes wrong, the stress and blame do not fall on only one individual's shoulders. Through interviews, it became clear that failure is more common in research than those of us who are not in the research sciences might imagine. Time and time again, my interview participants stressed that in dealing with repeated failures, it is very important that PhD students demonstrate qualities such as grit and persistence, because they often find themselves working alone and having little support to fall back on when things go wrong. A lot of stress and self-blame can come from failing repeatedly on one's own, and it requires a lot of strength to pick up the pieces and make repeated attempts. In contrast, failing as a team offers opportunities to share these difficulties and stresses among several individuals, and work together to motivate one another in crafting a solution. In a focus group discussion, women also mentioned that in collaborative work there is a sense that the project is still moving forward and progressing even if you experience some failure as an individual, so there is some comfort in knowing that your blunder is a small hiccup within a bigger whole.

In addition to the supportive environment that attracts students to work more collaboratively, there are added structural advantages to being part of a team. Holding a smaller share of the responsibility for any one project or endeavor means that researchers in industry and government are more easily substituted than the PI in academia, who is solely responsible for running his or her lab. The advantage of a more collaborative

structure is that researchers can take paid time off from their work, and take advantage of benefits such as paid parental leave. In interviews, several students spoke about the importance of having paid time off, and of parental leave, as if they were unaware about such institutional policies at MAU.

Participants reported not witnessing their advisors taking time off from their work or taking parental leave, leading them to conclude that these policies either do not exist, or that their PIs are unable to take advantage of them. Students were ignorant even when it came to policies ruling their own graduate assistantships. When asked if they were aware of an institutional policy that allows graduate assistants to take 10 workdays of "Time Away From Duty[1]" each year, for example, only one out of 20 participants replied in the affirmative, while another was aware of having vacation days but unaware of how many. Although several of the participants reported having taken at least some time off since beginning their PhD program at MAU, some reported being met with resistance or

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[1] Policies governing graduate assistantships at MAU are worded in deliberately vague terms that emphasize the liberty afforded to graduate supervisors in making determinations regarding things such as paid time off. Although the policy states that "Graduate Assistants working full-time on 12-month appointments may have time-away from their duties" and that 12-month assistantships carry the "expectation that the GA will be allowed 10 workdays" off, the exact terminology employed is that of a "collegially supported absence," implying that it is really up to the supervisor (in the case of engineering students, the lab PI) to determine whether the time off is possible, when it is possible, and what is considered "reasonable notice" for the request.

reluctance on the part of their advisor. Others reported being made to feel guilty when they took time off. All of this contributed to a general sense that academic research structures are not conducive to allowing PIs to take paid time off for vacation or for childbearing.

A more firmly bounded, nine-to-five work schedule also appealed to students, who tended to describe academic work as a stream of never ending tasks that compete with other priorities, like family and social life. In contrast to research in an academic setting, students described research in government and industry as being work that doesn't follow one home. This desire to be able to "put the work down," in the words of some students, did not stem from a poor work ethic. In fact, all of the interview participants described themselves as engaged, productive workers who feel a true passion for the research that they do. None of them described themselves as competitive, per say, but they did describe being committed to producing high quality work, and to setting high standards for themselves. Paradoxically, it is perhaps *because* of this committed and workaholic personality that engineering PhD students desire a workplace that not only allows but encourages them to step away from the work at the end of each day. Several students worried that they would have a tendency to continue to work long hours and into the night in a setting where the work is not well bounded enough. None of them shied away from the certainty that in industry, tough deadlines might have to be met and long work hours might be required on certain occasions. However, there was a sense that these long hours had a definite purpose and were bound by some achievable goal, in contrast with academic work where the end line is never in sight.

Job Market and Salary Considerations

Beyond these major attractions of industry and government work, there were several other positive factors associated with work in these sectors. These factors were of secondary importance, but they do relate to PhD students' expectations of the job search, their sense of agency while on the job market, and their predictions for how the first few years of their careers would be like.

As related to the job market and the job search itself, students remarked that there are many more openings in industry and government than there are for tenure-track jobs in academia. Although the most desirable jobs in these sectors are highly competitive, they are not perceived to be as competitive as academic positions. The variety of industry and government jobs is also attractive; students remarked that they could work in a variety of roles, from research and development to product design, product safety testing, or quality control. Therefore, students perceived higher chances of exploring roles and finding work that they enjoy outside of academic settings.

The greater number of openings in these sectors, especially in industry, also gave students a greater sense of agency in terms of selecting a desirable location or determining whom they want to work with. Both men and women students expressed the wish to find employment in specific locations or regions, for reasons such as being near family, personal preference, or to remain near a spouse or partner. In addition, students emphasized the importance of finding a good fit in terms of the personalities of the people they would be working with. This desire for agency in determining location and personal fit is more conducive to a job search focused on industry and government jobs.

While none of the students remarked on this directly, the desire for agency in determining the nature of one's work and whom one works with speaks to the greater ease of quitting or transferring from one's position in industry or government. Students remarked that once employed in industry or government, they might be able to transfer internally to a different project or department if they did not initially enjoy what they were working on, or whom they were working with. Working in a large company with multiple locations could also mean flexibility in requesting a transfer to a different location in the future. Also, the greater availability of positions could mean the agency to quit a position in one company and apply elsewhere if one comes to feel unsatisfied for any reason. This stands in contrast to the sense of being locked into a position in academia until one reaches the next career landmark, such as tenure or promotion.

Students did not directly express a desire for the greater certainty in career progression in industry and government settings. However, many of them did remark on the uncertainties inherent to a career in academia, including the difficulty of securing a position in the first place, and the uncertainties of the tenure process. Additionally, although several students did mention the higher salaries in industry and government sectors, this came almost as an afterthought, and was not one of their primary motivators in pursuing positions outside of academia. It is almost as if many positive factors exist in pursuing alternatives to academia career-wise, and on top of all that, industry also offers higher salaries and a greater sense of security in career progression.

One of the only drawbacks that students expressed to working in sectors outside of academia was the impression that there is less freedom to pursue whatever research they want to pursue. For students in aerospace engineering in particular, there was the

additional concern that a lot of the industry and government jobs available are tied to the US Department of Defense, leading to moral and ethical concerns that their research may ultimately be used for military purposes that are counter to their personal values. However, students expressed that there is still significant freedom within the constraints imposed by the clients, the company, and any outside partners. To some extent, students consider that academics are also constrained in the sense that they must pursue research areas for which funding is available. On the balance, sectors outside of academia offer many positive factors and few drawbacks.

Impressions of the Academic Career

Many of the factors repelling students from academic work stand in direct contrast to the nature of research work in industry and government sectors, as they perceive it. In describing what the academic profession entails and what the role of a PI is in an academic research setting, the overwhelming consensus was that PIs do not actually do hands-on research. PhD students in engineering perceive that their PIs are consumed with administrative tasks, meetings, teaching and mentoring duties, and pursuing funding opportunities through grant writing, and are thus not actually very involved in research. While they are the ones who identify broader research trends and define the overall direction of a project, it is the graduate students, research staff and postdocs working under them who actually plan and execute experiments, collect and analyze data, and keep the labs running. The PI oversees these processes and accompanies them, manages them, ensures continuous funding and sets the tone in terms of the pace of the lab and the research productivity. In addition, the PI is the ultimate

technical expert with in-depth knowledge of the research area, and is available to help with experiment design and analyses when problems arise.

It is ironic that in discussing aspects of academia that were unappealing to them, most engineering PhDs expressed their view that being a professor at a research institution would actually distance them from the very research processes that attracted them to embark on a PhD in the first place. This was most evident when students were asked about the qualities and skills most important to a successful PI, and many of the responses focused on managerial and organizational skills rather than research.

Beyond describing the work of a PI as managerial, students also compared the PI to the CEO of a small company. This analogy made sense to students because of the complex role of the PI in establishing a niche for the lab's research, procuring and managing funds, hiring and training research staff and students, and ultimately producing in the form of papers, conference presentations and, sometimes, physical products that could be patented and marketed. In another sense, the PI is largely responsible for establishing the culture of each lab, along with things like schedules and expectations for hours kept and research pace and productivity. The analogy of the lab as a small research enterprise with the PI as the chief executive also worked when students thought about entry-level assistant professors as being entrepreneurs in charge of a start-up company. In fact, academic job offers in engineering include what is called the "start-up package," which consists of lab space and a pool of money that can get a young professor started when he or she first begins at a new institution. PIs in engineering are thus executives in the small research endeavor that is their lab, and their success is tied to the lab's productivity and output in much the same way that the CEO of a small company is.

When tasked with describing the typical day of work for a PI in academia, students expressed a high degree of admiration and awe for the amount of work that their PIs are able to complete. Along with the awe came a sense of feeling overwhelmed and unable to fully understand how one is capable of doing so much. Students would describe days packed with meetings, administrative duties, teaching, mentoring, and endless emails – and come 5pm the PI wouldn't have done any work yet!

The sheer amount workload means that PIs are never truly off the clock. Students described receiving responses to their emails at all hours of the night, and many guessed that their professors do not get more than five to six hours of sleep on a regular basis. The flexibility of academic work is thus a double-edged sword; although it is enticing to envision a job in which one is able to leave early to care for a sick child or loved one, or to easily rearrange one's schedule, it also means that one is seldom able to fully disconnect. Students described that academic work can extend late into the evenings, as one tries to get ahead of administrative tasks and emails, and spends hours finalizing grant proposals or grading student work. This lack of boundaries was unappealing to most students due to the stress and competitiveness it can breed.

These features add up so that academic work ends up striking students as a never-ending task that competes with other aspects of life including family and sleep. Though students acknowledged that a certain prestige comes from being a professor, there was also a sense that academia can be a thankless field to be in, where success comes at great personal cost.

The variety of work that academics engage in led many participants to describe professors as "wearing many hats." For many participants, the majority of these hats felt

unappealing, and would not allow them to focus on the research work that they enjoy the most. Interestingly, teaching and mentoring were activities that many students actually claimed to enjoy. However, because their programs do not require that students teach or TA, and because students perceived their advisors to "put teaching and mentoring on the backburner," students did not perceive that an academic career would allow them to teach and mentor students in a way that they would deem to be fulfilling and meaningful.

The pressure to fund raise by applying for grants on a virtually continuous basis was another unappealing aspect of the academic career. Students estimated that their PIs spend approximately 30 to 50 percent of their time writing grants, something that many expressed would not be enjoyable to them.

In addition to the amount of time spent on grant-writing, students found this activity to be very stressful and high stakes. Writing and securing grants is the only means of securing funds to guarantee the continuity of a lab's research and productivity. In addition, the external funding that a PI secures determines their ability to pay their graduate students and other lab staff for the duration of their contracts. Ultimately, if a PI is no longer able to pay his or her graduate students, these students may be unable to complete their PhDs. The pressure to guarantee the well being of the students working under them was a source of significant anxiety for students interested in pursuing academic careers, particularly the women students.

Many students expressed finding it difficult to envision securing sufficient money from writing grants early on in their careers, which is when the pressure to produce is greatest. With research output linked to funding, and the ability to secure funding being linked to a history of strong research output, it is intimidating to enter the process as a

young PI. The students who had a stronger understanding of how grants worked explained that young professors would "piggyback" on grants written by more established researchers, allowing them to cement a stronger track record of securing funding and producing research in order to be able to apply for grants more independently later on. In this sense, a young professor's ability to forge relationships and networks within their department or university would also be important in the early stages of his or her career.

Students also brought up a degree of distaste with the grant writing process. To some extent, researchers who are "riding a wave" in terms of conducting research in an area that is currently popular or "in demand" will be able to secure funding with a lesser degree of scrutiny as to the quality of their work. Also, PIs who are more adept at "making the sell" or promoting their research in the right circles will be more successful at securing funding, something that seemed at odds with the academic quest for truth, or some of the higher and more noble purposes of doing research for the sake of expanding knowledge. To some extent, industry struck the students as more honest and straightforward than academia in its research goals, which are tied to the development and marketing of products that can be sold.

Students also expressed distaste in realizing that too much of an academic's worth to their department is measured in terms of the amount of grant money that they can bring in. Students expressed that a PI able to bring in competitive grants would be forgiven for all sorts of bad behavior, including bad teaching evaluations, being abusive and hostile towards graduate students, and creating bad working environments in their labs. This ties back to the idea that academic structures of rewards and promotions can cause toxic

personalities to be promoted to positions of power, leaving little recourse for those working under them.

Students were almost unanimous in describing the academic career as highly competitive. Many features of academia contribute to this, including the hypercompetitive job market for professors, the hypercompetitive landscape for securing grant money, and a job not bound by a nine to five schedule. As some students described it, it is not sufficient to be great at science and put in 40 hours per week, because others are great at science and willing to put in 80 or 100 hours per week. This means that to remain competitive and successful means to work as much as one can and never feel that it is quite enough. Students were also aware that many more PhDs are produced than there are tenure track academic positions, so even highly competitive candidates with years of postdoctoral experience are not guaranteed a job.

This means that alongside competitiveness there is also a sense of uncertainty and risk in choosing an academic career path. Almost nothing can guarantee that years of hard work and sacrifice at a low pay, both in graduate school and in postdoctoral positions, will amount to a tenure track position. Even once on the tenure track, the grueling process of working towards tenure comes with the potential for failure. The thought of putting in all those years of work and sacrifice only to be denied tenure was horrifying to students.

The academic career also requires sacrificing one's agency in determining job location and whom one works with. Students expected that in undertaking an academic job search, they would not be able to be selective with regards to location, and might just have to accept whichever position they were able to secure. In an academic career, one

would have much less flexibility to move or transfer out of a department or institution, especially while still working towards tenure. Even then, the limited availability of positions would limit the available options.

For most engineering PhD students, impressions of the academic career are quite negative overall. Out of the 20 students in my sample, only five expressed an explicit desire to pursue an academic career. Of the remaining 15 students, 14 planned to focus exclusively on industry and government sectors in searching for their first full time position following the PhD; one student expressed that he would be open to any full-time position, including industry, government or postdoctoral positions.

Gendered Experiences in Engineering

Initially, the women I interviewed would shrug off the notion of gendered experiences within engineering. Many remarked something along the lines of Amelia's statement that "since the work you turn in is objectively graded," there were few instances of discrimination against women in engineering. Some went so far as to describe the ways in which being a woman may have benefitted them, due to the existence of special programs and scholarships for women in science and engineering, and efforts to diversify science.

Although they mentioned these programs and opportunities as a sign that they are welcomed and encouraged to pursue opportunities in science and engineering, none of the women I interviewed took advantage of these programs beyond high school. As Amelia explained it, these programs are a paradox since they act as a reminder to women in engineering that they are considered different. Thus her desire to just "do the same things that everyone else is doing, not draw attention to whatever my characteristics are."

Part of the difficulty in pinpointing gendered experiences is due to the subtlety with which gender norms are enforced nowadays. Many women, in going on to describe some negative experiences that they had, went on to qualify that they could not be absolutely sure that the experience would have been different had they been men.

To at least some degree, the responses I received from the women students also suggested that they had come to normalize certain gendered experiences to the point that they barely even noticed them anymore. For example, women described experiences of being the only woman in the room as very common, and having encountered them so often along their path to becoming engineers, it barely registered with them anymore. Another common experience, particularly for women in engineering disciplines where female representation is still low, was that of being mistaken for a non-engineer. For example Blaine, an aerospace engineer, described being asked to refill the coffee by men assuming that she was a secretary rather than a presenter at conferences. However, women were dismissive of these events because they had grown used to them, and because they felt that just by being engineers they were working towards changing such outdated perceptions.

Underrepresentation had a greater negative impact on women in male dominated fields when they found themselves at conferences or at professional events As Amelia put it:

> I would say at conferences, the biggest problem is . . . when you don't know anyone it can be scary. . . . You're new to the field and you're walking in and there are thousands of people you don't know. And I think it's even scarier when none of them look like you in any way. . . . . Everyone is [sic] . . . people who

> stereotypically have authority, like old white men. And you're walking into a building with thousands of them and you're going to present your research. And in any given room there is one other grad student in the room who is female. . . and everyone is older than you and know each other.

In such settings, underrepresentation adds an additional layer of intimidation for young women scholars, who find themselves in the minority due to many elements of their identity. Being the only woman in the room is an additional stressor in an already vulnerable situation as a young scholar.

Along with the experience of underrepresentation came experiences that women met with a mixture of bemusement, annoyance and disappointment, such as being overlooked as researchers or ascribed gendered roles in working with groups of men. Tara, a woman in civil engineering, described being assigned tasks such as note keeping during meetings, or the role of formatting papers or presentations to "make them look pretty." Although for the most part these were just annoyances, she recognized that they had an impact on her learning in remarking that this took away opportunities to practice more challenging tasks.

There were few instances of outright hostility or discrimination towards women, and several of the reported instances happened outside of an academic setting. For example, Blaine was discriminated against while applying to jobs in industry following receipt of her master's in aerospace engineering. She described a phone screening in which the interviewer abruptly ended the conversation upon realizing she was a woman, and an in-person interview that she walked out of shaking in anger after her panel of

interviewers implied numerous times that being a woman would impact her ability to perform on the job.

The hostile climate for women in academic settings can also result from the difficulty of airing grievances described earlier. Despite the fact that women may experience discrimination outside of academic contexts, there is a perception that industry and government sectors offer better protections and clear avenues for filing grievances. Additionally, the greater availability of job openings and the variety of companies, government labs, and even departments within these organizations may provide women with a greater sense of agency in terms of which superiors they choose to work with, and greater flexibility in leaving or transferring out of a role and onto a different team or organization.

Perhaps one of the single most poignant examples of how gender affects engineering women in academic settings was seen in students' accounts of women PIs' experiences having children. The recounting of two women PIs' stories in the interviews conducted for this study were troubling in that they demonstrated that for women in engineering, many of the progressive, family friendly policies that research institutions have implemented in recent years do little to alleviate the burdens of pregnancy and childbirth. Students expressed being unaware of policies such as maternity leave at MAU, because the PIs they had worked with were unable to take advantage of the policies. These policies may not be well publicized or clear to students.

Given the nature of the PI's role in managing and supervising the lab, and the structures of the funding that keep a lab viable, it is difficult for PIs to take advantage of parental leave policies. First of all, the nature of academic research, lab operations and

the mentoring of PhD student work do not make it viable for someone else to temporarily fill the shoes of a PI on parental leave. In addition to this, even if the institution has a policy in place to pause the tenure clock for childbearing, a PI cannot afford to allow their research to slow down because they are still accountable to the outside funding organizations and their deadlines for producing results. Finally, the securing of future grants depends on continuous research productivity. A PI who wants to remain competitive in a tight market for research funding cannot justify taking the time off of research work for childbearing. Therefore, even with institutional teaching relief policies and fewer administrative duties following childbirth, women PIs were back to work in some capacity within just a few days of giving birth.

For the women engineers, the physical realities of childbearing within an academic context remained one of the principal and strongest deterrents to pursuing an academic career. Even for women who had no plans for having children in the near future, the prospect that they might someday desire to have children put academia at odds with their visions for the future they desired. Olive, a woman in bioengineering who expressed interest in pursuing an academic career, observed the strain that her own advisor, a woman assistant professor, went through in giving birth to a baby while on the tenure track:

> With working in the lab – it's a brand new lab – it's not like you could have another advisor that could just cover what you do. That's going to be me someday. My advisor was home but she didn't stop working. She answered every email. We still got papers out while she was gone. She did it all! But when you think about her – she has a brand new baby at home! But she doesn't really have a choice. So

> it was just one of these crazy things you have to think about – what it really means.

Even though Olive expressed having no immediate plans for a family, she described having "done the math" in her mind and concluded that were she to pursue a postdoc for a few years and then apply to academic positions, she would likely want to have children as an assistant professor, before going up for tenure. For this reason, she can see herself going through some of these very things that she witnessed her advisor going through.

Having an advisor that she could observe going through child bearing was difficult, but it was also a privilege. In envisioning themselves pursuing academic careers in engineering, many other women in more male dominated departments lamented the lack of role models, giving new significance to the issue of underrepresentation in the academy. In order to reassure themselves that pursuing an academic career does not necessarily exclude the pursuit of motherhood and family life, women expressed a desire to see female professors on the tenure track who are able to balance doing both. Women who expressed an interest in faculty positions were very aware of female representation in their departments, and specifically female representation in the rank of assistant professor. They paid attention to recent hires and observed carefully how young female PIs balanced the grueling process of building a case for tenure while also starting families. The following account by Amelia demonstrates the importance of having a role model:

> I literally, before a couple months ago, didn't know any tenure track research professor who is female and had kids successfully. So I had no role models. The only one I know is at my new [postdoctoral] lab. She's an assistant professor who

> just started, and she's due really soon. This is a huge deal to me. She is the first person that I know and will have seen, a female research tenure track professor who has kids.

Although Amelia acknowledged that it was helpful to see her male advisor participate in his family life, she was keenly aware of how gender roles differ, making it so that her male advisor would not experience the same burden as most women:

> My advisor has kids. Just to see an advisor who is successful and has family and kids and takes his responsibility to his family seriously was valuable. But then… I can't imagine what it would be like to have your career and have somebody who's a stay at home spouse to do all that. That would be great! But that's not the reality at all. There's still a difference between being a mom and a dad.

Amelia's perspective was not unique among women engineering students interested in academic careers. Their accounts made it clear that they are very aware of things that they observe about professors who have families, including things like the professor's gender and rank, the hours that they keep at work, the times at which they send out emails in the evenings, and even the nature of the support that the professors receive from their spouses at home. These women were constantly collecting information and assessing whether they could see themselves succeeding in those same situations. To them, observing a young, female, assistant professor that is beginning a family and does not have a stay at home spouse to take on the bulk of the care-giving role takes on special significance.

Conclusion

The experiences of engineering PhD students both leading up to and throughout the course of their graduate study shape student perceptions of the academic profession, and also of the career options available in industry and government. Although it became clear in interviews that most engineering PhD students tend to delay formal career preparation until very late in their programs, it also became evident that their time in graduate school is full of opportunities for information gathering about their career options. Students gain first-hand experience of doing research in an academic setting, and beyond this they also have opportunities to observe their advisors at work, gaining a sense of the duties of an academic PI, the nature of the work, the time allocation, and the demands of the academy. In addition, they observe interactions and the nature of relationships, power dynamics, hierarchies and politics within their departments. Informally, they are simultaneously gathering information about careers in industry and government sectors through conferences, professional groups, and peer and alumni connections. For some, previous work experiences in industry and government color their experiences of the academy as students, serving as a comparison point in evaluating their experiences of the university as a workplace. However, even students with little to no previous work experience outside of the academy draw comparisons between the academic career and the perceptions that they have formed of what work outside of academia entails.

Although the PhD student experience in engineering is very heterogeneous, some important underlying commonalities emerged across engineering disciplines. Most significantly, this chapter has highlighted the great latitude and freedom that academic

structures allow for people in positions of power – whether they be PIs or department chairs – to have considerable influence and leverage with those lower down in the hierarchy, with few recourses or systems that allow for disputes to be resolved. These structural conditions can contribute to the sense that in academia, a person on the lower rungs of the hierarchy can feel "stuck" in a bad situation.

Men and women students highlighted similar issues when it came to their experiences in academic settings. However, it is likely that the burdens that come along with being female in a traditionally male dominated space will be an additional consideration for women engineering students. In addition to the power dynamics that arise from the usual academic hierarchies, for example, women face the additional gender hierarchies that come from a patriarchal society and are compounded in an environment in which they are still underrepresented. This means women may be more sensitive to some of the structural issues highlighted in this chapter.

Finally, this chapter has also brought to the forefront the unique difficulty of bearing children and starting a family for women academics in engineering disciplines. The nature of academic research, funding, and mentoring in engineering disciplines, and perhaps in the sciences in general, make it so that parental leave policies that extend the tenure clock and reduce teaching obligations do little to alleviate the need to return to work very shortly after giving birth. Women interested in pursuing academic careers envision themselves starting families as assistant professors on the tenure track, a period during which grueling work and high research output are deemed necessary to build a tenure case.

Women engineering students, particularly those with inclinations to pursue academic careers, feel this acutely. Although many women expressed having become somewhat inured to issues of underrepresentation in the engineering sciences, women who intended to pursue academic careers all expressed an interest in observing female assistant professors able to balance childbearing with life on the tenure track. More than a generic need for representation, engineering women want to have role models and mentors in the very specific situations that they find to be the most intimidating and challenging barriers to their pursuit of academic careers.

CHAPTER 6: Discussion & Conclusions

In this final chapter, I return to some of the central questions guiding this study, and reexamine the bounded agency model that was the original theoretical framework for the research. In doing so, this chapter summarizes the main findings of this study by describing the career decision-making process of engineering PhD students and providing a gender analysis of the process, outlining the ways in which men and women approach career decision-making differently. The chapter then goes on to discuss the bounded agency model as it pertains to the process of career decision-making, simultaneously bringing in a discussion of the gender differences that this study has brought to light. Next, this chapter addresses some of the shortcomings of the original bounded agency model, proposing a revised model that adds nuance and complexity to our understanding of how bounded agency works in the context of PhD students' career decision-making. Finally, this chapter concludes with some policy implications of this study's results, and future directions for research.

Career Decision-Making: A description of the phenomenon

The career decision-making process of engineering PhD students is a complex phenomenon, and one not easy to describe. It is not a homogenous phenomenon, and can look different for different individuals as they make their considerations about what the future holds for them and how they want their careers to fit in with other aspects of their lives, from considerations about income and geographical location, to professional identity, a sense of "fit" and personal values. However, there are some common themes that came across through interviews that underlie the apparent heterogeneity; in focus

group discussions, men and women also agreed on certain key elements that are central to their experiences of determining their career direction.

First of all, it is necessary to acknowledge that the word "decision" is an inaccurate one in describing this phenomenon, because it implies a certainty of direction and a choice made at a fixed moment in time. In contrast, participants described their career choices as coming about through a much more gradual and almost unconscious process, in which an accumulation of experiences and exposures led one to a gradual realization of what one desires and values in a career. In breaking down this process, it is helpful to think about it in terms of three steps: 1) engaging in information-gathering; 2) crystalizing one's personal values; and 3) narrowing down of options. Although these three steps will be discussed separately and in this order for the sake of clarity, the process is not linear and can best be described as iterative. There is a non-linear repetition of these three steps, and a return to previous steps; the information gathered in step one informs steps two and three, and the results of two and three can, in turn, be used to guide future information gathering.

Information Gathering

Gathering information that guides career choices can take on a variety of forms for engineering PhD students. Some of this information gathering happens through direct experience, and some of it happens from learning about the experiences of others. Information gathering of this latter kind can take on many forms, from career panels and workshops to informal conversations and encounters, books and websites devoted to explaining career options and sharing experiences, and, increasingly, social media

platforms and blogs where individuals share their experiences working in certain industries or domains.

The direct experiences of PhD students during their graduate programs pertain mostly to research work as it happens in the academy. As students move past coursework, they spend their time devoted almost exclusively to research activities that bring them into intimate contact with the academic pressures to produce data, publish, and present research work at conferences. At the same time, their routine interactions with their advisors give them a good sense of the work of a PI in academia. Students observe details of their advisors' schedules, coming to understand how their time is spent. They receive email replies late at night and on the weekends, giving them a sense of the hours their advisors put in, and how little they are truly "off the clock." Finally, they come to understand the pressures inherent to writing grant proposals in order to keep the lab funded. Whether they work under very successful PIs whose labs are very well funded or under PIs who have to rearrange budgets in order to find the money for their research stipends, students become increasingly aware that there is a finite "pot of money" available to fund research in their respective fields, and that PIs must compete with one another to secure that funding for themselves. At the same time that the academy espouses collaboration in research projects and in moving the science forward, there is a paradoxical sense that one is in constant competition with other researchers doing similar work.

Beyond the limits of the labs in which they work, engineering students are exposed to the structures of their departments and of the university at large. Students observe interactions between their professors, advisors and department chairs; they pick

up on departmental dynamics, whether directly or indirectly, by observing relationships, registering the presence (or lack) of departmental functions and who attends them; they speak to one another, both within their own labs or departments and beyond, hearing about what goes on elsewhere on campus. This helps them to get a sense of how their own lab or department compares to others, and to understand the parameters within which they can make sense of their own graduate experiences.

Work experiences outside of academia, in government or industry settings, also serve as opportunities for gathering information about what research and work can look like in other settings. These outside experiences serve as a counterpoint with which students can compare and contrast their experiences of work in academic settings. They compare organizational structures that impact their day-to-day, such as the duties, responsibilities, and expectations for their scope of work, the hours put in, and the salary ranges; they take note of who occupies positions of power and the sorts of trajectories they had in their promotion and advancement; they try to see themselves living and filling these roles to assess their "fit" for different positions.

Many of the students who have not had a direct experience of work outside of academic settings lament the fact that they do not have a reference point for making sense of their experiences of academic work during graduate school. As a result, these students express a desire to experience work outside of academic settings before making a firm choice regarding their career direction. The schedules and demands of PhD study in engineering does not seem to allow students to experience work outside of the university, through, for example, internships in industry and government. Engineering PhD students at MAU are on 12-month research assistantship contracts, which makes it very difficult

for them to gain internship or work experiences while enrolled in their programs. They also work long hours that add up to upwards of 40 hours a week, even though their stipend only covers 20 hours of work each week. Only two of the students I interviewed were able to experience work outside of an academic setting while enrolled in their PhD program at MAU: one secured permission from his advisor and the source of the grant that his project was funded under to work in industry for a two-month period one summer, and the other kept a part-time position at a government lab for approximately ten hours each week, bringing his total hours of work to an estimated average of 60 hours a week. These situations were quite exceptional, however, and every other student I interviewed maintained that it would be impossible to take on an internship or other work without taking a leave of absence and extending their time to degree.

Beyond their direct experiences of work in different sectors, PhD students inquire and hear about the work lives of program alumni and recent graduates from their own labs, and through the people who they meet at conferences and other functions, such as career workshops and events organized through their departments. Through these indirect means, they gather information of work in sectors that they may not have experienced themselves. Students tend to take this information and compare it to their experiences within the university setting, and what they have learned about the academic career. This way, they begin to consider their different career alternatives and assess their fit for work in different sectors, even if they are unable to experience them directly.

Lastly, information gathering can happen through the use of sources such as online career quizzes and guides for PhD students, books, and social media such as Twitter and blogs. Women students interested in academia were particularly drawn to the

Twitter feeds and blogs of women professors in STEM fields. This is likely because these women are least likely to encounter mentors within their own academic institutions. Thus social media allows women to network with and share in the varied experiences of women professors in different STEM fields, working in a variety of institutional settings.

Men and women students demonstrated similar approaches to information gathering along the course of their PhD programs. However, there were some gender differences worth mentioning in terms of the importance of different sources of information, and the nature of mentoring relationships. Women students were much more likely to mention important mentors in the sciences, and maintained strong relationships with previous employers or academic advisors who encouraged them and guided them on their path to their doctorates and beyond. Women students focused on cultivating a small number of these close relationships with people who they could turn to repeatedly at different points in their careers. Even when the initial encounter with someone happened in passing, for example at a conference, professional meeting, or workshop, women tended to describe devoting time and energy to cultivating a small number of deeper relationships with people who they could turn to for advice. They described spending time meeting one-on-one with these mentors in intimate settings, like coffee or lunch.

In contrast, men students described developing broader, larger networks comprised of a greater number of individuals with whom their contact might be less intensive. These included peer, alumni, and professional networks with a broad reach. Men described fewer deep relationships with mentors that they turned to repeatedly over the years; the broad networks also meant that they would turn to different people for

different types of advice or at different junctures in their careers. These larger networks also meant that men devoted less time to cultivating deeper individual relationships. None of the men described coffee or lunch appointments, for example, tending to prefer email or the occasional phone conversation in reaching out to people within their networks.

Crystalizing of Personal Values

As students continue to gather information through direct experience and through other, indirect means of understanding what working in different sectors and institutional settings is like, they begin to understand with more clarity what sorts of things they value in their work life. They compare and contrast what life might look and feel like working in different contexts, and they also come to rank or prioritize these different core personal values, taking mental note of which ones are negotiable versus which ones they hold onto most firmly and are unwilling to compromise on. The personal values a given individual comes to see as most important end up being some of the most influential factors in narrowing down his or her career options.

In speaking about the personal values guiding their career decisions, research participants described coming to realize certain things about themselves throughout the course of their PhD programs. These things included, for example, a preference for either flexibility, or for a more predictable nine-to-five schedule; for more applied research with a palpable impact on individuals and society, or for making more abstract contributions to advancing scientific knowledge; and for either taking on a role with multiple responsibilities, or preferring to focus more exclusively on the research itself. Coming to terms with these personal preferences and values, students relate this

knowledge of themselves back to the information they have gathered about different career options, and begin to form an idea of where their compatibility lies. As they develop this sense of fit for different careers, they begin to narrow down options.

Both men and women students engaged in a similar process in coming to crystalize some of the core values that guide their career decisions. In addition, no gendered patterns emerged regarding differences in the core values between men and women students. As examples, men and women alike expressed their desire to remain focused on research in a hands-on way as being of importance to them in their careers; men and women alike favored work that might be closer to producing direct applications and products that could improve people's lives; finally, neither men nor women prioritized salary expectations as an important value in guiding their career choice. This runs counter to some research that suggests that women are more likely than men to value helping others through their career choices (Eccles, 2006; Gibbs, Jr. & Griffin, 2013; Sax, 2008), and that men are more likely to prioritize high salaries in making career decisions (Mullen, 2014).

Several gender differences emerged in considerations revolving family, and valuing either spending time with, or being close to family. For men, issues involving family limited themselves mostly to the question of how mobile and willing to relocate they considered themselves to be. However for women, family considerations also included the time demands of their partners' careers, and how these demands might impact their partners' ability and willingness to engage in an equal share of childcare and home responsibilities. Women whose partners had very demanding jobs worried about being burdened with the bulk of childcare and home responsibilities, whereas men whose

partners had demanding careers did not express this concern. Both men and women expressed taking family and their significant other, or partner, into consideration in making career decisions, particularly those pertaining to the question of mobility. Both men and women in my sample had partners who they described as being dedicated to their careers, with implications for moving to very small towns or rural locations where jobs in their areas might be unavailable. Also, both men and women considered the value of being able to take a job close to extended family, siblings and parents. However, their rhetoric surrounding this value was different. Women were more likely to describe themselves in a care-giving role, for example acting as mentors to younger siblings, or looking after aging parents. In contrast, men spoke about the benefits to themselves of living close to family, mentioning the comfort of having people nearby to help them in an emergency, or relatives to share a meal with over holidays. On the surface, men and women share similar family values; however, they differ in the how they speak about and define these values.

Narrowing Down of Options

Although many interview participants initially thought that their PhD programs would give them the time they needed to easily settle on a definite career path, the pattern for some students was actually the opposite, at least initially. Being in the PhD program, conferencing, and gathering information about the different career options available to them actually broadened some of their perspectives. In the words of one interview participant, embarking on a PhD in engineering actually brought about the awareness that he could do virtually anything with his degree, from finance or consulting to product design, academic research, or research in industry or government. Following the

information gathering and the crystalizing of personal values that happens as students progress through their programs, however, a narrowing down of viable options begins to happen.

This narrowing down of options usually takes on the form of a process of elimination, whereby an understanding of what different careers entails leads students to decide against certain alternatives and eliminate them from a mental list of possibilities. This suggests that most students will remain open to a given career option until they gain sufficient information to decide that it is *not* a good fit for them. This is likely a strategy developed in order to increase the chances for success in a competitive job market. Students are generally willing to apply to a range of different positions in a variety of sectors, so long as they have not developed an actual aversion to a certain sector or job type. Students described this approach to the job search in interviews by using phrases such as "casting a wide net," and "seeing what sticks" as they envisioned entering the market for jobs.

As a result of sampling bias, a disproportionate number of women in my study were interested in pursuing academic careers. Women drawn to academic careers were particularly drawn to this study, and sought me out for interviews because they were interested in discussing their experiences. In addition, snowball sampling led students to introduce women students interested in academic careers to me, since participants correctly assumed that they would be of particular relevance to my study. Despite this bias, the interview data suggest that in the process of narrowing down options, women may be more likely than men to decide that an academic career is *not* a good fit for them, and to eliminate it as a career option. Both men and women brought up similar structural

and organizational barriers to pursuing academic careers; however, men and women perceived these same barriers very differently. For women, many of the structural and organizational barriers within academia are compounded by broader societal structures and lingering patriarchal norms that guide gendered expectations of work and family life. Therefore, although some issues may look similar on the surface, closer inspection reveals that they can cause a much greater degree of anxiety, stress, and uncertainty about work in academic settings for women. Gender socialization processes contribute to this, as structural and organizational barriers interact with individual level characteristics and dispositions that are also grounded in a gender identity. These interactions are explored in more detail below, where a return to the bounded agency model employed in this study allows for a visualization of these relationships.

In narrowing down their options, it is also noteworthy that women interested in pursuing academic careers experienced a sense of duty in taking on the challenges of remaining in academia. This suggests that these women are aware of the targeted policy measures in place that are trying to facilitate their progression up the academic career ladder, and feel themselves part of a broader movement to bring women into the engineering professoriate. Along with this sense of duty, there is also a burden of sorts. Olive described feeling that if she chose to give up her pursuit of academia due to concerns about being a good mother, she would feel that she is not "feminist enough" and would be "letting down other females." Amelia echoed a similar sense of duty in describing her involvement in a student group devoted to promoting girls and women in aeronautics and astronautics. In some sense, men intending to pursue an academic career in engineering are making an individual decision. In contrast, women engineers'

decisions to pursue academic careers make them part of something bigger than themselves. This could be an additional motivator for pursuing a difficult career, adding a sense of support and momentum, but it also seems paradoxically to create an added burden because for individuals to move away from this career path could be perceived as a failure of the broader push to diversify the engineering professoriate.

Following the narrowing of down options, students often return to information gathering with renewed purpose. Having eliminated options gives them a better sense of what they may pursue after program completion, and they can use this knowledge to focus on networking more specifically with individuals in certain sectors or roles. They seek out informational interviews to glean more knowledge of specific careers, what sorts of qualifications they should seek to develop, and to learn more about the process of identifying and applying to such positions. Further information on a career interest can again lead to a further crystalizing of values and elimination of options. Thus career decision-making is best described as an iterative process.

The Bounded Agency Model

It is pertinent to examine the bounded agency model initially proposed as a theoretical framework in light of what this study has uncovered about the career decision-making process of engineering PhD students. As can be seen in Figure 2, below, the original bounded agency model used in this study allows for an examination of how structural and individual level factors interact and result in structural and dispositional barriers to in the decision to pursue an academic career path.

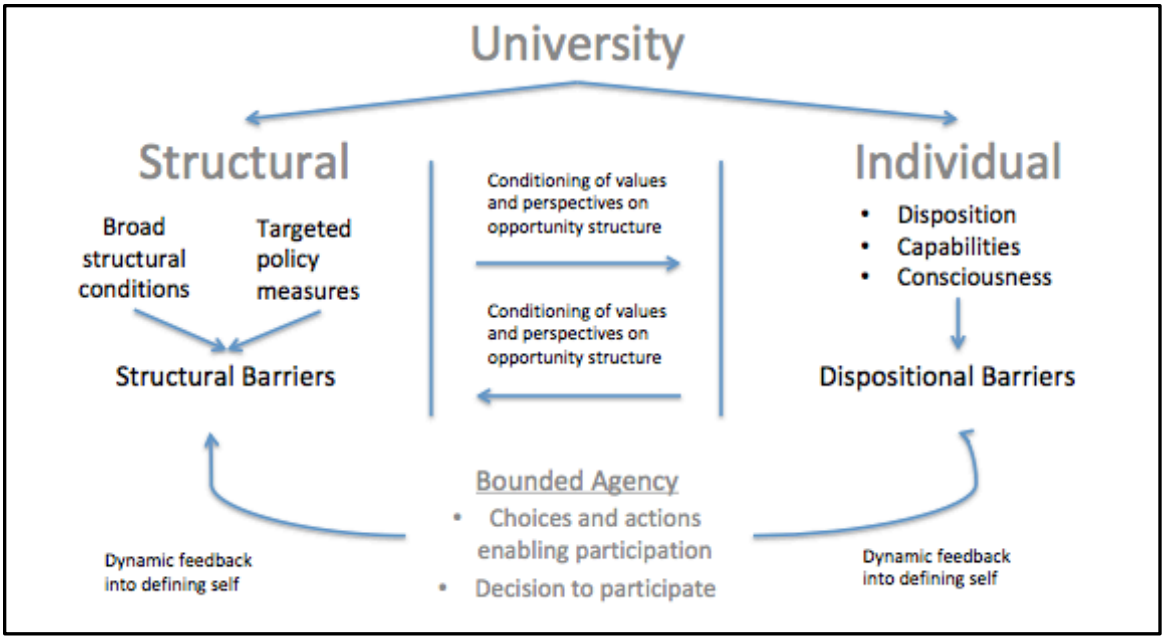

Figure 2. *Bounded agency model* (Adapted from Rubenson & Desjardins, 2009)

Structural and Organizational Elements

The bounded agency model proposed as the theoretical framework for this study focuses on the university as the central institution. This is due to the fact that throughout the course of their programs, the majority of engineering students will come into contact almost exclusively with the university as the major institutional setting that they experience. Although there are engineering PhD students whose research occurs off-campus for example, in government facilities, none of the participants in this study fit into this category. With the exception of two students, none of the participants in this study had opportunities to consistently experience work or research in an institutional setting that was not MAU. In discussing structural and organizational elements, the focus is therefore on MAU, an institution typical of the large, public, American research institution.

The structural and organizational elements of the university as an institution are highly complex and varied. As demonstrated through the various interviews conducted for this study, student experiences can vary considerably even within the same department. This reflects an institutional structure that gives a lot of leeway and few guidelines to those in positions of power. Students are quick to realize that individual experiences of work as a PhD are highly dependent on the personal characteristics and personality of the PI in charge of the lab, for example. From there, students come to realize that a similar pattern emerges in terms of experiences within the department being very dependent on the department chair, and so on. Professors who are tenured and have achieved success in research, publication output, and bringing in money for the department are perceived as enjoying special privileges and having bad behaviors overlooked. At the same time, there is little recourse to resolve grievances and disputes in an anonymous way.

Although the structural elements outlined above may seem gender neutral because they apply to both male and female students, deeper scrutiny reveals that they are in fact, gendered dynamics. For example, due to gender representation at the higher levels of the academic ladder, the numbers alone make it likely that those in positions of power will tend to be male. A male engineering PhD student will likely face a superior who is his gender equal, whereas a female student will likely have the added burden of an unequal gender dynamic. In an environment where they are underrepresented, women's gender adds an additional layer of vulnerability to the sorts of abuses of power and instances of discrimination likely to be experienced. This seems to make women particularly

sensitive to these structures, and to the difficulty of effectively addressing conflicts or disagreements with their superiors in academic institutional settings.

Another structural and organizational issue with different implications for men and women is that of the time demands associated with research work in academic settings. The engineering PhD students I spoke with often kept odd hours, running experiments that needed constant supervision over a 24-hour period, or coming into the lab on nights and weekends. They all worked far beyond the 20 hours per week that they received compensation for as research assistants. They also observed the hours that their advisors and other professors tend to keep, and the time stamps on emails sent out late at night or on weekends and holidays. Men and women students alike remarked often on the high demands of the academic career. However, when it came to describing how to manage and balance these demands with the competing demands of family life and parenting, women and men expressed their concerns very differently.

Men PhD students did not seem overly concerned that the time demands on faculty would be incompatible with family life or parenting. In fact, the men I interviewed did not seem to consider the demands of a faculty career to be too different from the demands of any other demanding and competitive career. The men students pointed out that most of their professors have families and children, and seem able to balance these competing demands quite well. While several men expressed concerns about time management, and remarked on the stresses of allocating the necessary amount of time to the many competing demands that faculty work entails, the problem to them was easily resolved with skills that they considered to be learnable. For the men, the difficulty of managing faculty work demands is a technical issue, and one that can be

conquered with discipline, hard work, and learning to prioritize tasks. As an example, three of the men interviewed brought up workshops that they had seen on time management, aimed at junior faculty in their departments. In their minds, although the time demands on faculty can cause time management issues, there are resources available for learning to tackle these difficulties.

In contrast, for the women interviewed, institutional demands on faculty time presented a much deeper and persistent incompatibility with their plans for family life, particularly child-bearing. In interviews, women who were still years away from starting families envisioned the daily stress of beating traffic to make daycare pickup on time, and envisioned catching up with emails and grant applications late at night, after their kids were in bed. Those interested in pursuing academic careers struggled imagining how they would balance all these demands on their time, and lamented the lack of role models that could provide examples for them to follow. Even those working under female PIs, or who had witnessed women succeeding as professors while also being mothers tended to question whether they themselves have what it takes. Such women were already preparing for challenges that they would have to face far into their futures, such as the potential for being continuously overlooked in grant applications following a period of decreased productivity due to maternity leave. There was much more stress and anxiety inherent to their decision to pursue academic careers because these problems that they envisioned lasting for several years at a very key juncture of their professional lives – the building of a tenure case – seemed to have no solution. For women, the structural issues associated with the time demands on faculty interact with broader societal gender structures and family norms, as well as with funding structures and organizational

elements that lie both within the university and beyond its walls. These are issues that no two-hour time management workshop can easily address.

Individual Characteristics

Just as the structural conditions of the university as an organization interact with broader societal structures, it is almost impossible to address individual level characteristics without considering the different socialization processes that men and women students have been through throughout their lives. As engineering PhD students progress through their programs, the career decision-making process outlined above is also a process of realizing, uncovering, and coming to terms with the ways in which individual dispositions, capabilities, and characteristics make one a good "fit" for a certain career trajectory. Men and women may show gendered tendencies in these regards, due to socialization processes that have contributed to shaping their gendered selves.

It is a delicate thing to generalize with regards to the personal attributes and characteristics of the male and female students in the study; however, some individual level dispositions and capabilities demonstrated gendered patterns that merit discussion. Dispositions displaying gender differences included confidence and a desire for external validation; fewer gender differences emerged when it came to individual capabilities, however engaging in more long-term career planning for faculty careers was more common among women than among men. Finally, when it came to consciousness of the structural conditions that work as barriers for individuals entering the academic profession, women had a unique awareness of a whole set of issues that men remained almost completely unaware of. On the whole, women had a much higher degree of

consciousness of the university as a gendered organization embedded within a gendered society. This additional burden was seen to cause a lot of personal anxiety and stress for women considering the pursuit of an academic career.

The importance of confidence arose repeatedly in interviews when students discussed the attributes of those who might wish to pursue academic careers. The uncertainties of the academic profession and the high degree of competitiveness that students associated with the career meant that men and women alike attributed a high degree of confidence to individuals who would choose to pursue this career path. This confidence pertained mostly to the individual's trust that they have the intellectual capacity to continuously generate ideas that are not just great ideas, but among the *best* ideas, in order to compete with other great ideas for a limited pot of money. One woman remarked that in a departmental workshop, a male faculty member had told the students present that if they believed they could truly be the best, and produce the best ideas, then they should consider pursuing a faculty career.

Confidence may have a gendered dimension. Indeed, the research literature suggests that there is a confidence gap between men and women in STEM (Bandura, 1997; Colbeck et al., 2001; Pajares, 2005; Sax, 2008). Examining the interview data from the men and women interested in pursuing academic careers, however, the women interested in pursuing academia come across as highly confident in their capabilities in research, teaching, and mentoring. The women I interviewed who were interested in academic careers asserted that they did not feel worried about their ability to come up with innovative and worthwhile research problems and formulate experiments to answer

them; they also expressed pride in their capabilities as mentors and teachers, citing positive student feedback on the work that they had done as TAs.

In contrast, the men interested in academic careers did not express this degree of confidence in their research, teaching and mentoring abilities. In fact, the men highlighted some of their shortcomings, but seemed unfazed by them; they were instead more likely to explain the ways in which they planned to make up for their shortcomings over time. For example, the men outlined plans to publish more, to work on their writing skills, and to work more closely with their advisors on upcoming proposals, in order to better understand the process of coming up with research ideas and putting them down on paper for potential grants; they also planned to seek out more opportunities to teach and mentor undergraduates, in order to make up for their lack of experience in these areas. To some extent, men's confidence came across in the way that they did not feel that they needed to have every box checked off, and every element perfected before they could consider pursuing an academic career.

The women who had self-selected into the academic career track came across as all-around high achievers, confident in their ability to perform well in each and every one of the areas associated with faculty work. These women were driven in their pursuit of opportunities to practice and learn in each of these areas of faculty work throughout the course of their graduate programs. They stood out as remarkably accomplished PhD students. In contrast, the men interested in academic careers stood out precisely because they were relatively unremarkable among PhD students. Save for their expressed interest in an academic career, which was relatively rare among engineering students interviewed, they were your run-of-the-mill engineering PhD students. They were highly talented and

driven scientists, but they were not exceptionally driven, and did not see themselves excelling beyond the level of their peers in the areas of research, publication, teaching and mentoring.

Perhaps related to this issue of confidence, women expressed the importance of external validation in encouraging them towards academic careers in ways that the men did not. For example, for each of the women interviewed, experiences teaching and mentoring were important not only due to the insight gained into these aspects of the faculty career, but because being told by students that they were good teachers and mentors was important in convincing them that they could perform well in the academic profession. For the women, being told by advisors, professors, or even strangers at a conference that they have what it takes to pursue an academic career path were very memorable experiences. The women mentioned these in interviews as making them feel validated, and giving them the confidence to pursue a career wrought with challenges and uncertainties. In contrast, none of the men mentioned having been told that they were good candidates for academic careers. This again suggests that men's confidence that they are capable of pursuing an academic career stems from different sources or manifests itself in different ways from the confidence that women expressed. Alternatively, it is possible that men do not ascribe enough importance to external validation to have formed lasting memories of such events.

Based on interview data, women interested in pursuing academic careers rated themselves more highly than the men in the key areas of faculty work, including research, teaching and mentoring. These women came across as remarkable high achievers who were going above and beyond all of the usual graduation requirements in preparing to

pursue academic careers. The women interested in academic careers also came across as more disposed to long-term career planning and preparation. These women had lost no time once they had made the choice to at least try to pursue the academic career path. They described working hard to set themselves up for success by achieving the metrics that they learned to be important, such as publishing research early and often throughout their graduate programs, presenting and networking and conferences, and seeking out opportunities to teach and mentor students. All of the women were or had been enrolled in the FPP. In contrast, the men interested in pursuing academic careers were unremarkable in terms of their long-term career planning, not standing apart from their peers interested in pursuing careers in industry or government. Much like students uninterested in pursuing academic careers, these men tended to take a more laissez-faire approach to career planning and to delay preparations. None of them had yet enrolled in the FPP, although one of them mentioned that he intended to apply the following spring semester, once applications to the program opened up.

The individual characteristics of the women in my sample interested in pursuing academic careers set them apart from other students in my sample. Women interested in pursuing academic careers shared traits that made them come across as highly focused and driven; with the understanding that the career path that they have chosen from themselves is a highly competitive and difficult one, they had chosen to set themselves up for success by investing early on in developing some of the key attributes, competencies, and skills that they will need in order to succeed in the academic job market. They displayed a high level of confidence in their research merits, and their skills in other areas pertinent to the academic career. However, their drive points to an underlying sense of

urgency and anxiety that relates to their consciousness of the structural and organizational barriers that they will have to surmount in pursuing the academic profession. It appears that engineering women PhD students feel the need to outperform their peers and excel on many different metrics before they can build up the confidence to pursue academic careers.

Teasing apart the effects of gender from the effects of age in terms of the career decision-making of engineering PhD students was difficult at times. In terms of individual level characteristics, the women in my sample also tended to be older than the men, and to have come in with more years of work experience relative to the men. Still, it was possible to attribute some differences to gender. For example, men came across as more confident than women in their ability to pursue whichever career path they chose, regardless of their competency level, whereas women had to perceive themselves as highly competent before finding the confidence to pursue an academic career. Men who were younger and had less work experience tended to express a need to explore career options and try new things before making a decision about whether or not to pursue an academic career, whereas women seemed to feel less of a need for this kind of exploration, even in cases where they were young and came in with little or no work experience.

Women and men displayed similar levels of consciousness when it came to the demands of the academic profession, and some of the organizational barriers to pursuing academic careers. On top of the elements that students of both genders demonstrated awareness of, however, women students demonstrated consciousness of gendered elements of the academic career that men had no awareness of. Many of these elements

resulted from the ways that academic structures interact with societal structures such as family and marriage, particularly expectations for the role of women in parenting and caregiving. Having children and the subsequent parenting responsibilities were a source of anxiety for women due to the ways in which the caregiving roles that they were expected to play (and in many cases, wanted to play) for their families would affect their ability to perform within the academic profession. Unlike for women in competitive careers outside of academia, however, temporary drops in productivity were perceived as having long-term consequences for women PIs, especially due to funding practices whereby past productivity impacts future ability to secure funding.

Reassessing the Model

The bounded agency model is very helpful in visualizing the interactions that take place between the structural and individual characteristics that then work to condition the values and perspectives of engineering PhD students as they make their career choices. However, there are also some shortcomings to consider in the original model, and perhaps a rethinking is necessary of the ways in which the model frames the career decision-making process.

First and foremost, in the original model the university stands alone and in isolation from external influences stemming from society, or from individuals and organizations that fall outside of the university. This implies that the career decision-making processes of engineering PhD students take place in a vacuum, when in reality many important forces are at play that operate beyond the university. First and foremost, of course, are societal norms that remain largely patriarchal, and guide social expectations of what constitutes a "normal" work and family life for men and women.

Among other things, these societal norms make it so that men and women's understanding of what it means to be a "good mother" or a "good wife" requires a lot more time, effort and devotion to children and household tasks than the general understanding of what it means to be a "good father" or a "good husband." This has enormous consequences for women's decisions to pursue demanding careers in a broad sense, but even more so perhaps, academic careers. In academia in general, and in engineering in particular, there is the added effect of funding practices to be considered. In engineering, research labs are largely funded through competitive grants that PIs apply for and secure through agencies external to the university. The ways that these external organizations select and award money for proposals inadvertently discriminates against primary caregivers who must take longer leaves.

Another related issue with the bounded agency model initially proposed is the way in which it sets up career decision-making as a choice about whether or not to participate in the academic career. This creates a false dichotomy. It fails to fully account for the opportunities and relative attractiveness of options that fall outside of the university, such as industry and government work. Although it is true that students are continuously learning about the university as an organization and forming perspectives on the opportunity structures and barriers within it, they are simultaneously considering alternatives and gathering information from other sources. Although few have opportunity to gain direct experience of work outside of the university during their time as graduate students, peer and professional networks, conferences, professional workshops, and even social media and blogs provide glimpses of professional life and work in other sectors.

Redrawing the model to include all of these nuances risks creating a model so complex as to be impractical. However, it has been possible to add some elements and nuance to the model in such a way as to reflect some of the insights this study has provided regarding the career decision-making process. The revised model can be seen in the figure below.

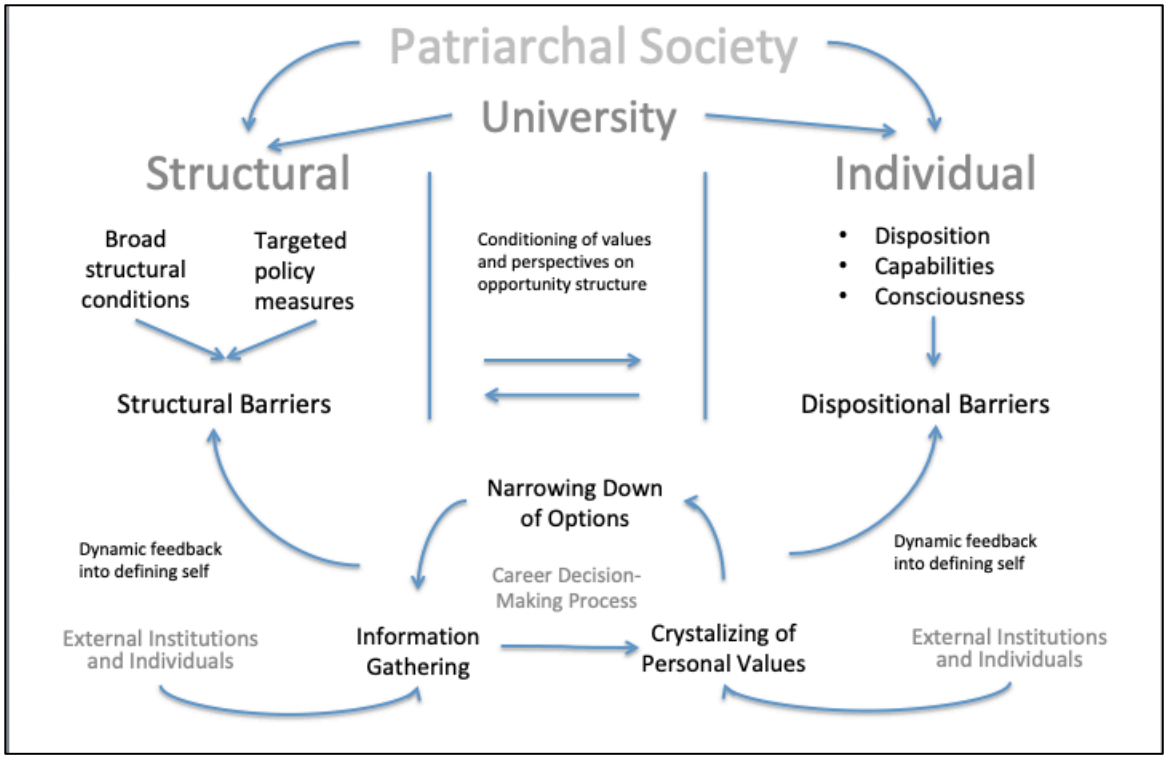

Figure 3. *Revised bounded agency model*.

As can be seen in the figure, the revised model acknowledges the role of a patriarchal society in shaping both structural and individual elements. In addition, it includes a visual representation of the iterative career decision-making process that expands on the dichotomy presented in the original model. Finally, the model allows for the role of institutions and individuals external to the university in contributing to the career decision-making process through direct and indirect means of information gathering and crystalizing of values.

This revised bounded agency model is useful in examining engineering PhD students' career decision-making process in a holistic way. Within it, the career decision-making process is embedded in a system of complex interactions and feedback mechanisms that stem from both individual and structural dimensions. This revised model builds on the earlier version of the bounded agency model by acknowledging external societal, organizational, and individual forces that act on individual students and also on the university as an organization. Within this new model, the career decision-making process is better described as an iterative process that is at the nexus of these many factors and influences. This goes beyond the earlier description of the career decision-making process of engineering PhD students as the binary choice of whether or not to pursue an academic career path. Instead, it acknowledges the complexity inherent in an open-choice process, in which several different factors are repeatedly evaluated as new information becomes available. Overall, this revised bounded agency model reflects a more thorough understanding of the career decision-making process of engineering PhD students.

Conclusions, Recommendations and Future Directions

This study was broadly motivated by concerns about the underrepresentation of women in science, technology, engineering, and mathematics (STEM) disciplines. More specifically, this study sought to illuminate the career decision-making process of engineering PhD students, in order to provide insight into the persistent lack of gender diversity in the engineering professoriate. To understand and explain these issues, the study approached the career decision-making process of engineering PhD students as a phenomenon that is embedded in complex interactions that occur between structural

conditions of the university as an organization, and individual dispositions, capabilities, and consciousness. The bounded agency model adopted as the theoretical framework for this study thus allowed for a holistic examination of how individuals' values and perspectives surrounding career choice are shaped by their experiences throughout graduate school.

The phenomenon of career decision-making was investigated through a qualitative case study approach, in which in-depth interviews with individual PhD students in engineering constituted the primary source of data. These interviews examined how student experiences of the university as an organization impacted their career decisions, revealing the PhD student experience to be an opportunity for information gathering regarding the academic profession. Interviews also examined how, throughout their PhD programs, students drew on other sources of information, and compared the different career options and trajectories that would be available to them following PhD completion. In doing so, this study revealed the career decision-making process to be an iterative and ongoing one, embedded in complex interactions between individual students, university structures, and external influences stemming from society, and organizations and individuals external to the university itself.

The concept of bounded agency was adopted as the theoretical framework for this study because it allowed for a holistic examination of how structural and organizational factors pertaining to the university as an institution have an effect on individual agency and decision-making. This study resulted in a refined bounded agency model, which includes a more nuanced understanding of the career decision-making process and an

acknowledgement of the role of forces external to the university in shaping students' career decision-making.

Policy Implications

Numerous policy recommendations emerge from this study's findings. The recommendations presented here flow from issues discussed in the previous chapters, particularly issues pertaining to the ways in which university structures are experienced and perceived differently by men and women PhD students. These recommendations are thus intended to address these gendered dimensions, and have the potential to reduce barriers to women students' pursuit of academic career paths. Although some findings from this study suggest that the PhD student experience could be improved by simple measures such as the implementation of a rotation program for incoming PhD students to choose a PI and lab to work in, such suggestions will not be addressed in this section. This is because the data do not support a direct connection between these practices and the career decision-making process of PhD students.

In making these policy suggestions, I return to the critical feminist lens that informed this study. Critical feminism warns against the assumption that organizational structures are gender neutral, and challenges the suggestion that simply adding women to the mix will result in greater equality. In attempting to remain true to this framework, my suggestions seek to avoid placing the burden of achieving gender diversity in engineering on individual women; instead, it is my hope that these suggestions can tackle the structures that continue to place women at a disadvantage within institutions of higher learning generally, and within engineering disciplines in particular. Indeed, addressing structural issues is an encouraging trend currently seen in diversity initiatives within the

STEM disciplines including, for example, the "inclusive Excellence" inititative by the Howard Hughes Medical Institute. There, initiatives focus on creating a "culture of inclusion" by focusing on the learning environment, the curriculum, and institutional policies and procedures (Asai, n.d.).

Improve policies governing graduate student work, and the advising relationship

One issue that emerged over the course of this study was that of graduate students and their advisors being left to navigate on their own the process of establishing expectations of work. The fact that PIs are given so much leeway in determining the duties of their PhD students and the nature of their obligations, their time away from duty and even the dynamics of the advising relationship itself leads to a great heterogeneity in the PhD student experience in engineering. Policies that do exist are deliberately vague in their wording, making it possible for PIs to have great flexibility in interpreting them and choosing whether to abide by them. Graduate students themselves are often unaware of the policies, since these are not openly discussed when students become employed as research assistants in a lab.

Establishing expectations for the advising relationship, and a clear set of guidelines regarding PhD student work as research assistants in their PIs' labs would be helpful in making the experiences of engineering PhD students more consistent across labs. However, establishing expectations would not suffice. These guidelines would have to be well publicized, and discussed in an ongoing basis. Ideally, PhD students would receive a copy of the policies when they first begin their employment as research assistants for a PI, and would also be familiar with where to access the policies in the

graduate school's website. Likewise, PIs would receive training on the policies and revisit them periodically, for example at the beginning of each academic year.

These steps would likely relieve students of the sense that individuals in positions of power in the academy can have such an outsize influence on the experiences of those working below them. This could be particularly beneficial for women students, whose gender identity adds an additional element to the power dynamics at play between student and PI. Establishing guidelines and expectations would also make students more secure in their ability to confront or challenge a PI who is demanding too much work-wise, is creating a hostile working environment, or is underperforming in his or her duties as an academic advisor and mentor.

Publicizing the work of the Ombuds Office

Related to the above is the need for a clear set of procedures that facilitate PhD students airing grievances or addressing concerns relating to their work under a PI or within their broader department. In the context of career decision-making, graduate students experiences of powerlessness in the face of unfair treatment reflects poorly on the university as a working environment. Currently, engineering PhD students are largely unfamiliar with the procedures in place that allow them to air grievances, or they believe there is no anonymity in the processes, raising concerns about retaliation from PIs or from the department. This adds to the sense of powerlessness that PhD students experience over the course of their programs, and may be of particular concern to women students due to the additional power dynamics at play in a context in which they are underrepresented. Although all of the formal grievance procedures in place at MAU are in fact, lacking in anonymity and confidentiality, the Ombuds office is a confidential and

off-the-record resource that few PhD students were aware of. In fact, only one of the twenty students interviewed expressed familiarity with the Ombuds Office, and had made use of their services.

At the Ombuds office, an Ombudsperson provides an "impartial, independent and confidential" resource for graduate students. The Ombudsperson's role is to hear complaints and grievances, discuss and explore options with individual students, and assist in opening channels of communication, or serving as a neutral third party in conflict resolution. The Ombudsperson can also assist graduate students in interpreting relevant university and graduate school policies, and determining whether the policies are being followed.

The work of the Ombuds office should be better publicized since interview participants largely expressed that there were no avenues for addressing and resolving issues confidentially. Students seemed to believe that only formal grievance procedures were in place, and that any formal grievances have to go through their Director of Graduate Studies or their Department Chair. This suggests that many engineering PhD students do not know about the work of the Ombuds office. It is also possible that students are too unfamiliar with graduate school policies to realize when the behavior of PIs or other individuals in their departments run counter to these policies. For this reason, these first two policy suggestions must take place in tandem in order to reinforce one another.

Improving uptake of parental leave and paid time off benefits in engineering

One of the biggest concerns facing women PhD students interested in pursuing academic positions was starting a family while on the tenure track. For both women and men students, however, concerns arose regarding the work-life balance of tenure-track faculty, and the existence of benefits such as paid time off. Since students observe that their PIs do not seem to take paid leaves, whether parental leave or simply vacation time, they come to the conclusion that such policies do not exist. Most engineering PhD students were not even aware of the policies governing their own time away from duty as graduate research assistants, revealing the need to better publicize and make students aware of such policies.

Beyond better publicizing the existing policies, it is also necessary for engineering departments at institutions such as MAU to ask themselves whether their faculty are able to take advantage of parental leave and vacation policies. It is possible that students have formed an erroneous impression, but the interview evidence analyzed in this study suggests that PIs are unable to take full advantage of parental leave policies. This is of particular concern to women PIs, since women take on the burdens of childbirth and early neonatal care more so than men. This is both a biological necessity (in the case of childbirth) and a social norm – albeit one that is increasingly and rightfully challenged, by women demanding more from their partners, and by men who are increasingly interested in participating in neonatal care and childcare. In challenging these social norms, it will be even more important that both men and women PIs are able to fully enjoy the benefits of parental leave.

In interviews, participants suggested that beyond the nature of academic research and mentoring work, one of the main reasons why PIs cannot enjoy parental leave is due to funding practices. Although many sources of funding for engineering research lie outside of the university, this does not mean that the institution is powerless to address and negotiate for better practices. For one thing, engineering departments can enter ongoing discussions with government agencies and private funders of research, in order to address the ways in which current funding practices can be detrimental to parents, especially mothers. There could be policies put in place that extend project deadlines when a PI has to go on parental leave, for example. Another idea would be for a small percentage of every grant awarded to PIs in a given department to be put aside. That way, each department would have a pool of funds to draw from in order to award PIs who have recently returned from parental leave. Returning from parental leave, PIs might have gaps in their research productivity that make it difficult to secure competitive grants; this pool of money could be used to help bridge any funding gaps. Knowing that such funds exist could help PIs enjoy their parental leave benefits more fully, and address women's concerns that funding agencies would overlook them following gaps in productivity.

Unmasking the professor and life on the tenure track

At MAU, the faculty career and life on the tenure track are things that most engineering PhD students gather information about only through indirect means, such as by observing their advisors and professors at work on a day to day basis. Only students with a certain level of commitment to pursuing an academic career path learn about the faculty career in a more formal way, by applying and enrolling in the FPP, for example.

For the majority of students, understanding of what the academic career is like remains largely speculative.

It became apparent through interviews conducted in this study that students have few formal opportunities to gain career advice and preparation throughout their PhD programs at MAU. This is consistent with the research literature, which demonstrates that career preparation in PhD programs in the US is very ad-hoc, and that there is a lack of support for the career development of PhDs.

The exception to this were PhD students in the bioengineering department, who described an active graduate student society that worked to put on many bioengineering specific career workshops and events. Bioengineering students enjoyed these highly specific and specialized opportunities for career development, and it appears that departmental career events are most helpful to engineering PhD students due to the highly specialized nature of their knowledge. The career workshops that bioengineering students described usually brought together panels of program alumni working in specific sectors, for example in industry or government, who would come to discuss their career trajectories with students. However, students did not describe similar panels happening with an emphasis on the academic career.

Based on interviews, engineering students might benefit from career workshops about the academic career, organized at the departmental level. The presence of engineering faculty in these panels, particularly young faculty on the tenure track, might illuminate the different paths that young PIs have taken in arriving at their current positions. Such discussions could clarify some areas in which students seem to have misunderstandings about the academic career trajectory, and the different pathways that

can lead to a tenure-track position in engineering. For example, it would be interesting for students to hear from individuals who started off in industry or government and then returned to academia, in order to better understand the benefits and drawbacks of that route, and how one goes about making the switch.

Students would also benefit from hearing about the challenges and failures that current PIs may have faced in the past. Many PhD students, particularly women PhD students, seem to believe that only the most highly accomplished students with the most impeccable records have a shot at making it as a PI. It would be very beneficial to challenge this assumption with anecdotes from PIs who may not have had a flawless path into academia. For example, hearing from professors who may have failed a course in graduate school, who had trouble with their qualifying exams, who published only later in their PhD program, or who initially struggled with teaching and mentoring would help undo this image of the PI as a perfect and rare engineering specimen. Candid conversations about difficulty and failure along the path to a professorship, and how these were overcome, may make the people who occupy those professions seem less like flawless super-humans.

This is not to imply that the academic profession is not a highly competitive one, or that the individuals who do make it to the coveted tenure-track positions are not exceptional scholars. However, interviews with students interested in pursuing academic careers did suggest that, especially for women PhD students, there was a perceived need to excel in a virtually flawless manner in each and every aspect of the PI role before even feeling that one is eligible to attempt the pursuit of an academic career. Demystifying the faculty career and the track records of the individuals who succeed in making it to a

tenure-track position in engineering has the potential to encourage a wider range of individuals to believe that this career is within the realm of possibility for them.

Implications for International Higher Education

Although this study was conducted in the United States, there are more similarities than differences across industrialized regions. Many of the patterns seen in the United States are also seen in other Anglophone countries such as in the UK, as well as in the European Union (EU) in general. In fact, many western European countries lag behind the US in terms of the percentage of female doctoral recipients in the sciences, and the pay gap between men and women scientists is bigger in the European Union than in the United States (Shen 2013). Concern over gender equality in universities in Europe has seen considerable growth in the last few decades (Rees 2007). Statistics showing that women constituted over 50% of undergraduates but made up only 14% of professorships in the region raised alarm among policy makers in the region, resulting in a push to recruit and retain more women into institutions of higher learning, particularly within the science disciplines (Rees 2007). A similar pattern was revealed in Switzerland, with the erosion of women at the higher levels of the academic career ladder (Widmer et al. 2008). Despite the increasing numbers of women, especially at the undergraduate level in Germany, the horizontal segregation of female students into the languages, humanities, medicine, and biological sciences acts as a barrier to equality; women are still greatly underrepresented in the sciences and technical disciplines (Müller 2007). While the contexts are different, these statistics ring familiar in relation to the United States higher education context as well.

Although this study examines the career decision-making processes of engineering PhD students in the context of a large, public research institution in the United States, this has relevance for institutions of higher learning worldwide. The US has long been the destination of choice for students around the world who choose to study outside of their own country, such that many nations to conform closely to the US model for research institutions (de Wit 2001; Bok 2013). The American system has been further strengthened due to the adoption of English as the common scientific language since the mid-twentieth century, and the US dominance of the Internet (Altbach 2011). Better understanding how engineering PhD students in the US experience their graduate education, and the structural and organizational factors affecting their career decisions can lead to insights on diversifying the professoriate in engineering and perhaps other STEM disciplines in similar institutions elsewhere. Although one must be cautious in assuming that any findings have universal application, this study can lend insight as to the effects of policies promoting gender diversity in STEM, including the limitations of current efforts to feminize the STEM professoriate. Additionally, a better understanding of how engineering PhD students approach their career decisions and approach their job search at the end of their graduate programs can have implications for engineering PhD students' career development and for university career services both in the US and beyond.

Limitations and Directions for Future Research

With the advantage of hindsight, or given more time and resources, many things may have been done differently in this study. More effort could have been made to recruit a more ethnically and racially diverse sample of participants, for example, and

more individuals could have been interviewed. Students representing engineering departments at different institutions could also have been recruited, in order to examine whether some of the structural elements tied to the university in this study are really representative of a broader range of institutional contexts. Beyond tweaking this study's methodologies or expanding on its reach in terms of institutional context and sampling, however, there are some questions that emerged from this study's data that lend themselves to further inquiry.

Among the many unanswered questions in this study is a need to determine the extent to which student perceptions of the academic career path and of the academic profession match up with reality. Overall, students perceive the academic profession as highly competitive, and having high time demands and while these perceptions are true, it could be valuable to try to quantify the extent to which student perceptions match up with reality. Are students accurate in their predictions regarding how much time PIs delegate to their different tasks? Are they accurate in their estimates regarding how much a typical PI sleeps, or how much paid leave they are able to take? Quantifying some of these would allow an investigator to determine whether students are overly intimidated by the academic career or not, and whether men and women students are forming similar impressions. It is possible that students of a certain gender identity are more or less accurate in their predictions regarding the demands of the academic profession, for example.

Much more research needs to be done on the sources of information and the networks that PhD engineering students turn to for their career information. In this study, interviews created the impression that men students maintain and turn to broader and

more extensive networks of individuals with whom they have looser relationship ties. In contrast, women students seemed more likely to forge and develop deeper and more meaningful relationships with more senior individuals who they would describe as important mentors. However, it fell outside of the scope of this study to map or analyze students' networks and their networking behaviors. Research on professional networking has demonstrated that women and men have different approaches to networking, and do not benefit equally from time invested in networking activities, with men receiving greater benefit than women (Forret & Dougherty, 2004). Research has also demonstrated the importance of networking in academia, with implications for the speed of women academics' career progression (Ismail & Rasdi, 2007). Scientists with broader networks have also been shown to have an edge when it comes to important performance metrics such as securing grants, publications, awards, job offers and invitations to speak (Streeter, 2014). Based on this, an understanding of the networking practices of men and women PhD students could be helpful in understanding their early career choices, and their progression following PhD graduation.

Although this study provided a good start in bettering our understanding of gender differences in men and women engineering PhDs' career decision-making process, it has barley scratched the surface in terms of fully exploring and describing the process. Future studies could further explore and develop the three outlined steps of information gathering, crystallization of values, and narrowing down of options. More detail about how men and women students approach each of these activities, and the potential implications of gender differences in each of these steps could lead to a fuller and more

detailed understanding of career-decision making, and to the development of more targeted policy interventions.

Much more needs to be known about the individual values and dispositions of engineering PhD students, and differences between men and women with regards to these individual level characteristics, as they relate to career decision-making. Although some gender differences have been outlined in previous research on this topic, this current study has produced results that run counter to some previous findings. For example, although it has been reported that women's personal values may be more at odds with academic careers in the sciences than men's values (Gibbs et al., 2014), men engineers interviewed for this study expressed similar concerns to women regarding their desire to see more concrete impacts and benefits as a result of their work. A closer look at the values that guide career decision-making, and the gendered nature of these values would thus be helpful in refining, confirming, or negating some of these initial research findings.

There is a need to conduct longitudinal studies of PhD students as they enter the job market and continue to progress in their careers in the years immediately following the PhD. It would be relevant to understand the extent to which the plans that students formulate as they near PhD completion and enter the job market pan out, and what sorts of experiences and barriers result in individuals changing career course. For example, a majority of the students expressing an interest in pursuing academic career paths planned to pursue postdoctoral positions following PhD completion. Following these individuals as they begin their postdoctoral careers and assessing how their feelings regarding the academic career might shift as a result of postdoctoral experiences, or facing rejection on the academic job market, would be a relevant follow-up to this study. As they progress

on the academic career path, are individuals of a certain gender identity more likely to persist than others? Do candidates of a certain gender identity demonstrate more resilience in the face of rejection, and what implications does this have in the highly competitive market for stable academic employment? These questions would all be best answered by following a cohort of individuals over a few years following PhD completion.

Finally, the method of sampling employed by this study restricted its ability to explore intersectional elements of career decision-making along dimensions such as race, ethnicity, first generation status, and other underrepresented statuses in the academy. Consequently the conclusions reached in the study are incomplete. Regardless of the difficulty of recruiting diverse engineering PhD students exploring these other dimensions of social identity is a highly worthwhile research pursuit, and has implications for increasing the diversity of the professoriate in many more ways than just gender identity.

Appendices

Appendix A – Consent Forms

Student Consent Form

Project Title	
Purpose of the Study	This research is being conducted by Romina da Costa, PhD Candidate, under the supervision of her dissertation chair, Dr. Nelly Stromquist, at the University of Maryland, College Park. I am inviting you to participate in this research project because you are a graduate student (doctoral or postdoc) in a STEM (science, technology, engineering, mathematics) field who is nearing program completion. The purpose of this research project is to explore how STEM graduate students make their career decisions and choices as they near program completion, particularly their decisions about whether or not to pursue an academic career. This research also seeks to highlight gender differences in the career decisions of STEM graduate students. In exploring these issues, the researcher will inquire about students' experiences during their graduate programs, personal factors weighing on their career decisions, and experiences with organizations, mentors, peers and career services staff, etc. that may have influenced students' career choices.
Procedures	You may consent to participate in any number of activities. Participation is voluntary and you are free to withdraw from the study at any time for any reason. Procedures for each research activity are

	described below: **Interviews:** The procedures involve participation in one one-on-one interview that will take approximately 60-90 minutes to complete. During the interview you will be asked questions about your decision to pursure your current graduate program, your experiences in your program, and your perceptions regarding your own strengths, preferences and talents in your field and in your future career. You will also be asked about influences that have helped shaped your career decisions, e.g. your perceptions of academia and how these evolved, the job market (academic or otherwise) in your field, influential mentors, peers, professors, etc. and personal considerations such as marriage status, plans for family, etc. With your consent, interviews will be audio recorded for transcription and future reference. **Focus Groups:** The procedures involve participation in one gender segregated focus group that will take approximately 60-90 minutes to complete. During this focus group you will join a group totaling 7-10 graduate students in STEM who are close to program completion, and who share the same gender identity as you. The focus group will address any gendered patterns or trends uncovered by the researcher in the one-on-one interviews, and will serve as an opportunity for students to respond to, question, or add to any of these patterns and trends based on their own experiences with gender identity in their

	graduate programs and in entering the labor market. **Observations of Career Services Workshops and Events:** The procedures involve the researcher observing graduate students as they engage in normal career workshop activities. This may involve taking notes on students' concerns and questions, recording the content and scope of the workshops, and making note of what skills, knowledge, etc. regarding careers and the job search students are most anxious to learn more about.
Potential Risks and Discomforts	I anticipate little risk associated with participation in this study. In interviews and in the focus groups, you will be asked questions about your experiences in your graduate program and with your job search process, which I anticipate will not be significantly uncomfortable. You may experience some mild discomfort from the questions asked or may experience sadness or negative emotions associated with recalling certain experiences or events. Observations will be passive on the part of the researcher and will in no way be disruptive of the workshop or event activities.
Potential Benefits	There are no direct benefits from participating in this research. However, some possible benefits include the development of recommendations for future career support, and consideration of gender differences for students pursuing graduate study in STEM fields. Furthermore, students may find benefit in the opportunity to talk through and speak about their experiences in their programs and

	in the job search process.
Confidentiality	All data collected in this study is strictly confidential. All students will be given a pseudonym, and the name of the University will not appear in the write-up of the research. Any potential loss of confidentiality will be minimized by storing data on a password protected computer with an encrypted hard drive. If I write a report or article about this research project, your identity will be protected to the maximum extent possible. Your information may be shared with representatives of the University of Maryland, College Park, or governmental authorities if you or someone else is in danger, or if I am required to do so by law.
Right to Withdraw and Questions	Your participation in this research is completely voluntary. You may choose which activities you want to take part in. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify. If you decide to stop taking part in the study, if you have questions, concerns, complaints, or if you need to report an injury related to the research, please contact the investigator: Romina da Costa rcosta2@umd.edu (202) 255-5537

	Dissertation Chair: Nelly P. Stromquist 2211 Benjamin Building, College Park, MD 20742 stromqui@umd.edu (301) 405-7925
Participant Rights	If you have any questions about your rights as a research participant or wish to report a research-related injury, please contact: **University of Maryland, College Park** **Institutional Review Board Office** **1204 Marie Mount Hall** **College Park, MD 20742** **Email: irb@umd.edu** **Telephone: (301) 405-0678** This research has been reviewed according to the University of Maryland, College Park IRB procedures for research involving human subjects.
Statement of Consent	Your signature indicates that you are at least 18 years of age; you have read this consent form or have had it read to you; your questions have been answered to your satisfaction and you voluntarily agree to participate in selected activities for this research study. You will receive a copy of this signed consent form. Initial next to the activities that you voluntarily agree to participate:

	_____ Observations of graduate student career workshops and events. _____ A one-on-one interview that will last about 60-90 minutes. _____ A gender segregated focus group with a total of 7-10 graduate students in STEM disciplines. If you agree to participate in the activities above, that you initialed, please sign your name below.	
Signature and Date	**NAME OF PARTICIPANT** **(Please Print)**	
	SIGNATURE OF PARTICIPANT	
	DATE	

Appendix B – Interview Protocol

Student Interview

#	Question	Research Question/Purpose
1	To start with, please tell me a little bit about your background. Where are you from? What is your field of study? When do you expect to be finished with your program of study at UMD?	Building Rapport/Case Description
2	Tell me about your interest in pursuing a PhD (or postdoc). Possible probes: • When did you become interested? • What interested you? • Where did you become interested? • What schooling or career experiences shaped the decision to pursue a PhD? • What affective experiences (love, one interest among many, mixed, slow to warm) shaped the decision to pursue a PhD?	Building Rapport/Case Description; Background for R1, R2 and R3.
3	What were your reasons for choosing the program at MAU, and has your experience at MAU lived up to your expectations? Possible probes: • What has been your favorite class and/or research opportunity, and why? • What have been your experiences with good and bad	R2

	professors/mentors? • How would you describe the atmosphere of the program? • If you were to describe the characteristics of students in your program, what would they be? Is this you? Do you fit in?	
4	What do you regard as your strengths, talents and preferences as a graduate student in your field? Possible probes: • What skills do you find necessary for a successful academic in your field? Do you have them? • If you were to describe the academic profession in your field, what would you say? • What are the qualities that make a good academic in your field?	R1
5	(For women students only) What has been your experience as a woman in your program? Possible probes: • Do any incidents come to mind that are related to being a woman in your program, or in your field of study? • Do you have ideas about why there are so few women pursuing academic careers in your field? • Do you have any ideas about what would have to be different to attract/excite more women to pursue academic careers in your field?	R3

6	Can you tell me about your current career plans following your program completion? Possible probes: • Were there any experiences were particularly influential in choosing this course of action • What has been your experience of career preparation, resources, workshops, etc. at MAU • What experiences if any, have been most responsible for your career decision(s)? Or would you describe a more gradual development of your career trajectory? • What has been the role of influential mentors, peers, teachers/professors, etc. and what have they advised? • How have your personal interests, aptitudes/talents and aspirations shaped your career decisions? • What other considerations (e.g. job market, salary expectations, mobility, family considerations, etc.) have shaped your career decisions? • What have been your experiences with job market, recruiters, finding employment of different types?	R1 and R2
6	Looking back on your experiences in graduate school, what were some of the most important in influencing your choice to pursue/not pursue an academic career? Possible probes: • What helped the most? • What hurt the most?	R1 and R2

	• What advice would you give to a prospective graduate student interested in an academic career in your field?	
7	(For those interested in academic careers) At the present time, what are some of the obstacles you face in being successful in an academic career? Possible probes: • Do you see academia being at odds with your plans for marriage? • Your desired work/family balance? Marriage plans?	
8	(For those interested in academic careers)	
9	Is there anything we haven't discussed that you think is relevant to understanding your decision to pursue/not pursue an academic career?	R1 and R2

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